United States
Department of
Agriculture

Forest Service

General
Technical
Report WO-43

Effects of Competing Vegetation on Forest Trees:

A Bibliography with Abstracts

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A Bibliography with Abstracts

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AN INTRODUCTION TO

EFFECTS OF COMPETING VEGETATION ON FOREST TREES: A BIBLIOGRAPHY WITH ABSTRACTS

This publication contains a compilation of both published and unpublished sources of data on the effects of competing vegetation on forest trees. In addition to this printed version, the bibliography will also be available electronically and accessible through one of the commercial telecommunication information networks. Users may periodically update the printed version by accessing the data base through this network. For information on use of the electronic version, contact:

Forest Pest Management
USDA Forest Service
P.O. Box 2417
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For all references cited, the American National Standards Institute (ANSI) recommended format has been used. Different sources reporting results from the same study are cross-referenced and only the most recent or complete cited document is abstracted. Each abstract describes the study location, vegetation and site conditions, treatments used, study design, and results and conclusions. Whenever possible, study results are summarized in tabular form.

Cited documents are listed in order by a three letter, six digit identification number. The three letters indicate the USDA Forest Service staff responsible for maintenance of the bibliography--FPM for Forest Pest Management. The first two digits indicate the year the citation was added to the bibliography. The final four digits represent the order in which the citations were added to the electronic data base. For example, FPM 83-0019 is the 19th citation and was added in 1983. For the initial printed and electronic versions--citations added in 1983--the numeric order also corresponds to the alphabetical order by senior author's name. Abstracts may be retrieved through a species index and an author index. In these indexes an abbreviated identification number--the last four digits--represents the corresponding citation, e.g., -0019 for FPM 83-0019.

The species index lists abstract identification numbers by five categories: forest crop tree species, vegetation management practice, competing vegetation type, vegetation control methods used, and type of data reported in the study results. These are arranged in hierarchical fashion; that is, each category is listed as a subdivision of all those to the left on any one line in the index. The categories as listed in the subject index are described as follows:

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

1. SPECIES - All forest crop tree species included in the bibliography are listed alphabetically by common name. Scientific names are also provided for reference.

2. PRACTICE - Abstract identification numbers are listed by vegetation management practice--site preparation or release--for each crop tree species.

3. VEGETATION - Identification numbers are listed by competing vegetation type--shrubs, weed tree, or herbaceous--for each combination of crop tree species and vegetation management practice.

4. METHOD - Identification numbers are listed by vegetation control methods used--manual, herbicide, mechanical, prescribed burn (burn), or varying levels of undisturbed natural vegetation (natural)--for each combination of crop tree species, vegetation management practice, and competing vegetation type.

5. RESULTS - Identification numbers are listed by type of result reported--total height or height growth (height), total diameter or diameter growth (diameter), basal area or basal area growth (basal area), total or merchantable volume or yield (volume), stocking, or percent survival (survival).

Many citations include more than one crop tree species, practice, vegetation type, control method, or type of result reported. The abbreviated identification number is listed separately in the species index for every applicable combination of subject categories.

In the author index, authors and co-authors are listed alphabetically with abbreviated identification numbers corresponding to cited references and abstracts.

Only the electronic version of the bibliography will be updated. The newest publications may be found by accessing the current year identification numbers. Updated species and author indexes may also be obtained at the same time.

PLEASE DO NOT CITE INFORMATION FROM THE ABSTRACT. ALWAYS REFER TO THE ORIGINAL SOURCE. Obtain unpublished information directly from the author. The citation for all unpublished sources includes the author's address for this purpose.

If you have documents or can identify additional documents that should be included in this compilation, send the information to :

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Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
American basswood (_Tilia americana_)	release site preparation: -0234	herbaceous: -0234	herbicide: -0234	survival height diameter: -0234
	release site preparation: -0235	herbaceous: -0235	mechanical herbicide: -0235	survival height: -0235
balsam fir (_Abies balsamea_)	release: -0012	shrubs: -0012	manual: -0012	height: -0012
	release: -0013	weed tree: -0013	manual: -0013	height diameter basal area: -0013
	release: -0014	shrubs: -0014	manual: -0014	height: -0014
	release: -0052	weed tree: -0052	manual: -0052	diameter volume: -0052
	release: -0133	shrubs weed tree: -0133	herbicide: -0133	height volume: -0133
	release: -0163	weed tree: -0163	manual: -0163	height: -0163
	release: -0177	weed tree: -0177	manual: -0177	height diameter: -0177
	release: -0184	weed tree: -0184	manual: -0184	basal area volume: -0184
	release: -0232	shrubs: -0232	manual: -0232	height: -0232

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SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
black cherry (*Prunus serotina*)	site preparation: -0112	herbaceous: -0112	herbicide: -0112	survival: -0112
black locust (*Robinia pseudoacacia*)	release site preparation: -0234	herbaceous: -0234	herbicide: -0234	survival height diameter: -0234
	release: -0252	weed tree: -0252	manual: -0252	survival height: -0252
black oak (*Quercus velutina*)	release: -0027	weed tree: -0027	manual: -0027	survival basal area: -0027
black spruce (*Picea mariana*)	site preparation: -0043	shrubs herbaceous: -0043	mechanical: -0043	survival: -0043
	release: -0052	weed tree: -0052	manual: -0052	diameter volume: -0052
	site preparation: -0117	shrubs weed tree: -0117	burn: -0117	stocking: -0117
	site preparation: -0131	shrubs: -0131	burn manual mechanical: -0131	survival: -0131
black walnut (*Juglans nigra*)	release site preparation: -0019	herbaceous: -0019	manual herbicide: -0019	survival height: -0019
	release: -0033	herbaceous: -0033	mechanical: -0033	height diameter: -0033

SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
black walnut (*Juglans nigra*)	release: -0071	herbaceous: -0071	herbicide: -0071	height diameter: -0071
	release site preparation: -0072	herbaceous: -0072	manual mechanical herbicide: -0072	survival height diameter: -0072
	site preparation: -0229	herbaceous: -0229	herbicide: -0229	survival height diameter volume: -0229
	release: -0233	herbaceous: -0233	manual mechanical herbicide: -0233	survival height: -0233
	release site preparation: -0235	herbaceous: -0235	mechanical herbicide: -0235	survival height: -0235
	release: -0252	weed tree: -0252	manual: -0252	survival height: -0252
blackgum (*Nyssa sylvatica*)	release: -0027	weed tree: -0027	manual: -0027	survival basal area: -0027
cherrybark oak (*Quercus phellos*)	site preparation: -0161	weed tree: -0161	manual: -0161	stocking: -0161
cottonwood (*Populus deltoides*)	site preparation: -0005	herbaceous: -0005	manual mechanical: -0005	survival height: -0005
	site preparation: -0119	herbaceous: -0119	herbicide mechanical: -0119	survival height diameter: -0119

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SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
Douglas-fir (*Pseudotsuga menzeisii*)	release: -0001	herbaceous shrubs: -0001	manual herbicide: -0001	height basal area volume: -0001
	release: -0018	weed tree: -0018	natural: -0018	volume: -0018
	site preparation: -0020	herbaceous: -0020	herbicide: -0020	survival: -0020
	release: -0021	weed tree: -0021	natural: -0021	height diameter basal area stocking: -0021
	site preparation: -0049	shrubs: -0049	natural: -0049	survival height diameter: -0049
	release: -0050	weed tree herbaceous: -0050	natural: -0050	height diameter: -0050
	site preparation: -0063	herbaceous: -0063	herbicide: -0063	survival height: -0063
	site preparation: -0065	herbaceous: -0065	herbicide: -0065	survival height diameter volume: -0065
	release: -0082	shrubs: -0082	manual herbicide: -0082	height: -0082
	release: -0090	shrubs: -0090	herbicide: -0090	height: -0090
	site preparation: -0091	herbaceous: -0091	herbicide: -0091	survival: -0091

SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
Douglas-fir (Pseudotsuga menzeisii)	release: -0092	shrubs: -0092	manual herbicide: -0092	height diameter: -0092
	release: -0096	weed tree: -0096	natural herbicide: -0096	height: -0096
	release: -0104	weed tree: -0104	herbicide: -0104	height: -0104
	release: -0105	weed tree: -0105	herbicide: -0105	height: -0105
	site preparation: -0121	shrubs: -0121	manual: -0121	survival height: -0121
	release: -0130	shrubs weed tree: -0130	herbicide: -0130	height: -0130
	release: -0157	weed tree: -0157	natural: -0157	volume: -0157
	release: -0165	weed tree: -0165	natural: -0165	height: -0165
	release: -0166	shrubs: -0166	herbicide: -0166	survival height: -0166
	release: -0173	shrubs: -0173	manual herbicide: -0173	height diameter volume: -0173
	release site preparation: -0179	herbaceous: -0179	herbicide: -0179	height: -0179
	release: -0180	weed tree: -0180	herbicide: -0180	basal area: -0180

SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
Douglas-fir (Pseudotsuga menzeisii)	release: -0186	shrubs: -0186	manual herbicide: -0186	height: -0186
	release: -0193	shrubs weed tree: -0193	natural: -0193	survival height: -0193
	release: -0194	shrubs: -0194	natural: -0194	survival: -0194
	release: -0226	weed tree: -0226	natural: -0226	volume: -0226
	site preparation: -0230	shrubs: -0230	manual: -0230	survival: -0230
	release: -0259	shrubs: -0259	natural: -0259	height: -0259
	release site preparation: -0260	shrubs: -0260	natural: -0260	height: -0260
eastern redcedar (Juniperus virginiana)	release site preparation: -0160	weed tree: -0160	manual: -0160	survival height stocking: -0160
	release site preparation: -0253	weed tree: -0253	manual herbicide: -0253	survival height: -0253
eastern white pine (Pinus strobus)	release: -0029	weed tree: -0029	manual: -0029	diameter volume: -0029
	release: -0048	shrubs weed tree: -0048	natural: -0048	height: -0048
	release: -0069	weed tree: -0069	manual: -0069	height: -0069

SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
eastern white pine (*Pinus strobus*)	site preparation: -0070	herbaceous: -0070	manual herbicide: -0070	survival: -0070
	release: -0073	weed tree: -0073	natural: -0073	height basal area: -0073
	release: -0076	weed tree: -0076	manual: -0076	volume: -0076
	site preparation: -0080	weed tree: -0080	manual herbicide: -0080	height diameter: -0080
	release: -0084	weed tree: -0084	manual: -0084	survival: -0084
	release: -0116	shrubs weed tree: -0116	herbicide: -0116	height: -0116
	release: -0149	weed tree: -0149	herbicide: -0149	height diameter: -0149
	site preparation: -0152	shrubs weed tree: -0152	herbicide: -0152	survival height: -0152
	site preparation: -0176	shrubs weed tree: -0176	burn manual mechanical herbicide: -0176	height: -0176
	release: -0177	weed tree: -0177	manual: -0177	height diameter: -0177
	release: -0205	weed tree: -0205	manual: -0205	height basal area stocking: -0205

SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
eastern white pine (Pinus strobus)	release: -0212	weed tree: -0212	manual: -0212	stocking: -0212
	site preparation: -0216	weed tree: -0216	herbicide: -0216	survival height: -0216
	release site preparation: -0218	weed tree: -0218	manual mechanical: -0218	survival height: -0218
	release site preparation: -0234	herbaceous: -0234	herbicide: -0234	survival height diameter: -0234
	site preparation: -0238	shrubs: -0238	manual: -0238	survival height: -0238
	release: -0242	weed tree: -0242	manual herbicide: -0242	survival height: -0242
	release: -0244	weed tree: -0244	manual: -0244	survival height diameter: -0244
	release: -0257	weed tree: -0257	manual: -0257	survival height: -0257
Engelmann spruce (Picea engelmannii)	site preparation: -0064	herbaceous: -0064	herbicide: -0064	survival: -0064
	release site preparation: -0260	shrubs: -0260	natural: -0260	height: -0260
Fraser fir (Abies fraseri)	site preparation: -0028	herbaceous: -0028	manual herbicide: -0028	survival height: -0028

SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
giant sequoia (Sequoiadendron giganteum)	site preparation: -0207	shrubs: -0207	natural: -0207	survival height: -0207
grand fir (Abies grandis)	release: -0166	shrubs: -0166	herbicide: -0166	survival height: -0166
green ash (Fraxinus pennsylvanica)	site preparation: -0119	herbaceous: -0119	mechanical herbicide: -0119	survival height diameter: -0119
hickory (Carya spp.)	release: -0027	weed tree: -0027	manual: -0027	survival basal area: -0027
	site preparation: -0138	weed tree: -0138	herbicide: -0138	stocking: -0138
hybrid larch (Larix spp.)	site preparation: -0167	shrubs herbaceous: -0167	mechanical herbicide: -0167	height diameter: -0167
hybrid poplar (Populus spp.)	site preparation: -0204	herbaceous: -0204	herbicide: -0204	height: -0204
	release site preparation: -0235	herbaceous: -0235	mechanical herbicide: -0235	survival height: -0235
jack pine (Pinus banksiana)	site preparation: -0167	shrubs herbaceous: -0167	mechanical herbicide: -0167	height diameter: -0167
	release site preparation: -0218	weed tree: -0218	manual mechanical: -0218	survival height: -0218
Japanese larch (Larix leptolepis)	site preparation: -0204	herbaceous: -0204	herbicide: -0204	height: -0204

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SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
Jeffrey pine (Pinus jeffreyi)	site preparation: -0066	herbaceous: -0066	herbicide: -0066	survival: -0066
	release: -0120	shrubs: -0120	natural: -0120	height diamter: -0120
	release: -0187	shrubs herbaceous: -0187	natural: -0187	survival: -0187
	site preparation: -0225	herbaceous: -0225	mechanical: -0225	survival height: -0225
loblolly pine (Pinus taeda)	site preparation: -0002	weed tree: -0002	mechanical: -0002	height: -0002
	release site preparation: -0006	weed tree: -0006	burn manual herbicide: -0006	diameter basal area volume: -0006
	release: -0031	weed tree: -0031	manual: -0031	diameter basal area: -0031
	site preparation: -0034	shrubs weed tree herbaceous: -0034	mechanical: -0034	survival height diameter volume: -0034
	release: -0035	weed tree: -0035	manual herbicide: -0035	height diameter volume: -0035
	site preparation: -0036	weed tree: -0036	burn mechanical herbicide: -0036	stocking: -0036

SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
loblolly pine (Pinus taeda)	site preparation: -0038	herbaceous: -0038	mechanical: -0038	height diameter: -0038
	site preparation: -0040	weed tree herbaceous: -0040	burn mechanical herbicide: -0040	height stocking -0040
	site preparation: -0041	weed tree herbaceous: -0041	burn mechanical herbicide: -0041	height stocking: -0041
	release: -0046	weed tree: -0046	manual: -0046	stocking: -0046
	release: -0047	weed tree herbaceous: -0047	manual herbicide: -0047	height diameter volume stocking: -0047
	site preparation: -0058	shrubs weed tree: -0058	mechanical: -0058	stocking: -0058
	site preparation: -0059	herbaceous: -0059	mechanical: -0059	survival height diameter: -0059
	site preparation: -0060	herbaceous: -0060	mechanical: -0060	survival: -0060
	site preparation: -0061	shrubs weed tree: -0061	mechanical: -0061	survival height diameter basal area volume stocking: -0061

SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
loblolly pine (Pinus taeda)	release: -0062	weed tree: -0062	burn manual mechanical herbicide: -0062	diameter basal area volume: -0062
	release site preparation: -0075	weed tree herbaceous: -0075	burn manual herbicide: -0075	survival: -0075
	release: -0081	weed tree: -0081	manual: -0081	height: -0081
	site preparation: -0083	shrubs weed tree: -0083	manual mechanical herbicide: -0083	survival diameter basal area volume: -0083
	release site preparation: -0087	weed tree: -0087	natural: -0087	survival: -0087
	release: -0088	weed tree: -0088	manual herbicide: -0088	basal area volume: -0088
	release: -0089	weed tree: -0089	manual herbicide: -0089	basal area volume: -0089
	release: -0102	weed tree: -0102	herbicide: -0102	survival height: -0102
	site preparation: -0103	shrubs weed tree: -0103	mechanical herbicide: -0103	survival height diameter: -0103

SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
loblolly pine (<u>Pinus taeda</u>)	site preparation: -0106	herbaceous: -0106	mechanical: -0106	survival height diameter volume: -0106
	release site preparation: -0108	weed tree: -0108	burn mechanical: -0108	height volume: -0108
	site preparation: -0109	shrubs weed tree herbaceous: -0109	burn mechanical: -0109	survival height diameter basal area volume: -0109
	site preparation: -0113	weed tree: -0113	burn mechanical: -0113	survival height: -0113
	release: -0114	weed tree: -0114	manual herbicide: -0114	height diameter basal area: -0114
	site preparation: -0115	weed tree herbaceous: -0115	burn mechanical: -0115	height diameter volume: -0115
	release: -0122	shrubs weed tree: -0122	burn: -0122	diameter: -0122
	release: -0123	weed tree: -0123	manual herbicide: -0123	height diameter: -0123
	release site preparation: -0126	weed tree: -0126	burn manual herbicide: -0126	diameter basal area volume: -0126

SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
loblolly pine (<u>Pinus taeda</u>)	site preparation: -0128	weed tree: -0128	burn mechanical herbicide: -0128	survival height diameter volume: -0128
	site preparation: -0137	shrubs weed tree: -0137	mechanical: -0137	survival: -0137
	site preparation: -0139	herbaceous: -0139	mechanical: -0139	survival height diameter: -0139
	site preparation: -0141	weed tree: -0141	burn herbicide: -0141	diameter stocking: -0141
	release: -0144	weed tree: -0144	manual: -0144	stocking: -0144
	site preparation: -0145	herbaceous: -0145	mechanical: -0145	height diameter: -0145
	release: -0148	weed tree: -0148	burn herbicide: -0148	diameter: -0148
	site preparation: -0152	shrubs weed tree: -0152	herbicide: -0152	survival height: -0152
	release: -0158	weed tree: -0158	manual herbicide: -0158	height diameter: -0158
	site preparation: -0159	weed tree: -0159	herbicide: -0159	survival height diameter basal area -0159

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SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
loblolly pine (Pinus taeda)	release: -0164	weed tree: -0164	manual herbicide: -0164	survival height: -0164
	site preparation: -0172	weed tree: -0172	mechanical: -0172	height diameter basal area volume stocking: -0172
	release: -0182	weed tree: -0182	manual: -0182	volume: -0182
	release: -0188	weed tree: -0188	herbicide: -0188	height diameter volume: -0188
	release: -0191	weed tree: -0191	manual herbicide: -0191	survival height: -0191
	release site preparation: -0199	weed tree herbaceous: -0199	mechanical: -0199	height diameter basal area volume: -0199
	release: -0202	weed tree: -0202	manual herbicide: -0202	height: -0202
	release: -0203	weed tree: -0203	manual herbicide: -0203	height -0203
	release: -0206	weed tree: -0206	herbicide: -0206	survival: -0206
	release: -0208	weed tree: -0208	manual herbicide: -0208	survival height: -0208

SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
loblolly pine (*Pinus taeda*)	release: -0210	weed tree: -0210	manual: -0210	stocking: -0210
	site preparation: -0211	herbaceous: -0211	mechanical: -0211	survival height: -0211
	site preparation: -0221	shrubs: -0221	burn mechanical: -0221	survival height diameter: -0221
	site preparation: -0222	weed tree: -0222	burn mechanical: -0222	survival height diameter: -0222
	site preparation: -0231	shrubs herbaceous: -0231	burn mechanical: -0231	height: -0231
	release: -0245	shrubs: -0245	natural: -0245	height: -0245
	site preparation: -0247	shrubs: -0247	manual mechanical herbicide: -0247	survival diameter basal area volume: -0247
	release: -0252	weed tree: -0252	manual: -0252	survival height: -0252
	release site preparation: -0253	weed tree: -0253	manual herbicide: -0253	survival height: -0253
	release: -0254	shrubs weed tree: -0254	manual herbicide: -0254	survival height basal area: -0254

SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
loblolly pine (*Pinus taeda*)	release site preparation: -0258	weed tree: -0258	manual: -0258	survival: -0258
lodgepole pine (*Pinus contorta*)	site preparation: -0140	herbaceous: -0140	burn manual: -0140	survival: -0140
longleaf pine (*Pinus palustris*)	release: -0024	weed tree: -0024	burn: -0024	height: -0024
	release: -0025	weed tree: -0025	burn manual: -0024	diameter: -0024
	release: -0026	shrubs weed tree herbaceous: -0026	burn manual herbicide: -0026	volume: -0026
	site preparation: -0053	shrubs herbaceous: -0053	burn mechanical herbicide: -0053	survival diameter: -0053
	release: -0094	weed tree: -0094	burn: -0094	survival height: -0094
	release: -0095	shrubs weed tree herbaceous: -0095	burn: -0095	survival height: -0095
	site preparation: -0141	weed tree: -0141	burn herbicide: -0141	diameter stocking: -0141
	release: -0156	weed tree: -0156	herbicide: -0156	height volume: -0156

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SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
longleaf pine (<u>Pinus palustris</u>)	release site preparation: -0199	weed tree herbaceous: -0199	mechanical: -0199	height diameter basal area volume: -0199
	release: -0209	weed tree: -0209	manual: -0209	volume: -0209
	release: -0210	weed tree: -0210	manual: -0210	stocking: -0210
	site preparation: -0211	herbaceous: -0211	mechanical: -0211	survival height: -0211
	release: -0241	weed tree: -0241	burn herbicide: -0241	diameter: -0241
	release site preparation: -0253	weed tree: -0253	manual herbicide: -0253	survival height: -0253
noble fir (<u>Abies procera</u>)	site preparation: -0064	herbaceous: -0064	herbicide: -0064	survival: -0064
	release site preparation: -0260	shrubs: -0260	natural: -0260	height: -0260
Norway pine (<u>Pinus resinosa</u>)	release: -0029	weed tree: -0029	manual: -0029	diameter volume: -0029
	release: -0073	weed tree: -0073	natural: -0073	height basal area: -0073
Norway spruce (<u>Picea abies</u>)	site preparation: -0142	herbaceous: -0142	mechanical: -0142	survival: -0142

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SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
Norway spruce (Picea abies)	release site preparation: -0218	weed tree: -0218	manual mechanical: -0218	survival height: -0218
Nuttall oak (Quercus nuttallii)	site preparation: -0119	herbaceous: -0119	mechanical herbicide: -0119	survival height diameter: -0119
oak (Quercus spp.)	release: -0057	shrubs weed tree: -0057	manual herbicide: -0057	basal area volume: -0057
	site preparation: -0138	weed tree: -0138	herbicide: -0138	stocking: -0138
overcup oak (Quercus michauxii)	site preparation: -0161	weed tree: -0161	manual: -0161	stocking: -0161
paper birch (Betula papyrifera)	release: -0124	weed tree: -0124	manual: -0124	height diameter: -0124
pecan (Carya illinoesis)	site preparation: -0119	herbaceous: -0119	mechanical herbicide: -0119	survival height diameter: -0119
pitch pine (Pinus rigida)	release: -0242	weed tree: -0242	manual herbicide: -0242	survival height: -0242
ponderosa pine (Pinus ponderosa)	site preparation: -0003	shrubs: -0003	manual: -0003	survival height: -0003
	site preparation: -0007	shrubs herbaceous: -0007	natural herbicide: -0007	survival: -0007
	release: -0008	shrubs herbaceous: -0008	herbicide: -0008	height: -0008

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SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
ponderosa pine (<u>Pinus ponderosa</u>)	release: -0009	shrubs: -0009	manual: -0009	height diameter basal area volume: -0009
	release: -0010	shrubs: -0010	manual: -0010	height diameter basal area volume: -0010
	release: -0011	shrubs herbaceous: -0011	natural: -0011	diameter: -0011
	release: -0016	shrubs: -0016	mechanical herbicide: -0016	height: -0016
	site preparation: -0020	herbaceous: -0020	herbicide: -0020	survival: -0020
	site preparation: -0045	herbaceous: -0045	herbicide: -0045	survival height: -0045
	site preparation: -0054	herbaceous: -0054	herbicide: -0054	survival: -0054
	site preparation: -0055	herbaceous: -0055	herbicide: -0055	survival height: -0055
	release site preparation: -0056	shrubs: -0056	manual: -0056	height: -0056
	site preparation: -0063	herbaceous: -0063	herbicide: -0063	survival height: -0063

SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
ponderosa pine (Pinus ponderosa)	site preparation: -0065	herbaceous: -0065	herbicide: -0065	survival height diameter volume: -0065
	site preparation: -0066	herbaceous: -0066	herbicide: -0066	survival: -0066
	release: -0074	shrubs: -0074	manual herbicide: -0074	height diameter: -0074
	release: -0085	shrubs herbaceous: -0085	herbicide: -0085	basal area: -0085
	site preparation: -0086	weed tree: -0086	manual herbicide: -0086	survival: -0086
	site preparation: -0098	shrubs: -0098	mechanical: -0098	height: -0098
	site preparation: -0099	herbaceous: -0099	burn manual: -0099	survival: -0099
	release: -0120	shrubs: -0120	natural: -0120	height diameter: -0120
	site preparation: -0129	herbaceous: -0129	natural: -0129	volume: -0129
	release site preparation: -0150	shrubs: -0150	herbicide: -0150	height diameter volume: -0150
	release: -0151	shrubs: -0151	manual: -0151	volume: -0151

SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
ponderosa pine (Pinus ponderosa)	release: -0168	shrubs: -0168	manual: -0168	diameter: -0168
	release: -0169	shrubs: -0169	mechanical herbicide: -0169	height diameter basal area volume: -0169
	release: -0170	shrubs: -0170	manual: -0170	height diameter volume: -0170
	release: -0178	shrubs: -0178	mechanical herbicide: -0178	height diameter: -0178
	release: -0187	shrubs herbaceous: -0187	natural: -0187	survival: -0187
	site preparation: -0207	shrubs: -0207	natural: -0207	survival height: -0207
	site preparation: -0217	herbaceous: -0217	manual herbicide: -0217	survival: -0217
	site preparation: -0225	herbaceous: -0225	mechanical: -0225	survival height: -0225
	release site preparation: -0236	shrubs: -0236	natural: -0236	survival: -0236
	release site preparation: -0237	shrubs: -0237	natural: -0237	survival: -0237

SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
ponderosa pine (Pinus ponderosa)	release site preparation: -0260	shrubs: -0260	natural: -0260	height: -0260
Port-Orford-cedar (Chamaecyparis lawsoniana)	release: -0104	weed tree: -0104	herbicide: -0104	height: -0104
	release: -0105	weed tree: -0105	herbicide: -0105	height: -0105
	release: -0193	shrubs weed tree: -0193	natural: -0193	survival height: -0193
	release: -0194	shrubs: -0194	natural: -0194	survival: -0194
post oak (Quercus stellata)	release: -0027	weed tree: -0027	manual: -0027	survival basal area: -0027
quaking aspen (Populus tremuloides)	release: -0042	weed tree: -0042	natural: -0042	height diameter volume: -0042
	release: -0124	weed tree: -0124	manual: -0124	height diameter: -0124
	release: -0132	weed tree: -0132	manual herbicide: -0132	height diameter volume: -0132
	release: -0215	weed tree: -0215	manual: -0215	height diameter basal area: -0215
red oak (Quercus rubra)	release: -0192	shrubs weed tree: -0192	manual herbicide: -0192	height diameter: -0192

SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
red oak (Quercus rubra)	release site preparation: -0218	weed tree: -0218	manual mechanical: -0218	survival height: -0218
	release site preparation: -0234	herbaceous: -0234	herbicide: -0234	survival height diameter: -0234
red pine (Pinus resinosa)	release: -0017	weed tree herbaceous: -0017	manual: -0017	volume: -0017
	site preparation: -0039	herbaceous: -0039	natural: -0039	survival: -0039
	site preparation: -0044	shrubs: -0044	manual mechanical: -0044	survival: -0044
	release: -0125	herbaceous: -0125	herbicide: -0125	height diameter: -0125
	release: -0181	weed tree: -0181	manual: -0181	height: -0181
	release: -0183	weed tree: -0183	manual: -0183	volume: -0183
	release site preparation: -0218	weed tree: -0218	manual mechanical: -0218	survival height: -0218
	site preparation: -0255	shrubs herbaceous: -0255	manual mechanical: -0255	height diameter basal area volume: -0255
	site preparation: -0219	shrubs herbaceous: -0219	manual mechanical: -0219	survival: -0219

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SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
red pine (*Pinus resinosa*)	release: -0220	weed tree: -0220	manual: -0220	survival volume: -0220
	release: -0223	shrubs: -0223	natural: -0223	survival height diameter: -0223
	site preparation: -0248	herbaceous: -0248	manual: -0248	height diameter basal area volume: -0248
red spruce (*Picea rubens*)	release: -0177	weed tree: -0177	manual: -0177	height diameter: -0177
	release: -0246	weed tree: -0246	manual: -0246	height diameter basal area volume: -0246
redwood (*Sequoia sempervirens*)	release: -0022	shrubs herbaceous: -0022	manual: -0022	height: -0022
	release: -0082	shrubs: -0082	manual herbicide: -0082	height: -0082
sand pine (*Pinus clausa*)	site preparation: -0032	weed tree: -0032	burn mechanical: -0032	survival height diameter volume: -0032
Scotch pine (*Pinus sylvestris*)	release site preparation: -0218	weed tree: -0218	manual mechanical: -0218	survival height: -0218

SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
Scots pine (Pinus sylvestris)	site preparation: -0028	herbaceous: -0028	manual herbicide: -0028	survival height: -0028
Shasta red fir (Abies magnifica var. shastensis)	site preparation: -0064	herbaceous: -0064	herbicide: -0064	survival: -0064
shortleaf pine (Pinus echinata)	release: -0023	weed tree: -0023	manual herbicide: -0023	basal area: -0023
	release: -0027	weed tree: -0027	manual: -0027	survival basal area: -0027
	site preparation: -0036	weed tree: -0036	burn mechanical herbicide: -0036	stocking: -0036
	release: -0046	weed tree: -0046	manual: -0046	stocking: -0046
	release: -0068	weed tree: -0068	herbicide: -0068	diameter: -0068
	release: -0081	weed tree: -0081	manual: -0081	height: -0081
	release: -0088	weed tree: -0088	manual herbicide: -0088	basal area volume: -0088
	release: -0089	weed tree: -0089	manual herbicide: -0089	basal area volume: -0089
	release: -0100	weed tree: -0100	manual herbicide: -0100	height: -0100

SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
shortleaf pine (*Pinus echinata*)	release: -0101	weed tree: -0101	manual herbicide: -0101	height: -0101
	release: -0135	weed tree: -0135	manual: -0135	height: -0135
	release site preparation: -0136	shrubs weed tree: -0136	burn mechanical: -0136	height stocking: -0136
	site preparation: -0141	weed tree: -0141	burn herbicide: -0141	diameter stocking: -0141
	release: -0143	weed tree: -0143	manual: -0143	volume: -0143
	release: -0144	weed tree: -0144	manual: -0144	stocking: -0144
	site preparation: -0146	weed tree: -0146	burn mechanical herbicide: -0146	stocking: -0146
	release site preparation: -0160	weed tree: -0160	manual: -0160	survival height stocking: -0160
	release site preparation: -0174	weed tree: -0174	manual: -0174	height: -0174
	release: -0175	weed tree: -0175	manual herbicide: -0175	volume: -0175
	site preparation: -0176	shrubs weed tree: -0176	burn manual mechanical herbicide: -0176	height: -0176

SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
shortleaf pine (Pinus echinata)	release: -0185	weed tree: -0185	manual herbicide: -0185	volume: -0185
	release: -0189	weed tree: -0189	manual herbicide: -0189	survival height: -0189
	release: -0190	weed tree: -0190	manual herbicide: -0190	survival height: -0190
	site preparation: -0195	shrubs: -0195	mechanical: -0195	stocking: -0195
	release: -0196	weed tree: -0196	herbicide: -0196	volume: -0196
	release: -0197	weed tree: -0197	herbicide: -0197	basal area volume: -0197
	release: -0209	weed tree: -0209	manual: -0209	volume: -0209
	release: -0210	weed tree: -0210	manual: -0210	stocking: -0210
	site preparation: -0211	herbaceous: -0211	mechanical: -0211	survival -0211
	release site preparation: -0253	weed tree: -0253	manual herbicide: -0253	survival height: -0253
Sitka spruce (Picea sitchensis)	release: -0104	weed tree: -0104	herbicide: -0104	height: -0104
	release: -0105	weed tree: -0105	herbicide: -0105	height: -0105
	release: -0166	shrubs: -0166	herbicide: -0166	survival height: -0166

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SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
Sitka spruce (*Picea sitchensis*)	release: -0193	shrubs weed tree: -0193	natural: -0193	survival height: -0193
	release: -0194	shrubs: -0194	natural: -0194	survival: -0194
slash pine (*Pinus elliottii*)	release: -0004	herbaceous: -0004	manual: -0004	height diameter volume: -0004
	release: -0015	herbaceous: -0015	manual herbicide: -0015	survival height diameter volume: -0015
	site preparation: -0032	weed tree: -0032	burn mechanical: -0032	survival height diameter volume -0032
	site preparation: -0034	shrubs weed tree herbaceous: -0034	mechanical: -0034	survival height diameter volume: -0034
	site preparation: -0037	herbaceous: -0037	burn mechanical -0037	height diameter volume -0037
	site preparation: -0038	herbaceous: -0038	mechanical: -0038	height diameter: -0038
	site preparation: -0059	herbaceous: -0059	mechanical: -0059	survival height diameter: -0059

SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
slash pine (Pinus elliottii)	site preparation: -0060	herbaceous: -0060	mechanical: -0060	survival: -0060
	site preparation: -0077	herbaceous: -0077	natural: -0077	height: -0077
	site preparation: -0093	weed tree: -0093	herbicide: -0093	survival height: -0093
	site preparation: -0097	shrubs herbaceous: -0097	burn mechanical herbicide: -0097	diameter basal area volume: -0097
	site preparation: -0106	herbaceous: -0106	mechanical: -0106	survival height diameter volume: -0106
	site preparation: -0107	herbaceous: -0107	mechanical: -0107	survival height diameter: -0107
	site preparation: -0109	shrubs weed tree herbaceous: -0109	burn mechanical: -0109	survival height diameter basal area volume: -0109
	site preparation: -0110	herbaceous: -0110	burn mechanical: -0110	height: -0110
	site preparation: -0111	shrubs weed tree: -0111	mechanical: -0111	height: -0111
	release: -0127	weed tree: -0127	manual: -0127	basal area volume: -0127

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SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
slash pine (*Pinus elliottii*)	site preparation: -0134	shrubs herbaceous: -0134	burn mechanical: -0134	survival height diameter: -0134
	site preparation: -0139	herbaceous: -0139	mechanical: -0139	survival height diameter: -0139
	site preparation: -0145	herbaceous: -0145	mechanical: -0145	height diameter: -0145
	site preparation: -0147	herbaceous: -0147	burn mechanical: -0147	height diameter volume: -0147
	release: -0164	weed tree: -0164	manual herbicide: -0164	survival height: -0164
	site preparation: -0171	weed tree: -0171	burn mechanical: -0171	survival height diameter volume: -0171
	release site preparation: -0199	weed tree herbaceous: -0199	mechanical: -0199	height diameter basal area volume: -0199
	site preparation: -0201	herbaceous: -0201	burn mechanical: -0201	survival: -0201
	site preparation: -0227	herbaceous: -0227	manual: -0227	height diameter volume: -0227

SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
slash pine (Pinus elliottii)	site preparation: -0228	weed tree herbaceous: -0228	mechanical: -0228	diameter volume: -0228
	release: -0242	weed tree: -0242	manual herbicide: -0242	survival height: -0242
	release site preparation: -0253	weed tree: -0253	manual herbicide: -0253	survival height: -0253
	site preparation: -0256	herbaceous: -0256	burn mechanical: -0256	height: -0256
southern pine (Pinus spp.)	site preparation: -0138	weed tree: -0138	herbicide: -0138	stocking: -0138
	release site preparation:	weed tree: -0200	mechanical: -0200	volume: -0200
	release: -0213	weed tree: -0213	herbicide: -0213	basal area volume: -0213
spruce (Picea spp.)	release: -0133	shrubs weed tree: -0133	herbicide: -0133	height volume: -0133
	release: -0163	weed tree: -0163	manual: -0163	height: -0163
sugar maple (Acer saccharum)	release: -0233	herbaceous: -0233	manual mechanical herbicide: -0233	survival height: -0233
	release site preparation: -0234	herbaceous: -0234	herbicide: -0234	survival height diameter: -0234

SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
sugar maple (Acer saccharum)	release site preparation: -0235	herbaceous: -0235	mechanical herbicide: -0235	survival height: -0235
	release: -0243	weed tree: -0243	manual: -0243	diameter volume: -0243
sugar pine (Pinus lambertiana)	release: -0008	shrubs: -0008	herbicide: -0008	height: -0008
	site preparation: -0207	shrubs: -0207	natural: -0207	survival height: -0207
swamp chestnut (Quercus nigrat)	site preparation: -0161	weed tree: -0161	manual: -0161	stocking: -0161
sweet birch (Betula lenta)	site preparation: -0138	weed tree: -0138	herbicide: -0138	stocking: -0138
sweet pecan (Carya illinoensis)	site preparation: -0119	herbaceous: -0119	mechanical herbicide: -0119	survival height diameter: -0119
sweetgum (Liquidambar styraciflua)	release: -0030	herbaceous: -0030	mechanical: -0030	survival height: -0030
	site preparation: -0115	weed tree herbaceous: -0115	burn mechanical: -0115	height diameter volume: -0115
	site preparation: -0118	herbaceous: -0118	mechanical herbicide: -0118	height diameter: -0118
	site preparation: -0119	herbaceous: -0119	mechanical herbicide: -0119	survival height diameter: -0119

SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
sweetgum (Liquidambar styraciflua)	site preparation: -0161	weed tree: -0161	manual: -0161	stocking: -0161
sycamore (Platanus occidentalis)	release: -0030	herbaceous: -0030	mechanical: -0030	survival height: -0030
	site preparation: -0078	herbaceous: -0078	herbicide: -0078	height diameter volume: -0078
	site preparation: -0115	weed tree herbaceous: -0115	burn mechanical: -0115	height diameter volume: -0115
	site preparation: -0119		mechanical herbicide: -0119	survival height diameter: -0119
Virginia pine (Pinus virginiana)	release: -0127	weed tree: -0127	manual: -0127	basal area volume: -0127
	release: -0209	weed tree: -0209	manual: -0209	volume: -0209
	release site preparation: -0253	weed tree: -0253	manual herbicide: -0253	survival height: -0253
water oak (Quercus phellos)	site preparation: -0161	weed tree: -0161	manual: -0161	stocking: -0161
western hemlock (Tsuga heterophylla)	release: -0166	shrubs: -0166	herbicide: -0166	survival height: -0166

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SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
western hemlock (Tsuga heterophylla)	release: -0193	shrubs weed tree: -0193	natural: -0193	survival height: -0193
	release: -0224	weed tree: -0224	natural: -0224	survival height: -0224
	release site preparation: -0260	shrubs: -0260	natural: -0260	height: -0260
western redcedar (Thuja plicata)	release: -0166	shrubs: -0166	herbicide: -0166	survival -0166
	release: -0224	weed tree: -0224	natural: -0224	survival height: -0224
western white pine (Pinus monticola)	site preparation: -0064	herbaceous: -0064	herbicide: -0064	survival: -0064
	release site preparation: -0260	shrubs: -0260	natural: -0260	height: -0260
white ash (Fraxinus americana)	release: -0030	herbaceous: -0030	mechanical: -0030	survival height: -0030
	release site preparation: -0072	herbaceous: -0072	manual mechanical herbicide: -0072	survival height diameter -0072
	site preparation: -0138	weed tree: -0138	herbicide: -0138	stocking: -0138
	release: -0233	herbaceous: -0233	manual mechanical herbicide: -0233	survival height: -0233

SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
white ash (Fraxinus americana)	release site preparation: -0234	herbaceous: -0234	herbicide: -0234	survival height diameter: -0234
	release: -0252	weed tree: -0252	manual: -0252	survival height: -0252
white fir (Abies concolor)	release: -0051	shrubs: -0051	manual herbicide: -0051	height: -0051
white oak (Quercus alba)	release: -0027	weed tree: -0027	manual: -0027	survival basal area: -0027
	release: -0153	weed tree: -0153	manual: -0153	volume: -0153
	site preparation: -0176	shrubs weed tree: -0176	burn manual mechanical herbicide: -0176	height: -0176
	release: -0198	weed tree: -0198	manual: -0198	diameter basal area: -0198
	release: -0252	weed tree: -0252	manual: -0252	survival height: -0252
white spruce (Picea glauca)	release: -0012	shrubs: -0012	manual: -0012	height: -0012
	release: -0014	shrubs: -0014	manual: -0014	height: -0014
	release: -0042	weed tree: -0042	natural: -0042	height diameter volume: -0042

SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
white spruce (Picea glauca)	site preparation: -0043	shrubs herbaceous: -0043	mechanical: -0043	survival: -0043
	release: -0052	weed tree: -0052	manual: -0052	diameter volume: -0052
	release: -0067	shrubs herbaceous: -0067	natural: -0067	height: -0067
	release: -0132	weed tree: -0132	manual herbicide: -0132	height diameter volume: -0132
	site preparation: -0154	herbaceous: -0154	mechanical: -0154	survival height: -0154
	site preparation: -0155	shrubs herbaceous: -0155	burn manual mechanical: -0155	survival height volume: -0155
	site preparation: -0162	herbaceous: -0162	manual mechanical: -0162	survival height: -0162
	site preparation: -0167	shrubs herbaceous: -0167	mechanical herbicide: -0167	height diameter: -0167
	release: -0214	weed tree: -0214	manual: -0214	survival basal area volume: -0214
	release: -0215	weed tree: -0215	manual: -0215	height diameter basal area: -0215

SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
white spruce (*Picea glauca*)	release site preparation: -0218	weed tree: -0218	manual mechanical: -0218	survival height: -0218
	release: -0232	shrubs: -0232	manual: -0232	height: -0232
	release site preparation: -0234	herbaceous: -0234	herbicide: -0234	survival height diameter: -0234
	release site preparation: -0235	herbaceous: -0235	mechanical herbicide: -0235	survival height: -0235
	release: -0239	shrubs: -0239	herbicide: -0239	survival height: -0239
	site preparation: -0240	shrubs: -0240	manual mechanical: -0240	survival: -0240
	release: -0249	shrubs herbaceous: -0249	manual: -0249	height diameter volume: -0249
willow oak (*Quercus falcata* var. *pagodifolia*)	site preparation: -0161	weed tree: -0161	manual: -0161	stocking: -0161
yellow-poplar (*Liriodendron tulipifera*)	release: -0030	herbaceous: -0030	mechanical: -0030	survival height: -0030
	release site preparation: -0072	herbaceous: -0072	manual mechanical herbicide: -0072	survival height diameter: -0072

SPECIES	PRACTICE	VEGETATION	METHOD	RESULTS
yellow-poplar (*Liriodendron tulipifera*)	site preparation: -0079	herbaceous: -0079	herbicide: -0079	survival height diameter: -0079
	site preparation: -0138	weed tree: -0138	herbicide: -0138	stocking: -0138
	site preparation: -0152	shrubs weed tree: -0152	herbicide: -0152	survival height: -0152
	release: -0250	weed tree: -0250	manual: -0250	height: -0250
	release: -0251	weed tree: -0251	manual: -0251	height diameter: -0251
	release: -0252	weed tree: -0252	manual: -0252	survival height: -0252

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Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

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Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

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Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0001

Allan, G. G.; Beer, J. W.; Cousin, M. J. Growth enhancement of a juvenile conifer forest six years after application of a controlled release herbicide. International Pest Control. 20(2): 6-13; 1978.

Six treatments were applied to release Douglas-fir seedlings from deciduous brush and herbaceous vegetation in a plantation near Sedro Woolley, Washington. A controlled release formulation of 2,4-DB chemically bonded to Douglas-fir bark was applied at 0, 200, 500, 1250, and 2000 grams to a 2.5-square-foot area around each tree. This corresponded to application levels of 0, 4.1, 10.2, 25.5, and 41 pounds acid equivalent per acre for a planting density of 250 trees per acre and a treatment area of 2.5 square feet. An equal area around another set of trees was hand weeded and covered with black plastic. One third of the original seedlings were eliminated from statistical comparisons due to deer browsing and insect damage. Measurements were based on between 18 and 36 seedlings per treatment. Results 6 years after treatment are in Table 1.

The most effective level of 2,4-DB tested, 500 grams per tree, increased tree height growth by more than 15 percent and stemwood volume by 74 percent compared with untreated seedlings.

Table 1. Effect of release on Douglas-fir seedling growth after 6 years

Treatment	Equivalent rate (lb/acre)	Height (cm)	Basal area at d.b.h. (sq cm)	Stem volume (fbm/tree)
Untreated	0	472	17.5	2.28
200 g 2,4-DB	4.1	528	23.7	3.24
500 g 2,4-DB	10.2	544	28.5	3.96
1250 g 2,4-DB	25.5	513	27.1	3.60
2000 g 2,4-DB	41.0	499	22.6	3.00
Plastic mulch	---	498	23.2	3.12

Abstract: Ronald E. Stewart

FPM83-0002

Arbour, Steven J.; Ezell, Andrew W. Effect of mechanical site preparation treatments on height growth of loblolly pine in East Texas sandy soils. In: Barnett, James P., ed. Proceedings of the First Biennial Southern Silvicultural Research Conference. 1980 November 6-7; Atlanta, GA. General Technical Report SO-34. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station; 1981: 96-99.

Four 10-year-old loblolly pine plantations located within the Willis Geologic Formulation of the Upper Coastal Plain Region were used as sample sites in this study. Plantation selection criteria were: (1) plantations 10 years of age; (2) similar grade of planting stock; (3) 60 percent survival rate; (4) no severe evidence of fire, insect, or disease damage; and (5) plantation site prepared during summer or fall of 1969.

The four plantations had received either chop/burn or shear/windrow/burn site preparation and had been machine planted during the 1969-70 planting season. A total of 20 two-acre study sites, 295 feet to a side, were laid out. Within each study site 3 circular 1/20-acre sample plots were established. In addition to other data collected from each plot, two trees were selected for stem analysis to evaluate height growth. Table 1 shows tree height at 11 years.

Trees growing on the chop/burn sites averaged 7 percent taller in total height than trees on the shear/windrow/burn sites.

Table 1. Effect of mechanical site preparation on growth of loblolly pine after 11 years

Chop/Burn (feet)		Shear/Windrow/Burn (feet)	
Plantation 1	Plantation 2	Plantation 3	Plantation 4
40.1	35.1	35.8	33.9

Abstract: Larry Gross

FPM83-0003

Baker, F. S.; Korstian, Clarence F. Suitability of brush lands in the Intermountain Region for the growth of natural or planted western yellow pine forests. Technical Bulletin No. 256. Washington, D.C.: U.S. Department of Agriculture; 1931. 83 p.

Describes vegetation, climatic, temperature, soil, and soil moisture conditions in the extensive brush fields of the mountains of northern Utah, eastern Idaho, and western Wyoming. The relationship of these conditions to ponderosa pine establishment and growth are discussed and results of several planting trials on brushy sites are presented. Rooting habits and numerous autecological characteristics of important shrub species and ponderosa pine are described.

Results 7 years after planting 100 2-1 ponderosa pine transplants each on a cleared and uncleared sagebrush flat in Ephraim Canyon, Manti National Forest, Utah are recorded in Table 1.

Table 1. Effect of site condition on survival rate and growth of ponderosa pine over a 7-year period

	Survival (%)	Average annual height growth (in/yr)
Uncleared sagebrush	19	2.43
Cleared sagebrush	39	10.19

Abstract: Ronald E. Stewart

FPM83-0004
Baker, James B. Intensive cultural practices increase growth of juvenile slash pine in Florida sandhills. Forest Science. 19(3): 197-202; 1973.

A study was installed on a typical sandhill site on Lakeland sand soil in Calhoun County, Florida, in 1966. The sandhill soils are excessively drained and are inherently droughty and low in available nutrients, especially N and P. In preparation for planting, the area was chopped with a duplex brush cutter in the fall of 1962 and 1964. In the fall of 1965, it was disk-harrowed to establish uniform conditions. Twenty-five 1-0 slash pine seedlings each were planted on 0.004-hectare plots receiving the following fertilization, irrigation, and weed control treatments, applied singly and in factorial combination: (1) control--no treatment; (2) fertilization with superphosate and ammonium nitrate; (3) irrigation for 5 years with at least 2.5 centimeters of water per week during the growing season either from rainfall or from a sprinkler; (4) weed control--periodic weeding each year for 5 years using a weeding hoe; (5) fertilizer plus irrigation; (6) fertilizer plus weed control; (7) irrigation plus weed control; and (8) fertilizer, irrigation, and weed control. Treatments were replicated four times in a randomized complete block design. Tree heights and diameters were measured on the nine interior trees of each plot.

Five-year height growth by treatment is shown graphically and height, diameter, and volume for untreated and single, combined, or complete treatments are shown in a table. All cultural treatments were responsible for significant annual increases in height growth. After 5 years, mean tree heights ranged from 1.7 meters for control trees to 2.5, 2.9, and 3.6 meters for trees receiving a single, combined, or complete treatment. Both fertilization and irrigation increased growth of the first flush only through the third year. Failure of fourth- and fifth-year response to weed control was probably due to natural reduction in herbaceous competition on all plots with advancing crown closure. All three treatments, especially when combined, resulted in increased growth of late flushes through the third year; fertilization and weed control also affected elongation of late flushes during the fourth year.

Tree diameter was increased by single and factorially combined treatments. Any single treatment or any two combined treatments resulted in one-fold increases in diameter over the control, while the combination of all three treatments produced a two-fold increase. Fertilization, alone or in combination, was responsible for the greatest increases. Tree volume was also affected by all treatments. Irrigation and fertilization had about equal influence. However, single, combined, and complete treatments resulted in one-, two-, and three-fold increases in volume over the control after 5 years.

Abstract: Ronald E. Stewart

FPM83-0005
Baker, James B.; Blackmon, B. G. Summer fallowing improves survival and growth of cottonwood on old fields. U.S. Forest Service Research Note SO-149. New Orleans, LA: U.S. Department Agriculture, Forest Service, Southern Forest Experiment Station; 1973. 3 p.

This study was established in Sharkey County, Mississippi to test several soil management techniques for rejuvenating old fields for cottonwood production. Soil management techniques applied prior to planting cottonwood cuttings included separate and combined treatments of cover cropping, deep plowing, summer fallowing plus herbicide, and control.

Treatments were replicated three times in a randomized complete-block design. Plots were 30 by 800 feet. All plots were disked in January 1971 prior to planting and were periodically cultivated during the first growing season.

In an exploratory trial 1 year prior to the main study, an adjacent area was deep-plowed with a disk panplow and a bullhead plow. Summer fallowing with and without deep plowing was also tested. No herbicides were used in this trial.

The main study showed that fallowing during the summer prior to planting and applying herbicides improved first-year survival and growth. Table 1 relates first-year height and survival to soil management treatments. In the exploratory trial trees on summer-fallowed plots were taller than trees on unfallowed plots. Table 2 relates second-year height and survival to deep plowing and summer fallowing.

Table 1. Effect of soil management on survival and height growth of cottonwood in the first growing season

Treatment	Height (feet)	Survival (percent)
No fallow or herbicide		
Control	6.0	68
Cover crop	7.1	62
Deep plow	7.2	73
Cover crop + deep plow	7.7	66
Mean	7.0	67
Summer fallow and herbicide	9.4	84
Cover crop	9.6	86
+ Deep plow	9.8	85
+ Cover crop + deep plow	10.0	85
Mean	9.7	85

Table 2. Effect of plowing and fallowing on survival and height growth of cottonwood in the second year

Treatment	Height (feet)	Survival (percent)
No summer fallow		
Disk panplow	18.3	80
Bullhead plow	17.7	67
Mean	18.0	74
Summer fallow	22.7	70
+ Disk panplow	22.7	78
+ Bullhead plow	22.3	65
Mean	22.6	71

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0006
Balmer, William E.; Utz, Keith A.; Langdon, O. Gordon. Financial returns from cultural work in natural loblolly pine stands. Southern Journal of Applied Forestry. 2(4): 111-117; 1978.

See: Langdon, O. Gordon; Trousdell, Kenneth B., 1974.

Yields from ascending levels of cultural treatment of naturally regenerated loblolly pine were compared on 90 areas in Virginia and North Carolina. In the first study, six 37-acre replications of three treatments were compared: (1) control burn before harvest only; (2) control burn before harvest and control of large hardwoods (above 5 inches d.b.h.) by chemical frill after harvest; and (3) control burn before harvest, control of large hardwoods by cutting after harvest, and precommercial thinning at age 6. Results on 90 randomly selected plots from site index 95 are in Table 1.

Control of large hardwoods doubled pine yields at age 20. Addition of precommercial thinning tripled yields compared with plots where hardwoods were not controlled. The relationship of hardwood basal area at age 10 and merchantible loblolly pine cubic foot yield at age 20 was: log (yield) = 3.800840 - 0.532998 (log BA) with a correlation coefficient of 0.75.

A second study established on 24 plots at age 7 to 8 in four of the precommercially thinned compartments included control of density and all small understory hardwoods by broadcast spray and chemical frill. Results at age 20 appear in Table 2.

Control of large hardwoods alone doubled pine production and increased financial returns more than 200 percent. Additional treatments, such as precommerical thinning and control of small hardwoods, tripled pine production above levels with no treatments and increased financial returns four to six times. The most dramatic increase occurred when the pine component was precommercially thinned and all hardwoods controlled at an early age. This more than doubled the financial returns from all the preceeding steps.

Table 1. Merchantable loblolly yield by method of cultural treatment

	Merchantable yield (cu ft/acre) Age 10	Age 15	Age 20	MAI (cu ft/ acre/yr)	Average d.b.h. (inches)	Total basal area (sq ft/ acre)
Hardwoods not controlled	10	290	848	42	4.8	63
Large hardwoods controlled	70	782	1,776	88	5.7	111
Pine precommercially thinned	120	1,198	2,554	128	6.7	131

Table 2. Merchantable yield at age 20 with stand density and understory hardwood controls

Pine basal area level (sq ft)	Understory not controlled (cu ft/acre)	Understory controlled (cu ft/acre)	Yield increase (cu ft/acre)	Percent increase (%)
60	1,978	2,390	412	21
80	2,351	2,816	465	20
100	2,590	3,037	447	17

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0007
Baron, Frank J. Effects of different grasses on ponderosa pine seedling establishment. Research Note No. 199. Berkeley, CA: U.S. Department Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station; 1962. 8 p.

In September 1957, several thousand acres of old brush, growing on sites formerly covered pine stands, were severely burned in Siskiyou County, California. The intense fire consumed all the aerial parts of the vegetation and most organic matter in the topsoil. Rehabilitation was planned to restore timber production and grazing and to reduce the threat of erosion. An experiment was designed to test various combinations of planting trees and tree seeds among each of eight species of grass.

In April 1958, the following grasses were all sown individually on 240 plots (33 x 66 feet): big bluegrass, hard fescue, pubescent wheatgrass, red top, orchard grass, perennial ryegrass, tall oat grass, and timothy. An additional 30 plots, not sown to grass, served as controls. In each of 3 years, beginning in 1958, 2-0 ponderosa pine were planted on 45 plots and ponderosa pine seeds were spot-seeded on an additional 45 plots. Brush resprouted profusely over the whole area: cover was 40 percent snowbrush, 20 percent willow, 20 percent bitter cherry, and 20 percent chinkapin. Therefore, the 1959 and 1960 pine plantings were made on split plots and 2,4-D was sprayed on brush plants in one of each pair of subplots during mid-June of 1959 and 1960.

Four grass species (Group B) were especially good competitors: tall oatgrass, timothy, perennial ryegrass, and orchard grass. The other four species (Group A) provided less competition.

Tree survival and seed-spot stocking in October 1960, from five blocks each are shown in Table 1.

The effect of brush control and grass upon planted tree survival and seed-spot stocking after one growing season (1959 planting) are shown in Table 2.

On a hard burn, ponderosa pines were established successfully when planted or direct-seeded simultaneously with grass sown the first year after the burn. New pine plantings in the second and third years after fire were progressively poorer, and seedspots failed. In first-year plantings, pine establishment was not seriously impeded by four species of grass, but was impeded by four other species. In second- and third-year plantings, the harmful effect of grasses became apparent for all eight species. Tree survival was somewhat better where brush regrowth was sprayed with 2,4-D, but not as good as on plots planted immediately after the fire.

Table 1. Effect of grass on survival of ponderosa pine seedlings and spot-seeds as measured in October, 1960

Grass species	1958 Planting Planted trees	1958 Planting Seed-spots	1959 Planting Planted trees	1959 Planting Seed-spots	1960 Planting Planted trees	1960 Planting Seed-spots
	Survival rate (percent)					
Group A	66	51	27	1	6	0
Group B	44	40	15	0	7	1
Control	57	69	68	14	26	8

Table 2. Effect of brush control and grass on survival of ponderosa pine seedlings and spot-seeds after one growing season

Plantation	Brush treatment	Control	Group A	Group B
		Survival rate (percent)		
Planted trees	Unsprayed	31	12	13
	Sprayed	42	17	7
Seed-spots	Unsprayed	10	0	0
	Sprayed	18	1	0

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation of forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0008
Baron, Frank J.; Stark, N.; Schubert, Gilbert H. Effects of season and rate of application of 2,4-D and 2,4,5-T on pine seedlings and mountain whitethorn in California. Journal of Forestry. 62(7): 472-474; 1964.

Intermingled sugar and ponderosa pine and mountain whitethorn on the Stanislaus-Tuolumne Experimental Forest near Sonora, California were treated with foliage sprays of 2,4-D or 2,4,5-T to test season of application, concentration applied to individual pines growing in brush, and spray dosage applied on an area basis. Five trees each were treated with 200 parts per million of 2,4-D and 2,4,5-T at monthly intervals between April and September. Growth of treated sugar pines was compared with 10 untreated trees and 10 trees released by mechanically removing the brush and root crowns. Five trees each were treated with 50, 100, 200, 400, and 600 parts per million of 2,4-D or 2,4,5-T in September in the concentration study. Ten unsprayed tree-brush clumps served as controls. Finally, six 1/10-acre plots were sprayed with 2,4,5-T at 0, 1/4, 1/2, 1, 2, and 4 pounds in 50 gallons of water per acre. The 2,4-D treatments were less effective on mountain whitethorn and severely damaged the intermingled pines. Sprays containing 2,4,5-T applied before August or at concentrations above 200 parts per million were also damaging. Results 2 or 3 years after spraying the most effective treatments are in Table 1.

Sugar pine height growth exceeded that of the untreated controls following an August or September application of 2,4,5-T. Pines released with 2,4,5-T in September also grew more rapidly than trees released mechanically. Height growth of sugar pines also increased following broadcast sprays of 2,4,5-T at dosages up to 1 pound per acre.

Table 1. Effect of season and rate of application of brush controls on reproduction of ponderosa pine over a 3-year period

Method of control	3-yr height growth (percent of control) Sugar pine
Untreated	100
2,4,5-T:	
100 p/m September	105
200 p/m August	113
200 p/m September	143
Mechanical	100

2,4,5-T application (pounds per acre)	2-yr height growth and survival rate (percent of control)			
	Sugar Pine		Ponderosa	
	Height	Survival	Height	Survival
0	29	100	28	100
1/4	33	100	48	100
1/2	33	97	31	100
1	37	96	--	--

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0009

Barrett, James W. Ponderosa pine saplings respond to control of spacing and understory vegetation. USDA Forest Service Research Paper PNW-106. Portland, OR: U.S. Department Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1970. 16 p.

See: Barrett, James W., 1973.

FPM83-0010

Barrett, James W. Latest results from the Pringle Falls ponderosa pine spacing study. USDA Forest Service Research Note PNW-209. Portland, OR: U.S. Department Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1973. 21 p.

See: Barrett, James W., 1970.

Six replications each of 0.192-acre plots were thinned to spacings of 6.6, 9.3, 13.2, 18.7, and 26.4 feet in 40- to 70-year-old sapling ponderosa pine that had developed under an old-growth overstory of about 20 trees per acre. Understory vegetation was removed on three of the six replications for each treatment. Tree and vegetation measurements were made every 4 years for 12 years. Results after 12 years are in Table 1.

Logging old-growth ponderosa pine carefully, thinning the understory saplings, and controlling the brushy understory vegetation appear to have distinct advantages over clearcutting and planting. Possibly 10 years of stand growth may be saved by treating the brush early in the rotation.

Table 1. Response of ponderosa pine to control of spacing and understory over a 12-year period

	Trees per acre				
	1000	500	250	125	62
Untreated					
Diameter (in)	3.7	4.1	4.9	6.0	6.3
Basal area (sq ft)	73.7	46.6	32.8	24.7	13.6
Height (ft)	16.5	15.9	17.6	21.0	21.0
Net yield (cu ft /acre)	654.0	381.0	291.0	241.0	127.0
Treated					
Diameter (in)	3.7	4.5	5.8	7.3	8.4
Basal area (sq ft)	74.1	55.7	45.3	36.7	24.1
Height (ft)	15.1	17.0	20.7	25.1	25.0
Net yield (cu ft /acre)	602.0	459.0	426.0	403.0	255.0

Abstract: Ronald E. Stewart

FPM83-0011
Barrett, James W. Silviculture of ponderosa pine in the Pacific Northwest. USDA Forest Service General Technical Report PNW-97. Portland, OR: U.S. Department Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1979. p. 66-69.

Presents the results from an unpublished report, "An informal study of free-growing ponderosa pine trees", by Walter G. Dahms and Roy R. Silen, U. S. Department of Agriculture, Forest Service Program Representative, Pacific Northwest Forest and Range Experiment Station, Silviculture Laboratory, Bend, OR. After excurating roots of ponderosa pine near Bend, Oregon, the original authors concluded that roots might overlap slightly from two trees 80 feet apart, but set this distance as the criterion for selecting 20 free-growing trees. Trees ranged from 5 to 20 inches d.b.h. and from 19 to 36 years old. All trees averaged 4.9 inches of diameter growth during the previous decade. Trees with no competitive ground cover averaged 6.5 inches of growth per decade while those completely surrounded by understory vegetation grew only 3 inches. The relationship of 10-year diameter growth of free-growing trees to percent of ground covered by brush, grass, and other herbs was:

$$y \text{ inches} = 6.55 - 0.0352\, x \text{ (percent)}$$

The correlation coefficient, r squared was 0.62.

The authors concluded that the potential for diameter growth had been grossly underestimated and much wider spacing should be tested.

Abstract: Ronald E. Stewart

FPM83-0012

Baskerville, G. L. Softwoods respond to weeding. Pulp and Paper Magazine of Canada. 60(8): 140, 144; 1959.

See: Baskerville, G. L., 1961, also Vincent, A. B., 1954.

FPM83-0013
Baskerville, G. L. Development of immature balsam fir following crown release. Forest Research Division Technical Note No. 101. Ottawa, Canada: Canada Department Forestry, Forest Research Division; 1961. 15 p.

A study to determine the effects of crown release on the subsequent growth of selected balsam fir was established on the Green River Watershed in Northwestern New Brunswick.

The stand is 10 acres of 40- to 50-year old balsam fir with some white and black spruce with a density of about 2500 stems per acre. The experimental design included 120 immature balsam fir chosen in 30 groups of four trees. Ten groups consisted of trees in the 3 inch diameter class, ten groups comprised 4 inch trees, and ten comprised 5 inch trees. Treatments were assigned randomly to the four trees within each group as follows: (1) crown release of 1 to 3 feet, (2) crown release of 3 to 5 feet, (3) crown release of 5 to 7 feet, and (4) unreleased controls.

The treatments led to increased basal area growth, but the degree of release had relatively little influence on the rate.

Change in d.b.h., basal area, and total height for the first 5 years after treatment is shown in Table 1.

Table 1. Effect of crown release on growth of balsam fir over a 5-year period

Treatment		D.b.h. (in)	Basal area (sq ft)	Total height (ft)
Untreated		0.3	0.015	2.6
Crown release -	1 to 3 ft	0.3	0.016	2.2
-	3 to 5 ft	0.3	0.020	2.5
-	5 to 7 ft	0.4	0.022	2.3

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation of forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0014

Baskerville, G. L. Response of young fir and spruce to release from shrub competition. Forest Research Division Technical Note No. 98. Ottawa, Canada: Canada Department of Forestry; 1961. 14 p.

See: Baskerville, G. L., 1959; Vincent, A. B., 1954.

In 1949, all softwood reproduction on a 1-acre plot at Green River, New Brunswick, was released by removing shrubs within 3 feet of each stem. An untreated plot was observed as a control. For each stem, annual height growth was recorded for the 9 years following release; measurements were based on 728 balsam fir and white spruce on the treated plot and 1,422 on the untreated. Mountain maple was the dominant shrub species before treatment but raspberry rapidly invaded openings after cutting. Average annual height growth for the 9 years following treatment is in Table 1.

Four years after release the shrubs had closed in on the conifers and were denser than before treatment. Despite this competition, the rate of height growth on released fir increased steadily for 4 years following release before stabilizing at a level several times greater than on the controls. Spruce height growth increased steadily over the period. There is no indication of the increased growth rates falling back towards the level of the controls. Balsam fir responded more rapidly to release than did spruce, with the most rapid response on stems between 1 and 4 feet high for fir and between 3 and 4 feet for spruce.

Table 1. Average annual height growth over nine years for treated and untreated firs

	Average annual height growth (ft)	
	Balsam fir	White spruce
Untreated	0.14	0.23
Treated	0.59	0.74
Ratio of treated to untreated	4.2	3.2

Abstract: Ronald E. Stewart

FPM83-0015

Bengtson, G. W.; Smart, G. C., Jr. Slash pine growth and response to fertilizer after application of pesticides to the planting site. Forest Science. 27(3): 487-502; 1981.

Two experiments carried out successively on a west-central Florida Sandhills site in Citrus County near Holder, Florida, evaluated effects of various means of temporary weed and nematode control on growth and response to fertilizer of planted 1-0 slash pine. The first experiment was installed in 1964 using a randomized block design with three blocks of 18 treatments each -- three fertilizer and six weed control-cover crop treatments (a 3 x 6 factorial) -- applied to 24 x 36 meter plots containing 8 rows of 20 trees each. The effects of natural weed vegetation (control) and four methods of clean weeding (methyl bromide, simazine, diuron, and hand removal) were comprised of three fertilizer regimes. A total of 48 trees were observed on each control plot and 40 trees on each treated plot.

The second experiment compared fertilizer effects on four fumigation treatments and on untreated control. A randomized block design with three blocks was employed. The four treatments - strip or whole plot treatments of D-D, a nematocide, and Vorlex, an herbicide-nematocide-and control were randomly assigned to one of five 15 x 112 meter main plots in each block. Seedlings were planted about 6 weeks after fumigation and the main plots were then subdivided into four 15 x 28 meter subplots. Phorate, a systemic insecticide, and NKMgS fertilizer in a 2 x 2 factorial were randomly applied to the subplots within each fumigation treatment and control.

Results of the clean weeding experiment 2 and 13 years after planting are in Table 1. Results of the fumigation study 2 and 11 years after planting are in Table 2.

Seedlings grew strikingly and persistently better in soil fumigated with methyl bromide before planting, showing increases of 29 percent in height and 134 percent in stemwood volume per hectare over untreated controls after 13 years. Trees in simazine and hand weeding treatments produced somewhat less growth but substantially more than those in unweeded plots (an 18 percent increase in height and 40 percent increase in stemwood volume per hectare for simazine and 10 percent increase in height and 26 percent increase in volume for hand weeding). Soil fumigation with Vorlex, an herbicide-nematocide, produced better growth than with D-D, and fumigation was better than no treatment. Whole-plot fumigation was better than fumigation in 1.5 meter wide strips centered on the row of trees. Stemwood volume per hectare increases were 0 percent for D-D in strips, 21 percent for D-D broadcast over the plot, 43 percent for Vorlex in strips, and 96 percent for Vorlex broadcast compared with untreated plots after 11 growing seasons.

Table 1. Effect of weed and nematode control on survival rate and growth of slash pine over a 13-year period

	Survival rate and growth						
	After 2 years		After 13 years				
	Survival	Hgt.	Survival	Hgt.	D.b.h.	Stemwood	
Treatment	(%)	(m)	(%)	(m)	(cm)	(cu m/tree)	(cu m/ha)
Simazine	81	0.82	80	9.8	11.2	0.036	58.6
Diuron	30	0.77	--	--	--	--	--
Hand weeding	76	0.73	74	9.1	11.2	0.035	52.7
Methyl bromide	80	1.34	79	10.7	14.0	0.064	98.2
Untreated	91	0.50	81	8.3	9.9	0.025	41.8

Table 2. Effect of fertilizer and fumigation treatments on survival rate and growth of slash pine over an 11-year period

	Survival rate and growth						
	After 2 years		After 11 years				
						Stemwood	
	Survival	Hgt.	Survival	Hgt.	D.b.h.	(cu m/	(cu m/
Treatment	(%)	(m)	(%)	(m)	(cm)	tree)	ha)
D-D, in strips	73	0.53	72	7.4	10.2	0.026	42.9
D-D, whole plot	84	0.62	82	7.9	10.5	0.028	51.6
Vorlex, in strips	82	0.71	82	8.3	11.2	0.033	61.1
Vorlex, whole plot	86	0.84	85	9.1	12.5	0.044	83.6
Untreated	76	0.52	71	7.3	10.0	0.025	42.7

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation of forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0016
Bentley, Jay R.; Carpenter, Stanley B.; Blakeman, David A. Early brush control promotes growth of ponderosa pine planted on bulldozed site. USDA Forest Service Research Note PSW-238. Berkeley, CA: U.S. Department Agriculture, Forest Service, Pacifc Southwest Forest and Range Experiment Station; 1971. 6 p.

Seedling 2-0 ponderosa pine were planted the spring following bulldozing of a dense stand of native brush at Mount Shasta, California. Forty-five plots, 66 x 132 feet, were sprayed the same year or 1 year after planting with various treatments and then 2 years after planting with 4 pound acid equivalent per acre 2,4,5-T to control greenleaf manzanita and snowbrush seedlings and Sierra plum and bush chinkapin sprouts. On 10 plots, brush was not sprayed.

Brush seedlings did not noticeably affect growth of the small pine seedlings during the first 2 years after planting on the cleanly bulldozed area. After the third season, however, vigor of the pines was obviously reduced by brush competition in the unsprayed plots. Reduced growth of pines in unsprayed plots became more apparent each year. On sprayed plots having an average brush crown volume less than 10,000 cubic feet per acre 5 years after clearing, pines averaged 35 inches tall. Pines averaged only 20 to 28 inches tall on plots having more than 20,000 cubic feet per acre of brush. The 5-year level of brush control had continuing marked effects on growth of pines during their 7th year. Levels of brush control producing less than 5000 cubic feet of brush per acre at age 5 years were beneficial for growth of young pines. Table 1 shows heights after 5 and 7 years.

Table 1. Effect of early brush control on growth of ponderosa pine

	Brush crown volume index (1000 cu ft/acre)				
	2	8	14	24	40
Height at age 5 (in)	34	34	30	26	20
Height at age 7 (in)	62	59	50	40	30

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0017

Benzie, John W. Manager's handbook for red pine in the north central states. U.S. Department of Agriculture Forest Service General Technical Report NC-33. St. Paul, MN: U.S. Department Agriculture, Forest Service, North Central Forest Experiment Station; 1977. 22 p.

Presents a graph based on results from an unpublished study by J. Cooley, USDA Forest Service, North Central Forest Experiment Station, Grand Rapids, MN. The study examined the relationship of hardwood overstory basal area on the growth of red pine from release studies in nine plantations ranging from 2 to 40 years old on medium to good sites in lower Michigan. Overstory densities varied from 25 to 70 square feet per acre, and based on trends in the data, the graphs are extrapolated to a free-growing condition. Height, diameter, and volume growth as a percent of growth in full sunlight is shown in relation to hardwood overstory basal area. The values in Table 1 were obtained from the graph.

Table 1. Relation of hardwood overstory to expected harvest yield

Hardwood overstory (sq ft/acre)	Expected harvest yield as a proportion of normal yield (percent)
0	100
10	70
20	47
30	27
40	13
50	4
60	1

Abstract: Ronald E. Stewart

FPM83-0018

Berntsen, Carl M. Growth and development of red alder compared with conifers in 30-year-old stands. USDA Forest Service Research Paper PNW-38. Portland, OR: U.S. Department Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1961. 20 p.

See: Miller, Richard E; Murray, Marshall D., 1978; also Tarrant, Robert F., 1961.

FPM83-0019

Bey, Calvin F.; Krajicek, John E.; Williams, Robert D.; Phares, Robert E. Weed control in hardwood plantations. Herbicides in forestry. Proceedings John S. Wright Forestry Conference; Purdue Univ., West Lafayette, IN. West Lafayette, IN: Purdue University; 1975: 69-84.

Paper summarizes the results of several weed control studies conducted by others in the north central region. Results of original research by the authors, mostly with black walnut, are also presented to answer questions about what weed control method to use, how much weed control is necessary, is ground preparation necessary, and how many years of control are needed. Results of original research are summarized below.

First-year height and survival of white ash on three sites in southern Illinois and Indiana with several chemical and cultivation treatments on prepared and unprepared ground are shown in Table 1.

All three herbicides (simazine, dymid, and tandex) caused damage to white ash. Trees recovered after treatment with simazine and dymid, but not after treatment with tandex.

Growth and survival of black walnut in Indiana after 8 years are shown in Table 2.

In this study, cultivation was delayed until weeds were quite dense. In other studies where no weeds were allowed to grow in the cultivated sites, trees in chemically treated plots were no larger than those in cultivated plots.

Bar graphs and line graphs showing heights of white ash and black walnut after various weed control treatments were applied are also presented. These graphs show dramatic increases in height due to weed control.

Table 1. Effect of weed control on first year survival and height growth of white ash

Treatment	Survival (%)	Height (ft)
Plowed and disked:		
Cultivation	100	1.7
3 lb/acre simazine	90	1.3
4 lb/acre simazine	81	1.4
4 lb/acre dymid	99	1.3
5 lb/acre dymid	99	1.4
3 lb/acre tandex	34	1.5
4 lb/acre tandex	33	1.3
Untreated	95	1.2
No site preparation:		
8.5 lb/acre dalapon	99	1.2
8.5 lb/acre dalapon + 3 lb/acre simazine	91	1.2
8.5 lb/acre dalapon + 4 lb/acre simazine	93	1.2
8.5 lb/acre dalapon + 4 lb/acre dymid	99	1.2
8.5 lb/acre dalapon + 5 lb/acre dymid	99	1.2
8.5 lb/acre dalapon + 3 lb/acre tandex	37	1.2
8.5 lb/acre dalapon + 4 lb/acre tandex	25	1.2
Untreated	93	1.0

Table 2. Effect of weed control on survival rate and growth of black walnut after 8 years

Treatment	Survival (%)	Height (ft)	Diameter (in)
4 lb/acre simazine, 1 yr	91	13.8	2.2
, 2 yr	97	14.2	2.4
, 3 yr	96	16.9	3.0
4 lb/acre atrazine, 1 yr	93	11.8	1.7
, 2 yr	93	13.0	2.1
, 3 yr	83	15.1	2.6
Cultivation, 1 yr	73	8.9	1.3
, 2 yr	88	10.5	1.6
, 3 yr	81	13.7	2.3

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation of forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0020
Bickford, M. L.; Zavitkovski, J.; Newton, M. Atrazine improves survival of Douglas-fir seedlings and ponderosa pine seed spots. In: Research progress report. Western weed control conference; 1965 March 17-19; Albuquerque, NM. Reno, NV: Western Weed Science Society; 1965: 48-49.

A study was installed on a gentle south slope with a high clay soil on a site near Corvallis, Oregon, to test the suitability of atrazine for use with coniferous seedlings and seed spots. Three rates of atrazine--5, 3-1/3, and 1-2/3 pounds per acre--were applied in March. Douglas-fir 2-0 seedlings were planted on five dates ranging from November to March on all plots. Douglas-fir and ponderosa pine seed spots were randomly placed in each plot, with four spots of each species and five seeds to a spot. Seeds were sown on April 30.

Table 1 shows results at the end of the first growing season.

Survival was doubled on plots where 1-2/3 pounds per acre atrazine was applied, and increased to nearly five times the survival obtained on untreated plots, where 3-1/3 pounds per acre were applied. Growth of both roots and tops clearly was increased in the chemically treated plots.

Table 1. Effect of atrazine on survival rate of Douglas-fir seedlings and ponderosa pine seed spots after one growing season

	Survival by rate of atrazine application (percent)			
Seedling or seed spot	0 lb/ acre	1-2/3 lb/ acre	3-1/3 lb/ acre	5 lb/ acre
Douglas-fir seedlings	13.0	27.0	62.0	60.0
Ponderosa pine seed spots	0.0	3.3	36.7	41.7
Stocked 5-seed spots, pine	0.0	16.7	83.3	83.3

Abstract: Larry Gross

FPM83-0021

Binkley, Dan; Lousier, J. Daniel; Bradley, A. J. Douglas-fir growth and nutrition as affected by Sitka and red alder. Unpublished manuscript submitted to Forest Science, on file. Corvallis, OR: Oregon State University, Department of Forestry Science; 1981.

Growth and nutrition of crop trees in a 22-year-old Douglas-fir plantation were evaluated at three adjacent sites, one with Sitka alder, one with red alder, and one without alder on Mt. Benson near Nanaimo, British Columbia. Average stand age for all species was 15 to 17 years in 1979. The Sitka alder (average basal area, 10.6 square meters per hectare) formed a dense, closed canopy at 6 meters with all Douglas-fir crop trees extending above. The red alder (average basal area, 13.9 square meters per hectare) also formed a closed canopy and were typically dominant or codominant with the Douglas-fir. In the pure Douglas-fir stand, the canopy was open and salal formed a dense understory. Total height, d.b.h., sapwood width, and previous 5-year height and radial increments for the 10 largest Douglas-firs (where present) were measured on 10 randomly located 0.01-hectare plots in each site. Table 1 shows the results.

The presence of Sitka or red alder did not significantly affect Douglas-fir stocking level, basal area, and average diameter or height. Although means for the red alder site were generally lower, the differences were not significant. However, Douglas-fir on the alder sites were significantly taller for a given diameter than those on the no alder site.

The presence of alders significantly affected various growth parameters for Douglas-firs during the previous 5-year period. Height growth decreased on the red alder site, but Douglas-fir height and basal area increments were best on the Sitka alder site. A given diameter class of Douglas-firs on the Sitka alder site averaged 14 percent greater height growth than the same diameter trees on the other two sites.

Table 1. Effect of Sitka and red alder on Douglas-fir growth and nutrition

Growth trait	Occurance of alder No alder	Sitka alder	Red alder
Stocking (crop trees/ha)	700.0	720.0	620.0
Basal area (sq m/ha)	8.7	8.2	6.4
D.b.h. (cm)	12.6	12.0	11.5
Height (m)	9.41	9.50	8.69
Height growth (m/tree)	3.51	3.54	3.08
Basal area growth (sq m/tree)	67.0	68.0	59.0

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0022

Boe, Kenneth N. Growth of released redwood crop seedlings on the Redwood Experimental Forest. USDA Forest Service Research Note PSW-229. Berkeley, CA: U.S. Department Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station. 1971. 5 p.

Potential redwood crop trees, 3- to 4-years old, were released from shrub and grass competition. The release distances tested were radii of 2, 3, and 4 feet; the methods used were basal or foliage spraying with 2,4,5-T and 2,4-D mix and hoeing-cutting. Three replications, each containing ten trees, were arranged in a randomized block design.

For the first 3 years, released seedlings (except those released by cutting) grew faster than untreated seedlings. By the end of the fourth growing season, when competing vegetation had already reoccupied the weeded areas, height growth of all seedlings appeared to be equalizing. This age-class of redwood crop seedling (vigorous, healthy, and tallest at a specific minimum spacing) may not need weeding-release for satisfactory growth in environments similar to that where tested.

Abstract: Ronald E. Stewart

FPM83-0023

Bower, David R.; Ferguson, Edwin R. Understory removal improves shortleaf pine growth. Journal of Forestry. 66(5): 421-422; 1968.

Twenty 1/10-acre plots were located in a pure stand of shortleaf pine on the Alum Creek Experimental Forest in the Ouachita Mountains of Arkansas. The basal area of the understory averaged about 31 square feet per acre and was composed predominantly of white, post, and red oaks, black gum, hickory, and maple. Plots were selected in groups of four with overstory basal areas of 60, 70, 80, 90 or 100 square feet per acre. One plot in each group was left as a control, and in the spring of 1960, the understories of the others were cut to an average of 18.6, 9.8, and 0 square feet. Hardwoods as small as 0.5 inches in diameter were injected with 2,4,5-T and suppressed pines were felled. Low brush that was too small to inject was left standing and not tallied.

Table 1 shows basal area growth for the 5 years before and after treatment.

Because of the lack of rain during the growing season, all trees grew slower during the study than they had for the previous 5 years. The relationship between present growth as a percent of previous growth and the amount of understory removed was linear--removing 33 square feet of hardwood understory increased the growth of the shortleaf pine overstory by 31 percent. The relationship G = 1.725 0.037B + 0.374P, where G is basal area growth, B is residual understory basal area, and P is basal area growth during the previous 5 years, accounted for 81 percent of the variation in basal area growth.

Table 1. Basal area growth of shortleaf pine before and 5 years after treatment

	Pine basal area growth			
Residual understory basal area (sq ft/acre)	Before treatment (sq ft/acre)	After treatment (sq ft/acre)	After/ before (%)	After (adjusted) (sq ft/acre)
32.8	1.900	1.018	53.6	0.962
18.6	1.852	1.139	61.5	1.103
9.8	1.586	1.066	67.2	1.138
0.0	1.716	1.242	72.4	1.261

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0024

Boyer, William D. Brown-spot infection on released and unreleased longleaf pine seedlings. U.S. Department of Agriculture Forest Service Research Paper SO-108. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station; 1975. 9 p.

This paper reports on four studies on relation of brown-spot infection to overstory density of pines and hardwoods, and to seedling age at time of release. The four studies were: (1) pine overstory density - pine overstories of 9, 27, and 45 square feet basal area per acre were created on square 2.5-acre plots in 40- to 60-year-old stands in the Escambia Experimental Forest in southern Alabama in spring 1957. Additional densities of 30, 60, and 90 square feet per acre were studied in uncut stands. Zero overstory plots were also sampled on an area that had been clearcut in January 1957. Twelve seedlings were marked on each plot or subplot and examined annually for 7 years for root collar diameter, height and brown-spot infection; (2) seedling release from pine overstory -- seedlings were released in the Escambia Experimental Forest in January 1960 by clearcutting strips 2.5 or 3.3 chains wide and 20 chains long on the east side of each compartment and along the north sides of two more in February 1961. Five transects were randomly established at right angles to each strip. Transects were 132 feet long and 3.3 feet wide, thus comprising 40 quarter-milacre quadrats. The tree nearest the middle of each quadrat was marked for study. Three prescribed burns were made in January of 1962 and 1964; (3) timing of release - three blocks were laid out in early 1962 in the Mountain Province in Coosa County, Alabama. The blocks were under longleaf stands averaging more than 100 years of age. Each block consisted of six square 1.6-acre plots divided again into nine square subplots. Twelve seedlings on each subplot were marked for study. Treatments used in the study included the complete removal of overstory at 0, 1, 2, 3, and 5, years after seedling establishment, and a check; and (4) release from hardwood overstory - six blocks each comprised of six 0.1-acre plots were established in early 1949 in the Escambia Experimental Forest and the Conecuh National Forest in Alabama. Treatments consisted of complete overstory removal 1, 2, 3, 4, and 8 years after seedlings were established and an unreleased check. Seedlings were thinned at age 3 years to a maximum of three per quadrat at a minimum spacing of 1 foot. All main plots were prescribe-burned in winter when seedlings were 2, 5, and 7 years old.

Results are illustrated in graphs and some results from Study 2 are presented in Table 1.

Study 1 showed that brown-spot development from age 2 through 8 differed with pine overstory density. Infection at age 2 was low everywhere, but was highest in uncut stands of 30 square feet and next highest in clearcut stands. Infection was significantly heavier under the light overstories of 9, 27, and 30 square feet than under overstories of 45, 60, and 90 square feet. Study 2 revealed that for all the years following release of the pine seedlings, infection averaged 19 percent in the open and 9 percent in the forest. Seedlings in the open grew almost twice as fast as those in the forest but when seedlings of equal height were compared, those in the open had more than double the infection of those beneath an overstory. In Study 3 the infection rate remained low through the age of 3 but then intensified. At age 1, 23 percent of the seedlings were infected; 34 percent at age 2; 74 percent at age 3. And the intensity of infection did not differ significantly whether under the pines or in the clearcut openings as was the case in Study 2. Study 4 revealed that the disease was not particulary affected by hardwood overstory. When seedlings were 4 years old, infection averaged 41 percent under hardwoods and 44 percent in the open.

Table 1. Severity of infection in relation to seedling heights in Study 2, December 1965

Seedling height (feet)	Infection (percent)	
	Clearing	Forest
0	27	11
0.1-0.5	34	13
0.6-1.0	40	16
1.1-2.0	36	2
2.1-3.0	10	10
3.1+	3	2

Abstract: Ronald E. Stewart

FPM83-0025
Boyer, William D. Timing overstory removal in longleaf pine. Journal of Forestry. 73(9): 578-580; 1975.

Three studies were established in Alabama to test the response of longleaf pine seedlings to overstory removal. Two of the studies involved removal of pine overstories. The third study included both poor and average sites in southern Alabama with hardwood basal areas ranging from 27 to 42 square feet per acre. Seedlings were from the 1947 and 1951 seed crops. The hardwood overstory was removed at various times ranging from 1 year before longleaf seedling establishment to 8 years after. Check plots were not released. All plots were periodically burned by winter prescribed fires. The 1947 plots were burned when seedlings were 2, 5, and 7 years old. The 1951 plots were burned when seedlings were 3 years old. At age 3, all stands were thinned to a maximum of three seedlings per 1/4-milacre sample quadrat, with a minimum of 1 foot between seedlings. Final measurements were obtained in 1957, at age 10 for the 1947 seedlings and at age 6 for the 1951 seedlings.

Root-collar diameters of longleaf seedlings at age 6 (1951 seedlings) and age 10 (1947 seedlings) in relation to year of hardwood overstory removal appear in Table 1.

Overstory competition retarded seedling growth. The earliest date of removal produced the largest seedlings at the final measurement. Seedlings released before age 3 grew significantly better than unreleased seedlings the first year after overstory removal. Those released at a later age generally did not show a significant response until the second year, except on poor sites where seedlings responded immediately at age 3.

Even with early release, seedling root-collar diameter growth increased most during the second growing season after release; only seedlings released at age 1 showed a greater response in the first growing season than in the second. The benefit of early release was most pronounced on poor sites.

Table 1. Effect of timing of overstory release on growth of longleaf pine

Years between seedling establishment and release	Root collar diameter (inches) 1947 planting at age 10	Root collar diameter (inches) 1951 planting at age 6
-1	-	0.81
0	-	0.75
1	1.30	0.65
2	1.05	0.52
3	1.03	-
4	0.97	-
8	0.77	-
Unreleased	0.70	0.44

Abstract: Larry Gross

FPM83-0026

Boyer, William D. Growth of young longleaf pines affected by biennial burns plus chemical or mechanical treatments for competition control In: Proceedings of the Second Biennial Southern Silvicultural Conference 1982 November 4-5; Atlanta, GA. General Technical Report SE-24. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station; 1983: 62-65.

A study was initiated in 1973 on the Escambia Experimental Forest in south Alabama to determine the effects of repeated understory competition control treatments on understory structure and biomass, and growth of a 12-year-old longleaf pine overstory. The study was located on sandy upland soils of the middle coastal plain, predominantly Troup soil series with some Wagram and Dothan soils present. Three study blocks, each comprised of 12 square 0.4-acre plots, were established in relatively uniform, even-aged stands of young longleaf pine originating from the 1958 seed crop. All plots were thinned to 500 dominant pines per acre, and 50 pines in a centrally located 0.1-acre subplot were numbered for response measurements. Twelve treatment combinations were randomly assigned among the 12 plots in each block. Four burning treatments include prescribed fire at 2-year intervals in winter, spring, summer, and unburned check. Combined with each burning treatment were three supplemental treatments. These were chemical treatment of all woody stems with 2,4-D at time of study establishment; hand clearing of all wood vegetation 4.5 feet or more in height at the beginning of the study and at 2-year intervals thereafter; and an untreated check.

Average annual volume growth of overstory longleaf pines 7 years after the first treatment is shown in Table 1.

Results of this study indicate that the biennial burning regimes lessened longleaf pine growth. All measures of pine growth were significantly reduced by burning treatments, although excessive mortality on the summer burn-check treatment was partly to blame. The supplemental treatments eliminated nearly all hardwood competition above the 0.5-inch diameter class on all plots. Yet these treatments while eliminating mid- and under-story hardwoods, did not significantly improve pine growth. Over the first 7 years of this study, presence of a hardwood component comprising 13 percent of total plot basal area for unburned-check plots has not slowed pine growth, while all biennial burning treaments have. Apparently, under the conditions studied, competition on untreated plots was not great enough to adversely affect growth of overstory pine.

Table 1. Effect of biennial burns and supplemental treatment on survival and growth of longleaf pine after 7 years

Supplemental treatment	Growth of pine by season of biennial burn (cu ft/acre)				
	Winter	Spring	Summer	None	Average
Chemical	94	91	134	118	109
Hand clearing	99	104	90	134	107
None	111	113	65	125	104
Average	102	103	96	125	107

Abstract: Ronald E. Stewart

FPM83-0027
Brinkman, Kenneth A.; Liming, Franklin G. Oak and pine reproduction responds to overhead release. Journal of Forestry. 59(5): 341-346; 1961.

The studies were installed on the Mark Twain National Forest in Howell County and the Clark National Forest in Reynolds County, Missouri. The overstory stand was about 40 years old and contained about 390 trees per acre at least 1 inch in diameter. One fourth of the trees were shortleaf pine, white oak, and black oak; the rest were low value oaks and hickories. Total basal area averaged about 79 square feet. All sites were planted with 1-0 shortleaf pine. The plots were square and 0.1 acres in size. The treatments on the Clark area consisted of four degrees of release and three methods of release. (1) No release (leave 79 square feet basal area); (2) One-third release (leave about 53 square feet basal area); (3) Two-thirds release (leave about 27 square feet basal area); and (4) Complete release. Methods of release were: (1) cut, (2) deep (notch) girdle, and (3) shallow (peel) girdle. On the Mark Twain plots, the same methods of release were repeated in three seasons: March, May, and August. Results were evaluated on a total of 10,000 marked trees.

Neither method nor season of release had any significant effect on the results. The understory trees of all species benefitted from the release. The most obvious result of release was that the growth rate of trees of all species consistently increased with the amount of overstory reduction.

Table 1 shows height growth of reproduction during the 11-year study period.

The increase in survival of the reproduction (except pine released a year after planting) was essentially the same for all methods and seasons of release. For the reproduction as a whole, survival was related directly to extent of overstory removal and ranged from 56 percent without release to 79 percent where all trees were killed or cut. However, survival of pines was not greatly increased by release. Post, black, and blackjack oak, comprising nearly two-thirds of the total stocking, benefitted most.

Survival of all reproduction, including seedlings, sprouts, and planted pines, after 11 years is shown in Table 2.

Table 1. Effect of overhead release on height growth of oak and pine over an 11-year period

Species	Height growth by overstory basal area (feet) 0 sq ft basal area	27 sq ft basal area	53 sq ft basal area	79 sq ft basal area
Pine	15.0	6.2	3.1	3.1
White and black oak	8.5	4.1	2.4	2.1
Post oak, hickory, blackgum	6.2	2.1	1.3	1.1

Table 2. Effect of overhead release on survival rate of all pine reproduction over an 11-year period

Species	Survival rate by overstory basal area (percent) 0 sq ft basal area	27 sq ft basal area	53 sq ft basal area	79 sq ft basal area
Pine--delayed release by cutting	13	77	78	72
Pine--all other releases	75	82	75	69
White and black oak	90	71	77	77
Post oak, hickory, blackgum	78	73	73	62
Blackjack oak, sumac, sassafras	69	62	56	44
All pine	71	81	76	70
All hardwoods	75	69	66	54

Abstract: Larry Gross

FPM83-0028

Brown, James H. Competition controls in Christmas tree plantations. Tree Planters' Notes. 1980(Winter): 16-20; 1980.

The study site was level to gently sloping and was covered with dense vegetation consisting of a mixture of broadleaved herbaceous and grass species. Five replicates, each containing four plots, were established in spring of the year prior to planting. The treatments used were: (1) complete vegetation control using scalping and handweeding, (2) competing vegetation controlled with herbicide (aminotriazole-simazine), (3) broad-leaved ground cover (sprayed with dalapon), and (4) grass-sod ground cover (sprayed with 2,4-D). Fraser fir (2-2) and Scots pine (2-0) were planted on subplots within each treatment plot. Survival and growth of seedlings were generally closely related to cover treatments on the plots, which in turn, were related to soil moisture. Survival and growth of Fraser fir and Scots pine appear in Table 1.

Survival and growth of both Fraser fir and Scots pine were significantly affected by weeds. Seedlings were largest on plots kept completely free of weeds by scalping and cultivation and were about 10 percent smaller where weeds were controlled by herbicides. When broadleaf weeds competed with trees, where grass competed with trees, survival of seedlings was reduced by more than 40 percent and growth was 60 percent less than in areas where weeds were controlled. Fraser fir was more seriously affected than Scots pine.

Table 1. Effect of vegetation controls on survival and growth of Christmans tree plantations over a 3-year period

Type of cover or control	Species	3-year survival (%)	3-year height growth (cm)
Scalp and weed	- Fraser fir	93	30
	- Scots pine	87	51
Herbicide	- Fraser fir	93	26
	- Scots pine	87	46
Broad-leaf herb	- Fraser fir	60	18
	- Scots pine	67	35
Grass sod	- Fraser fir	47	16
	- Scots pine	60	31

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0029

Buckman, Robert E.; Lundgren, Allen L. Three pine release experiments in northern Minnesota. USDA Forest Service Station Paper 97. St. Paul, MN: U.S. Department Agriculture, Forest Service, Lake States Forest Experiment Station; 1962. 9 p.

See: Roe, Eugene I., 1951.

Three studies were installed in young pine that contained mixtures of aspen and paper birch. Small eastern white pine poles 28-years-old were released from a 36-year-old overstory of aspen and birch at the Squaw Point Road in 1934. Three 1-acre plots were established: (1) all hardwoods cut removing 90 percent of the basal area (full release); (2) only hardwoods overtopping pines cut removing 70 percent of the basal area (moderate release); and (3) no cutting (no release). At the time of release, the full release plot had more white pine trees (315 trees per acre) than the moderate (231) or no release (226) plots. This difference may magnify the contrast between full release and the other two treatments.

The second study was installed in 1931 at Birch Lake to test effects of release on 19-year-old red pine. Three 0.25-acre plots were established: (1) all hardwoods cut removing 58 percent of the basal area in trees over 0.6 in d.b.h. (full release); (2) cutting hardwoods from around only the better pines removing 28 percent of the basal area (moderate release); and (3) no cutting (no release). The stands were roughly comparable before treatment but contrasts between treatments were less than at Squaw Point, probably due to defoliation of aspen by forest tent caterpillars in 1934, 1935, and 1936.

The third study was installed in 1939 in a 35-year-old stand of white and red pine suppressed by an overstory of older aspen and birch near Itasca Park. Two 1/4-acre plots were established: cutting of hardwoods that were competing with, over-topping, or injuring the pine, removing 36 percent of the basal area (moderate release), and no release. In addition, densely stocked areas of pine were thinned to a spacing of 6 x 8 feet on the treated area.

Results after 22 years (Squaw Point), 25 years (Birch Lake), or 18 years (Itasca Park) appear in Table 1.

Board foot volumes are presented graphically for hardwoods and conifers on each plot. Financial aspects are briefly discussed and indicate that release, as done in these experiments, is one of the better investments to be made in forestry. Earlier results from the Birch Lake red pine plantation were reported in:

Young, Leigh J.; Eyre, Francis H. Release cuttings in plantations of white and Norway pine. Michigan Academy of Science, Arts, and Letters (Papers) 22: 301-320; 1937.

Table 1. Effect of release treatment on pine diameter and volume growth

	Squaw Point		Birch Lake		Itasca Park	
Treatment	D.b.h. (in)	Volume (cords)	D.b.h. (in)	Volume (cords)	D.b.h. (in)	Volume (cords)
No release	5.3	4.3	5.9	16.8	--	14.9
Moderate release	6.9	14.4	7.8	25.4	--	22.6
Full release	8.6	32.2	8.2	33.6	--	--

Abstract: Ronald E. Stewart

FPM83-0030
Budelsky, Carl A. Weed control increases survival and early growth of hardwoods. Agriculture South. Spring-Summer: 2-3; 1973.

A study was undertaken in southern Illinois to determine the effect of weed control on the survival and early growth of sycamore, yellow-poplar, sweetgum, and white ash. A total of 144 one-year-old seedlings of each species was hand-planted on an upland site. The soil type was Hosmer silt loam. Half of the seedlings were shallow cultivated with a disk in May of each year for 5 years to reduce weed competition.

During the five years, 46 percent of the noncultivated seedlings and 22 percent of the cultivated seedlings died.

Height growth in feet for the five-year period is recorded in Table 1.

Table 1. Effect of weed control on survival and growth of hardwoods after 5 years

	Height growth in first 5 years (feet)			
	Sycamore	Yellow-poplar	Sweetgum	White ash
Cultivated	11.4	8.4	10.0	8.5
Noncultivated	4.4	2.8	4.7	4.2

Abstract: Larry Gross

FPM83-0031
Bull, Henry. Increasing the growth of loblolly pine by girdling large hardwoods. Journal of Forestry. 43(6): 449-450; 1945.

Two 2-acre permanent plots were established near Urania, Louisiana in 1933, in second growth loblolly pine intermixed with larger loblolly and shortleaf pines and mixed hardwoods. One plot was left untouched, the other was given an improvement cutting that removed pine and hardwood sawlogs and pine pulpwood and also included considerable girdling.

Table 1 summarizes data on pines that were within 15 feet of girdled hardwoods and more than 9.5 inches d.b.h. in 1933.

Table 1. Effect of hardwood girdling on growth of loblolly pine over a 10-year period

	Improved plot	Check plot
Number of trees		
1933	300	288
1943	230	147
Mortality	70	141
Ave. d.b.h. growth (in)	1.35	0.46
Basal area (sq ft)		
1933	23.3	22.1
1943	40.2	20.3
Merchantable volume (cords)		
1933	2.38	1.85
1943	6.83	2.81

Abstract: Larry Gross

FPM83-0032

Burns, Russell M. Effects of regeneration methods on later management. Proceedings, symposium on management of young pines. Atlanta, GA: U.S. Department Agriculture, Forest Service, Southeastern Area State and Private Forestry; 1974: 190-200.

The paper considers species selection, the relative merits of various methods of site preparation, amelioration of infertile soils, and stand density and spacing as they affect the management of young pines, especially on sandhill sites.

Table 1 presents the results of a study on a lakeland sand soil comparing no site preparation, burning, and double chopping at a plantation age of 10 years for slash pine.

On another site, Choctawhatchee sand pine survival and height were compared on a chopped site versus an unprepared site. The results after 5 years are in Table 2.

Table 1. Effect of regeneration methods on survival and growth of slash pine over a 10-year period

Survival and growth	Regeneration method		
	No preparation	Burned	Double chopped
Survival (%)	41.0	39.0	62.0
Height (ft)	7.2	8.0	17.8
D.b.h (in)	1.0	1.3	3.0
Tree vol. (cu ft)	0.013	0.025	0.291

Table 2. Effect of chopped site versus unprepared site on sand pine survival and growth after 5 years

Survival and growth	Site preparation	
	Unprepared site	Chopped site
Survival (%)	84.0	95.0
Height (ft)	5.5	10.6

Abstract: Larry Gross

FPM83-0033

Byrnes, W. R.; Krajicek, J. E.; Wichman, J. R. Weed control. In: Black walnut as a crop. Black Walnut Symposium; 1973 August 14-15; Carbondale, Ill. 114 p. USDA Forest Service General Technical Report NC-4. St Paul, MN: U.S. Department Agriculture, Forest Service, North Central Forest Experiment Station; 1973: 42-48.

Beneficial effects of weed control on black walnut growth are evident in results of field experiments conducted by Purdue University and the North Central Forest Experiment Station. At Purdue University, two studies of walnut growth response to weed control on bottom land sandy loam to loam sites were initiated in 1963 and 1965. In both studies, 2-year-old seedlings were planted at a 10- by 10-foot spacing in a randomized complete block design with three replicates of the following weed control treatments: (1) none (no weed control), (2) mechanical (cultivation with rotary tiller), (3) chemical (Amizine at 7 pounds per acre). In the mechanical treatments, plots were cultivated three times per season for 3 years after planting in both studies. In the chemical treatments, Amizine was applied once each spring for 3 years after planting. In the 1963 study, applications were restricted to milacre plots (6.6 feet square) around each tree. In the 1965 study, the entire treatment areas were sprayed. Weed control treatments were discontinued after the third year, but survival and growth measurements have been made annually.

Average survival and growth after 10 growing seasons in the 1963 study are shown in Table 1. Survival and growth after 8 growing seasons in the 1965 study are shown in Table 2.

Black walnut survival after 10 years in the 1963 test was excellent, ranging from 85 percent on mechanically treated plots to 95 percent on chemically treated plots. Average height and diameter were best on the plots receiving total area cultivation and somewhat less on the chemically treated plots. Walnut survival after 8 years in the 1965 study was 89 percent with no weed control, 88 percent with chemical control, and 79 percent with mechanical control.

In Hardin County, Illinois, two small coves were cleared and planted to black walnut. Treatments were (1) complete control of competing vegetation, (2) control of herbaceous vegetation only, (3) control of woody vegetation only, and (4) competition not controlled. For each of the first three treatments, annual, biennial, and triennial control was tested. After five growing seasons, survival was excellent for all treatments ranging from 94 to 100 percent. Average height (almost 11 feet) was best for annual complete control.

A study was established on old-field sites on a bottom land area in south-central Indiana, an upland area in southern Illinois, and a bottom land site in southern Illinois. Both soil preparation and no preparation were tested on all areas. One-year-old black walnut seedlings and germinating nuts were used. Chemical weed control was applied after planting and sowing on circular spots 2, 4, 6, and 8 feet in diameter. On other areas, no weed control was used. After two growing seasons, few differences in growth and survival are evident. The most significant finding to date is that soil preparation prior to planting had no advantage over no preparation.

Table 1. Effect of weed control on survival and growth of black walnut after 10 growing seasons

Weed treatment	Survival (percent)	Height (feet)	D.b.h. (inches)
None	88	10.1	1.4
Chemical	95	14.5	2.2
Mechanical	85	16.5	2.6

Table 2. Effect of weed control on survival and growth of black walnut after 8 growing seasons

Weed treatment	Survival (percent)	Height (feet)	D.b.h. (inches)
None	89	8.0	0.9
Chemical	88	13.4	2.0
Mechanial	79	11.2	1.5

Abstract: Ronald E. Stewart

FPM83-0034
Cain, Michael D. Planted loblolly and slash pine response to bedding and flat disking on a poorly drained site - an update. Southern Forest Experiment Station Research Note SO-237. New Orleans, LA: U.S. Department Agriculture, Forest Service, Southern Forest Experiment Station; 1978. 6 p.

See: Mann, W. F., Jr.; Derr, H. J., 1970. Derr, H. J.; Mann, W. F., Jr., 1977.

A study was established on Beauregard and Caddo silt loam soils on the western Gulf Coastal Plain of southwestern Louisiana to test the growth response of planted loblolly pine and slash pine on sites that were prepared mechanically before planting. The Caddo soil has slow surface and internal drainage; the Beauregard soil has medium drainage throughout. The site was originally covered with longleaf pine and had not been cultivated. At study installation, cover species included Andropogon spp. and scattered post oak, blackjack oak, and southern bayberry. The area was burned to eliminate grass rough and woody vegetation was removed. Three site preparation treatments -- control, flat disking, and bedding (mound disking) -- were tested on 108- by 144-foot plots arranged in a randomized complete block design with four replications. Loblolly and slash pine seedlings were hand planted and the center 100 planting spots in each plot selected for subsequent measurement of effects. Plots were selectively thinned at age 13, leaving an average of 345 trees per acre. Thinning helped to equalize stocking among and within treatments, reduce incidence of fusiform rust cankers, and insure more precise height measurements.

Loblolly pine and slash pine survival at age 13, and height, diameter, and volume at age 15 are shown in Table 1.

Both species excelled in height and diameter growth on bedded plots for the first 6 to 8 years. Thereafter, periodic annual growth response (height and d.b.h.) on bedded plots has generally fallen behind control and flat-disked plots, but differences have been relatively small. Early height gains achieved by bedding were maintained through age 15. Early response to that treatment is attributed to improved soil moisture and aeration. Bedding increased total loblolly volume production over controls by about 6 cords per acre after 15 years, but on a per-tree basis the difference among treatments was less than 1 cubic foot. Flat disking was as effective as bedding for increasing loblolly volume production. Much of the difference in total production among loblolly treatments was probably due to higher survival on bedded and flat-disked plots. Although slash pines have averaged consistently taller on bedded plots, volume production at age 15 was practically the same for all treatments. It appears that the soil modification treatments gave marginal economic benefits at best, especially for slash pine.

Earlier studies suggest that the best response to bedding occurs on the poorly drained Caddo silt loam soil. The site tested in this study has proved to be excellent for pine growth. Since Beauregard silt loam is usually capable of supporting pine without mechanical modifications, it may be that the gains in height and volume that were achieved by bedding and flat disking in this study occurred on the Caddo soil.

Table 1. Effect of site preparation on survival and growth of slash and loblolly pine after 13 and 15 years

Species and treatment	Age 13 survival (percent)	Growth at age 15: Total height (feet)	D.b.h. (inches)	Volume (cu ft/acre)
Loblolly pine				
Control	72	50.6	7.49	3707
Flat disked	81	53.4	7.38	4122
Bedded	87	52.6	7.18	4209
Slash pine				
Control	76	48.7	7.16	3687
Flat disked	74	48.6	7.07	3566
Bedded	76	50.4	7.08	3684

Abstract: Ronald E. Stewart

FPM83-0035

Cain, M. D.; Mann, W. F., Jr. Annual brush control increases early growth of lobloly pine. Southern Journal of Applied Forestry. 4(2): 67-70; 1980.

Three treatments were applied to newly planted loblolly pine at three locations on gently rolling, moderately drained sites in north Louisiana: (1) untreated check; (2) annual cutting of all hardwoods (cut only); and (3) cutting, grubbing, and herbicide spray (2,4-D amine on stumps and broadcast 2,4-D and 2,4,5-T mixture). A randomized complete block design with three replications at each test area was used. Results after 6 years are in Table 1.

Diameters were about 30 percent greater on treated compared with untreated plots after 6 years; volumes were 49 percent higher than on untreated areas. Results imply that one intensive preplant mechanical site preparation may allow planted loblolly pine to become established, but it does not retard hardwood vegetation sufficiently to maximize pine growth.

Table 1. Effect of brush control on growth of loblolly pine after 6 years

Control treatment	Total height (ft)	D.b.h. (in)	Volume per tree (cu ft)
Untreated	15.5	2.51	0.374
Cut only	17.2	3.14	0.559
Cut and spray	17.1	3.25	0.619

Abstract: Ronald E. Stewart

FPM83-0036

Cain, M. D. Site preparation for establishing pine reproduction in small openings within pine stands. Unpublished progress report on study FS-SO-1117-18, on file. USDA Forest Service, Southern Forest Experiment Station, Monticello, Arkansas. 1983.

A study was installed on the Crossett Experimental Forest in Arkansas to demonstrate the intensity of site preparation needed to naturally regenerate spot-openings occupied by hardwood brush within loblolly/shortleaf pine stands. Treatments include: (1) control -- no site treatment, (2) minimum site preparation -- simulated logging or salvage operation plus hardwood injection, (3) moderate site preparation -- summer burn plus foliar spraying plus hardwood injection, (4) maximum site preparation -- rotary mowing followed by disking.

Three replications of each treatment were established in each of two years (1980 and 1981) to account for variable seed crops. Treatments were applied prior to October 1 to coincide with peak seedfall. Plots are 0.1 acre with measurements of seedling catch and heights taken on the interior 0.05 acres.

All three site treatments were effective in establishing natural pine regeneration and were much more effective than no treatment. Pine seedling density in the fall of 1982 is shown in Table 1.

These treatments were thought to be adequate for seedbed preparation but there was some doubt that reinvasion by competing vegetation would be delayed. Therefore, a third site treatment (mow + chemical) was utilized in a supplemental study to assess long-term control of competition and was compared to mow plus disk and to untreated controls.

Four replications of each treatment were installed in a randomized complete block design. Plots are 0.1 acre with measurements of seedling catch and heights taken on the interior 0.05 acres. In the mow + chemical treatment, mowing was done in October 1980 with foliar spraying (Velpar-L at 4 pounds acid equivalent per acre) in September 1981. In the other treatment, mowing was done in July 1981 followed by disking in September 1981.

Pine seedling counts were taken in the fall of 1982. The mow + disk plots had significantly more seedlings per acre (19,550) than the mow + chemical plots (8,800). There were no pine seedlings on control plots. In the fall of 1982, there were significantly more stems of woody competition on the mow + chemical plots and those stems were significantly taller than similar competition on the mow + disk plots.

Table 1. Effect of site preparation on growth of pine after 2 years

Treatment	Pine seedling density two years after treatment (Seedlings/acre)
Control	67
Log	5,733
Burn + Chemical	2,433
Mow + Disk	8,167

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0037

Campbell, T. E.; Mann, W. F., Jr. Site preparation boosts growth of direct-seeded slash pine. USDA Forest Service Research Note SO-115. New Orleans, LA: U.S. Department Agriculture, Forest Service, Southern Forest Experiment Station; 1971. 4 p.

A study was established in central Louisiana on a Beauregard silt loam soil with fair internal drainage to evaluate the effects of sowing season and seedbed treatment on direct-seeding success. The only ground cover, a dense stand of native grasses, was burned in the spring of 1954. Six treatments, including all combinations of three seedbeds and two seasons of sowing, were replicated six times in a completely randomized design on 0.1 acre plots sown with 0.1 pound of seed. Seedbeds were a light grass rough (burned), disked strips 6 feet wide and 7 feet apart, and plowed furrows 1.5 feet wide and 11 feet apart. Sowing dates were early November 1954 and late February 1955. Seeds were evenly distributed over the burned plots, but they were confined to the prepared portion of disked strips and furrows.

First-year stocking on fall-sown plots ranged from 305 seedlings per acre in furrows to about 1,100 on disked and burned sites. Spring sowing was more effective--stocking averaged 630 on disked, 1,300 on furrowed, and 1,540 on burned plots. There was considerable variation within treatments. Season of sowing has no influence on survival or growth after the first year, so fall and spring data were combined. Total height at age 5, excluding suppressed and diseased trees, averaged 5.4 feet on burned, 8.2 on disked, and 7.3 on furrowed seedbeds. Results at age 14 for merchantable trees (4.6 inches d.b.h. and larger) are given in Table 1.

It was found that seedbed preparation significantly increased mean diameter when stocking differences were adjusted. Covariance analysis showed that prediction equations for each seedbed had a common slope, but that trees on disked and furrowed sites averaged 0.4 inches larger than on the grass rough at any level of stocking. The increased height and diameter growth on disked strips and plowed furrows is equivalent to about 1 year's increment, which is approximately 2 cords per acre on the study area. Covariance analysis to correct for differences in stocking showed that compared with burning, disking increased yields by 5.7 cords and furrowing increased it by 2.8 cords per acre.

Table 1. Effects of site preparation on growth of direct-seeded slash slash pine over a 14-year period

Site treatment	Number of trees per acre	Mean height (feet)	Average diameter at breast height (inches)	Volume (rough cords)
	Results for trees 4.6 inches d.b.h and larger			
Light rough	386	36	6.3	13.1
Disked	444	39	6.6	19.2
Furrowed	377	38	6.7	15.2

Abstract: Ronald E. Stewart

FPM83-0038

Campbell, Thomas E. Growth and development of loblolly and slash pines direct-seeded or planted on a cutover site. Southern Journal of Applied Forestry. 5(3): 115-119; 1981.

This paper summarizes 15-year results of a study evaluating growth and yield effects of several site preparation methods for direct-seeded loblolly and slash pines on a cutover grassy site. It also compares performance of the seeded pines with that of stands planted on a 1-year-old burn in the lower Coastal Plain of the West Gulf region. The study area was burned in February 1961, with the treatments installed in February 1962 with three replications. The results at age 15 appear in Table 1.

Loblolly pine: Heights of dominant and codominant trees on the planted plots were significantly greater than those on five of the direct seeded treatments. Differences in average diameters were significant with planted trees excelling. Site preparation did not stimulate height growth of slash pine.

Mechanical site preparation for direct seeding this grassy site did not boost growth as expected. The study did not reveal a single outstanding establishment method for enhancing future growth and development of either species.

Table 1. Effect of site preparation on growth and yield of loblolly and slash pine after 15 years

Treatment number and description	Lobolly pine: Total height, dominants and codominants (ft)	Lobolly pine: D.b.h. (in)	Slash pine: Total height, dominants and codominants (ft)	Slash pine: D.b.h. (in)
1. Planted	46	6.3	46	6.4
2. Broadcast-sown rough	41	5.0	45	6.0
3. Broadcast-sown flat strips	42	4.9	42	5.6
4. Broadcast-sown mounded strips	43	5.1	44	5.7
5. Swath-sown flat strips	43	5.3	45	6.1
6. Swath-sown mounded strips	45	5.8	44	6.1
7. Furrow-sown	42	5.7	43	5.9

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0039
Carmean, Willard H. Large, well balanced stock and control of grass competition needed for red pine planting on sandy soils. Tree Planters' Notes. 22(1): 8-10; 1971.

The study was installed on Zimmerman loamy fine sand in Sherburne County, Minnesota. Three sizes of planting stock were tested on a site with no site preparation or vegetation control. Seedlings were machine planted in randomly assigned rows of 50 to 100 trees each. A total of 500 2-0, 250 3-0, and 1000 4-0 seedlings were planted. Results indicate that large, sturdy, well-balanced seedlings will survive best. Also, the poor survival and growth during the second season indicate that planting of sturdy, well-balanced seedlings must also be accompanied by control of competing vegatation.

Abstract: Larry Gross

FPM83-0040

Carter, M. C.; Martin, J. W.; Kennamer, J. E.; Causey, M. K. Impact of chemical and mechanical site preparation on wildlife habitat. In: Bernier, B.; Winget, C. H., eds. Forest soils and land management. Proceedings Fourth North American Forest Soils Conference; 1973 August; Laval University, Quebec, Canada. Quebec, Canada: Les Presses de l'Universite Laval; 1975: 323-332.

Results are reported from studies comparing various site preparation methods on large scale trials conducted by American Can Company in west central Alabama. Some studies were replicated and others were not, but all were installed with the same equipment, personnel, and procedure involved in operational practice. Merchantable timber was harvested from all study sites before site preparation. Sites were prepared during summer and fall and 1-0 loblolly pine were hand planted during the following winter.

A comparison of broadcast burning and tree injection with 2,4-D amine with shearing, piling, disking, and bedding was conducted on 400 square meter plots replicated three times. Pine seedling stocking and height four growing seasons after planting are shown in Table 1.

Differences between treatments were not great. Stocking tended to be lower on the injected plots, while height growth was slightly greater.

A 150-hectare area was divided into 5- to 20-hectare plots and one of four site preparation treatments applied: (1) sheared and burned; (2) sheared, piled, and disked; (3) sheared, piled, and bedded; and (4) aerial sprayed with 2,4,5-T and burned. Pine growth and stocking were assessed on four transects in each plot. Results after 3 years are shown in Table 2.

The aerial spraying did not result in pine stocking and growth comparable to the mechanically prepared areas. But the aerial spray represents a less expensive alternative whereby the land manager can sacrifice pine growth for improved wildlife habitat.

In another study, aerial sprays of 2.2, 4.4, and 6.6 kilograms per hectare of 2,4,5-T were compared with 27 and 36 liters per hectare of Tordon 101 Mixture. Treatments were applied in May by helicopter to two 1.25-hectare plots for each treatment. Results two growing seasons after planting are presented in Table 3.

Table 1. Impact of site preparation on pine stocking and height after 4 growing seasons

Method of preparation	Pine stocking (trees/ha)	Pine height (m)
Injected and burned	1413	1.9
Sheared, disked, bedded	1620	1.7

Table 2. Impact of site preparation on pine stocking and height after 3 growing seasons

Method of preparation	Pine stocking (trees/ha)	Pine height (m)
Sheared and burned	1584	1.2
Sheared, piled, disked	2076	1.6
Sheared, piled, bedded	1680	2.0
Aerial spray and burn	1440	1.1

Table 3. Impact of site preparation on pine stocking and height growth and overstory control after 2 growing seasons

		Overtory control (%)	Pine stocking (trees/ha)	Pine height (m)
2,4,5-T	2.2 kg/ha	42	686	0.49
	4.4 kg/ha	64	679	0.43
	6.6 hg/ha	69	847	0.55
Tordon 101	27 l/ha	81	1070	0.61
	36 l/ha	88	1087	0.82

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation of forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0041
Carter, Mason C.; Martin, James W.; Kennamer, James E.; Causey, M. Keith. Impact of chemical and mechanical site preparation on wildlife habitat. Industrial Vegetation Management. 8(1): 5-9; 1976.

See: Carter, M. C.; Martin, J. W.; Kennamer, J. E.; Causey, M. K., 1975.

FPM83-0042

Cayford, J. H. Influence of the aspen overstory on white spruce growth in Saskatchewan. Forest Research Division Technical Note No. 58. Sault Ste. Marie, Ontario, Canada: Canada Department Northern Affairs and National Resources, Forestry Branch; 1957. 12 p.

In 1953, a study was established near Prince Albert, Saskatchewan, to evaluate the effect of early aspen dominance on the development of white spruce. Five stands -- three at Candle Lake and two at Big River -- in the Mixedwood Section of the Boreal Forest Region were selected. They were composed of mixtures of white spruce and aspen with an occasional scattering of black spruce or white birch. There was a wide variation in diameters and heights of spruce growing in the same stand. Study areas were chosen in which white spruce had penetrated the aspen canopy and which provided a maximum range of stand age. Ten groups of trees were measured within each stand. Each group consisted of three trees: one free white spruce (those growing in small openings withing the stand), one suppressed white spruce, and the main competing aspen adjacent to the suppressed spruce. In each group the spruce were selected so they would be as nearly the same age and in as nearly the same position as possible. Within any stand, the average age of the free trees did not differ by more than 2 years from that of the suppressed trees. Stem analysis was used to determine the height, diameter, and volume growth of free and suppressed spruce. A basis for replication was sought in the age distribution of trees in the sample. For comparative purposes, three age groups of spruce were selected: 55 to 60 years, 70 to 75 years, and 95 to 100 years.

Height and diameter growth of free and released spruce are presented graphically. Total volume per tree by age is shown in Table 1.

The results of a highly subjective method of selecting sample trees show that up to 100 years of age, suppressed white spruce were retarded in diameter, height, and volume growth by an aspen overstory. Aspen may reduce volume of white spruce by as much as 50 percent as compared with that of nearby free-growing spruce of the same age. An aspen overstory will also lower the quality of the white spruce which it suppresses by damaging leaders as a result of whipping and by causing such commonly found defects as forked top, crook and sweep.

Table 1. Effect of release from aspen on growth of white spruce

	Total volume (cu ft/tree)	
Age group	Free spruce	Suppressed spruce
55-60 years	11.1	6.0
70-75 years	17.7	9.0
95-100 years	19.8	10.0

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0043

Cayford, J. H. Furrowing improves first-year survival of planted spruce and pine in Manitoba. Tree Planters' Notes. 48(10): 13-14; 1961.

First-year survival of small 1959 test plantations in the Interlake Area of Manitoba was greatly improved by preplanting ground preparation. Three species, 2-3 white spruce, 2-3 black spruce, and 2-2 jack pine, were planted (1) on unprepared ground, and (2) in furrows prepared with a middlebuster plow. Furrows were approximately 1 1/2 to 2 feet wide and 2 to 4 inches deep; the sod layer was overturned on both sides of the furrow. Two sites were planted, a gravel ridge and a sand flat. The former was characterized by a grass and herb cover, the latter by a shrub and herb cover. Growing-season precipitation (April to September inclusive) in 1959 was 18.0 inches; the long-term average for the area is 13.4 inches.

The effects of furrowing on first year survival are shown in Table 1.

The effects of furrowing on the ridge plot was of more value than on the flat as shown in Table 2.

Table 1. Effect of furrowing on first-year survival of spruce and pine

Species	Percent survival: Furrows	Percent survival: Unprepared
Jack pine	48	30
White spruce	58	25
Black spruce	58	8

Table 2. Effect of furrowing on growth of trees in flat versus ridge plots

Plot	Percent survival: Furrows	Percent survival: Unprepared
Flat	42	25
Ridge	67	16

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0044
Cayford, J. H.; Jarvis, J. M. Furrowing and sheltering to improve early survival of planted red pine on dry sites, southeastern Manitoba. Tree Planters' Notes. 59: 21-24; August 1963.

In 1960 and 1961, 900 2-2 red pine transplants were planted by the slit method, one half in furrows and the other half in unfurrowed ground on a droughty site with medium to coarse sandy soils on the Sandilands Forest Reserve in southeastern Manitoba. Furrows 1.5 feet wide and 2 to 4 inches deep were made through the cover of ericaceous plants using a fire-line plow. Sheltering treatments were randomly applied after planting. A total of 150 trees were planted by each of the following: (1) control, (2) rock shelter, (3) paper shelter, (4) furrow, (5) furrow and rock shelter, and (6) furrow and paper shelter. Results after 2 years appear in Table 1.

Sheltering provided only limited benefits. Furrowing provided greater benefits. Survival after 2 years was increased by 14 percent for a plantation set out in a year of near-average precipitation and 56 percent for a plantation set out in a dry year by furrowing.

Table 1. Effect of site treatment on survival of red pine after 2 years

	Survival rate (percent)	
Treatment	1960 plantation	1961 plantation
Control	40.0	0
Shelter	52.0	1.3
Furrow	53.7	56.0
Furrow and shelter	67.6	54.3

Abstract: Ronald E. Stewart

FPM83-0045

Christensen, M. Dale; Young, James A.; Evans, Raymond A. Control of annual grasses and revegetation in ponderosa pine woodlands. Journal of Range Management. 27(2): 143-145; 1974.

The studies were conducted at Adin Pass and Baggett Gulch on the Modoc National Forest in northeastern California. The Adin Pass site is a steep south-facing slope with a very heavy vertisol clay overlying ash beds. Baggett Gulch is located on a north-facing slope with a silt-loam soil highly influenced by ash. At both locations treatments were applied to 6 x 6 meter plots arranged in a random block design with four replications, except Baggett Gulch where three replications were used.

At Adin Pass atrazine was applied at 0.56, 1.12, 1.68, and 2.24 kilogram per hectare in October 1966. Atrazine was applied at 1.12, 2.24, 4.48, and 8.96 kilogram per hectare on separate plots at Baggett Gulch in October 1968 and May 1969. In the spring of each year, plots that had been sprayed the previous fall and control plots were planted with 2-year-old, nursery grown ponderosa pine.

Survival and height of ponderosa pine on Adin Pass in 1972 five years after planting are shown in Table 1.

Survival and height of ponderosa pine at Baggett Gulch two years after planting are shown in Table 2.

Table 1. Effect of grass control on growth and survival of ponderosa pine after 5 years

Atrazine treatment (kg/ha)	Height (cm)	Survival rate (percent)
Control	30	8
0.56	40	18
1.12	60	90
1.68	65	88
2.24	75	96

Table 2. Effect of grass control on survival and growth of ponderosa pine after 2 years

	Spring application of atrazine		Fall application of atrazine	
Atrazine treatment (kg/ha)	Survival (%)	Height (cm)	Survival (%)	Height (cm)
Control	20	10	20	18
1.12	18	18	80	43
2.24	30	18	90	40
4.48	24	20	90	56
8.96	40	45	95	78

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0046

Clark, S. F. Releasing pine from hardwood competition. Southern Forestry Notes No. 50. New Orleans, LA: U.S. Department Agriculture, Forest Service, Southern Forest Experiment Station; 1947. 1 p.

In 1939, a release cutting study was begun in the Crossett Experimental Forest in typical shortleaf-loblolly pine-hardwood stands in which low-grade hardwoods were suppressing pine reproduction. The object was to determine the costs and the increased pine growth to be expected from removal of different portions of the hardwood overstory. Three removal treatments were used: (1) removal of all hardwoods over 6 inches d.b.h.; (2) removal of all hardwoods over 2 inches d.b.h.; and (3) removal of all hardwoods over 5 feet high.

Table 1 gives the results per acre of the 3 removal treatments.

The 2 more intensive treatments gave adequate pine stocking - non-overtopped pines at an average spacing of D + 6 (average d.b.h. in inches + 6). These are excellent results for a relatively small investment. Removing low-grade hardwoods from pine-hardwood stands is one of the most effective forestry measures a landowner can take.

Table 1. Results of three release treatments after 7 years

Description	Size of hardwoods removed in 1939: Over 6 inches d.b.h.	Over 2 inches d.b.h.	Over 5 feet high
No. of hardwoods removed, 1939	22	137	186
Costs, 1947 rates	$1.50	$3.00	$4.00
Approximate adequacy of pine stocking, 1946	60%	115%	150%
No. pine seedlings-1946			
C-0.5 in. d.b.h.	961	1,154	1,485
Same, not overtopped	98	141	172
0.5-3.5 in. d.b.h.	491	445	758
Same, not overtopped	140	268	402
Pine stems, all sizes	1,520	1,746	2,440
Same, not overtopped	306	552	763

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0047

Clason, T. R. Removal of hardwood vegetation increases growth and yield of a young loblolly pine stand. Southern Journal of Applied Forestry. 2(3): 96-97; 1978.

Four treatments were applied to 1/5-acre plots in a precommercially thinned 7-year-old natural stand of loblolly pine: (1) untreated; (2) hardwoods and grass removed by cutting and spraying with 2,4,5-T and dalapon; (3) hardwood vegetation only removed by cutting and spraying with 2,4,5-T; and (4) herbaceous vegetation only removed by spraying with dalapon. A randomized block design with four replications was used. Results after 5 years are in Table 1.

Compared to thinned-only plots, the additive effects of removing hardwood and herbaceous vegetation increased radial growth rates 36 percent and cubic volume growth 63 percent. Removing hardwoods alone accounted for a 23 percent radial growth increase and a 45 percent volume growth increase. Thinning and herbaceous vegetation removal offered no advantage above thinning alone. Optimal increases in growth were obtained when the precommercial thinning included the eradication of hardwoods.

Table 1. Effect of competing vegetation removal on pine yield after 5 years

Type of removal	Stocking (trees/acre)	D.b.h. (in)	Height (ft)	Volume (cu ft/acre)
Untreated	280	2.84	16.9	376
Herbaceous only	320	2.60	15.8	495
Hardwood only	300	2.94	15.6	546
Hardwood and herbaceous	304	3.37	15.9	612

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation of forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0048

Clements, John R. Development of a white pine underplantation in thinned and unthinned aspen. Forestry Chronicle. 42: 244-250; 1966.

Thinned and unthinned portions of a 12-year-old aspen sucker stand were underplanted in 1936 with 2-2 eastern white pine stock on the Petawawa Forest, Chalk River, Ontario. By 1950, most seedlings were still small and slow-growing. Mortality among these individuals was high in the following 10 years but mortality was relatively low among seedlings of taller height classes (over 4 feet). Height growth of seedlings continued to be poor so long as the crowns were below the red maple and beaked hazel shrub layer. Data are shown in bar graphs.

White pine planted beneath young aspen stands require care at least until they are 4 feet tall, especially on moist sites where shrub cover is greater. The undergrowth must be controlled or excessive mortality and poor growth of the survivors will result.

Abstract: Ronald E. Stewart

FPM83-0049
Coffman, Michael S. Shade from brush increases survival of planted Douglas-fir. Journal of Forestry. 73(11): 726-728; 1975.

Plantation survival in relation to aspect and brush cover was studied in a Douglas-fir plantation on the Mayhill District of the Lincoln National Forest, about 7 miles southwest of Sacramento, New Mexico. The area supported a mixed conifer forest until it was severely burned in 1953. In 1974, when the area was planted, the cover consisted of Gambel oak and New Mexican locust on the south slopes; Gambel oak, New Mexican locust, mountain maple, oceanspray, and honeysuckle on north slopes; and a mixture of grasses, clumps of aspen, and elderberry on the deeper soils. Planting began on the snow-free south slopes in late February 1974, using fall-lifted 3-0 Douglas-fir. North slopes were planted last after the soil on south slopes became too dry to plant. An 18-inch scalp was made at each planting site to eliminate grass competition. There was no deliberate attempt to plant seedlings next to or within clumps of brush or aspen, but about one-half the seedlings were planted in positions where they received some degree of competition from adjacent vegetation. Precipitation after planting was exceptionally low.

A single transect paralleling the slope contour was established on lower, mid, and upper slope positions on each aspect in late June 1974, 3 to 4 months after planting. The amount of brush competition and type of shade received by each seedling that was encountered in an area 12 feet on each side of the transect line were recorded. Competition classes were: (1) none (planted trees more than 5 feet from brush dripline), (2) light (planted trees within 2 to 5 feet from brush dripline), (3) moderate (planted trees within 0 to 2 feet from brush dripline, and (4) heavy (planted trees completely under brush canopy). Table 1 shows Douglas-fir survival. The highest survival was on the southwest and east aspects, the slopes that were planted first. Brush density was much greater on north slopes than on south slopes. More than 80 percent of the seedlings on north slopes had some degree of competition, compared to less than half of the seedlings on south slopes. On north slopes, survival was 63 percent where brush was heavy but only 21 percent where seedlings had no competition. Survival was poorest among seedlings planted in positions receiving full sunlight and best among those receiving shade all day. The influence of individual brush species on Douglas-fir survival is shown in Table 2.

These results are, however, confounded by aspect and soil conditions. The fact that survival was dramatically increased the first year by planting under brush does not necessarily mean that long-term survival will be increased.

Table 1. Effect of brush competition on survival of ponderosa seedlings in the first growing season

	Percent survival by aspect						
Competition	N	S	SE	SW	E	Ridge top	Mean
None	21	47	22	64	59	18	38.5
Light	57	43	44	74	47	21	48.7
Moderate	56	71	53	56	63	37	56.0
Heavy	63	67	43	75	84	67	66.5

Table 2. Influence of individual brush species on survival of ponderosa seedlings in the first growing season

Brush species	Percent survival
Trembling aspen	83
Elderberry	79
Oceanspray	77
Mountain maple	71
Gambel oak	55
New Mexican locust	45

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0050

Cole, Elizabeth C.; Newton, Michael; Zedaker, Shepard M. Inter and intraspecific competition in Douglas-fir plantations in the Oregon Coast Range. Presented at the 20th Proceedings of the Western Society of Weed Science, Las Vegas, Nevada, March 1983. Manuscript on file. Coravallis, OR: School of Forestry, Oregon State University; 1983. 6 p.

The study was conducted in three zones of the Oregon Coast Range: warm, dry sites in the Willamette Valley; warm, moist sites in the valleys of the Coast Range; and cool, moist sites in the fog belt within a few miles of the Pacific Ocean. Douglas-fir seedlings were planted in a Nelder circular design in four plots in each zone. Each plot contained 866 trees planted in 18 concentric circles of 48 trees each, with the differences in radii between circles equal to the distance between radial lines. This resulted in spacings of from 300 square centimeters to 15,250 square centimeters per tree. The circle was then divided into six "pie slices" of equal size. Three treatments were then assigned to two of these subplots. The treatments were: (1) total weed control throughout the 5 years of the experiment; (2) complete weed control the first year, followed by grass seeding; and (3) planting alternate radii with Douglas-fir and red alder seedlings in a 50:50 mixture, with complete grass control for the life of the experiment.

Results are presented in Table 1.

The average height and diameter of Douglas-fir was strongly affected by density of Douglas-fir and less by grass and red alder. Effects of grass varied from negligible on the coastal site, where grass was difficult to establish, to a 10.4 meter decrease in diameter. Alder competition varied in its effects, with Douglas-fir diameter growth under alder ranging from 2.4 meters more than in pure conifers to 7.8 meters less, depending on stand density and locality. Both competitor types caused the greatest decreases at the lowest densities of Douglas-fir. Height growth was depressed by both competitors about equally, about 0.63 meters in the first 5 years. The pattern of effect differed by the two competitor types, however. Grass inhibition was greatest during the first 3 years while alder suppression had its greatest effect later, and appears to be gaining rapidly in adverse effect.

Table 1. Effect of inter and intraspecific competition on Douglas-fir plantations over a 5-year period

Density*	Warm, dry site Height (m)	Warm, dry site Diameter (mm)	Warm, moist site Height (m)	Warm, moist site Diameter (mm)	Cool, moist site Height (m)	Cool, moist site Diameter (mm)
Douglas-fir						
High density	2.16	19.6	2.10	18.6	2.14	21.0
Medium density	2.57	29.5	2.37	28.9	2.65	29.1
Low density	2.76	43.9	2.40	39.9	2.80	45.9
Douglas-fir/grass						
High density	2.10	19.3	2.04	17.5	2.13	19.4
Medium density	2.21	27.3	2.18	25.3	2.40	32.7
Low density	2.13	33.5	2.11	31.6	2.88	49.3
Douglas fir/ red alder						
High density	1.68	17.6	1.47	15.9	2.30	21.8
Medium density	2.24	30.0	1.94	23.4	2.42	31.5
Low density	2.78	43.6	2.65	38.7	2.29	38.1

* High density 300 to 1110 square centimeters per tree; medium density 1491 to 4107 square centimeters per tree; low density 5339 to 15,250 square centimeters per tree.

Abstract: Ronald E. Stewart

FPM83-0051

Conard, S. G.; Radosevich, S. R. Growth responses of white fir to decreased shading and root competition by montane chaparral shrubs. Forest Science. 28(2): 309-320; 1982.

Experiments were established in spring 1975 on two sites in Sierra County in the Northern Sierra Nevada mountains in California. Five treatments were installed at each site to explore the effects of root and canopy interference by shrubs on growth of white fir. On each site all treatments were replicated three times in a randomized complete block design. Treatment blocks were 18 x 18 meters square. Treatments consisted of: (1) control; (2) canopy removed, roots undisturbed (manual); (3) shade present, roots killed (manual with herbicide stump treatment); (4) shade removed, roots killed (same as 3 with brush removed); and (5) broadcast herbicide.

White fir growth was doubled in the fourth growing season when artificial shade was provided in conjunction with removal of competing shrubs. A smaller growth increase was observed when no shade was provided if shrub control was greater than 80 percent. Increased soil moisture availability was the most important factor for release. Manual shrub removal may require repeated cutting of resprouts to achieve release. Growth data are presented in bar graphs.

Abstract: Larry Gross

FPM83-0052
Cooley, John H.; Lord, W. B. A study of aspen-balsam fir cutting methods in northern Wisconsin-five year results. Journal of Forestry. 56(10): 731-736; 1958.

A test of cutting methods in the aspen-balsam fir types was installed on the Argonne Experimental Forest in northern Wisconsin in 1950. The aspen overstory averaged 36 years old and the understory of balsam fir with some black and white spruce was 15 to 35 years old. Merchantable volumes of aspen and paper-birch ranged from 10.6 to 11.5 cords per acre with an average of 11.0 cords. Most of the understory conifers were seedlings or saplings and not yet merchantable. Aspen and birch basal area ranged from 60 to 95 square feet per acre with an average of 74 square feet; balsam fir and spruce basal area ranged from 8 to 43 square feet per acre with an average of 24 square feet. Six treatments were established in 5/8-acre square plots in a randomized block design with five replications. Treatments were: (1) no treatment; (2) clearcut - all aspen and birch removed; (3) cut from below - a light thinning from below removing about 10 percent of the volume, remaining aspen and birch to be removed in 1960; (4) cut from above - all aspen and birch having three or more pulpwood sticks were cut, remaining aspen and birch to be cut in 1960; (5) commercial clearcut - all aspen and birch with at least two pulpwood sticks were cut, remaining aspen and birch to be cut in 1960; and (6) to be clearcut in 1960 - all aspen and birch to be removed in 1960.

Average volume and 5-year volume growth for the four treatments cut in 1950 (treatments 2,3,4, and 5) and for the untreated plots are shown in bar graphs. Average 5-year diameter growth for these same treatments is shown graphically. The total production of the understory increased as the volume removed from the overstory increased. Mean cubic foot volumes of the understory were not significantly different between treatments in 1950 before cutting, but by 1955 the mean volumes for all treatments except the cut from below were significantly higher than on the uncut plots. Diameter growth showed a similar trend of increase as overstory volume removed increased.

Abstract: Ronald E. Stewart

FPM83-0053

Croker, Thomas C., Jr. Seedbed preparation aids natural regeneration of longleaf pine. U.S. Department Agriculture Forest Service Research Paper SO-112 New Orleans, LA: U.S. Department Agriculture, Forest Service, Southern Forest Experiment Station; 1975. 7 p.

This paper reports a 7-year study to appraise various types of bed preparation and test the utility of supplemental seedling. The study was on two sharply contrasting sites (Alaga and Bowie soils) of the Escambia Experimental Forest in southern Alabama. The study was repeated 5 times (1966-1970). The sites received three burning treatments: winter burn, fall burn, and no burn. Six seedbed treatments were superimposed on each burning plot; disked, rototilled, rototilled and cultipacked, scaribedded, herbicide, and no treatment. Supplemental seeding was used to provide the equivalent of 100,000 natural seeds per acre.

Both burning and mechanical site preparation significantly improved establishment. The herbicide treatment was ineffective. Burning nearly doubled and mechanical treatment more than doubled seedling establishment. Burning followed by the mechanical treatment was more effective than either treatment alone. Site quality apparently had no effect.

Seedling survival and root-collar diameter of largest seedlings in each 1/4-milacre plot at age 6 years are recorded in Table 1.

Table 1. Effect of seedbed preparation on regeneration of longleaf pine over a 7-year period

Seedbed preparation	Survival (percent)		Root collar diameter (inches)	
	Good site	Poor site	Good site	Poor site
No burn				
Disk	4	1	0.34	0.18
Rototill	5	5	0.33	0.39
Roto-cultipack	21	13	0.52	0.52
Scaribed	21	7	0.56	0.39
Chemical	6	4	0.28	0.29
None	6	1	0.31	0.13
Mean	10	5	0.39	0.32
Winter burn				
Disk	27	14	0.63	0.60
Rototill	28	13	0.61	0.52
Roto-cultipack	19	14	0.52	0.60
Scaribed	31	30	0.51	0.73
Chemical	31	24	0.54	0.61
None	19	15	0.58	0.49
Mean	26	18	0.56	0.59
Fall Burn				
Disk	28	17	0.56	0.65
Rototill	27	24	0.57	0.53
Roto-cultipack	33	14	0.54	0.52
Scaribed	38	25	0.55	0.57
Chemical	21	21	0.49	0.57
None	24	21	0.54	0.61
Mean	28	20	0.54	0.58

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0054

Crouch, Glen L.; Hafenstein, Erwin. Atrazine promotes ponderosa pine regeneration. USDA Forest Service Research Note PNW-309. Portland, OR: U.S. Department Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1977. 7 p.

Atrazine was applied by helicopter on the Cave Mountain Burn near Chiloquin, Oregon to improve survival of planted ponderosa pines subjected to competition from herbaceous vegetation and to predation by pocket gopher. Atrazine improved the seedling-establishment environment; seed fall from scattered overstory trees produced 45 percent stocking and more than 300 trees per acre 7 years after the herbicide was applied. Unfortunately, no untreated plots were established to permit a direct evaluation of weed control. However, comparisions were made among unsprayed buffer areas that were planted or left unplanted and sprayed plots planted with 2-0 ponderosa pine. Results were confounded by a replanting of the sprayed plot.

Abstract: Larry Gross

FPM83-0055

Crouch, Glen L. Atrazine improves survival and growth of ponderosa pine threatened by vegetative competition and pocket gophers. Forest Science. 25(1): 99-111; 1979.

Atrazine was applied to 0.1-acre plots of planted ponderosa pine in south-central Oregon to alleviate competition from herbage and remove the food supply of pocket gophers that prey on the trees. Twenty-four plots were planted with 36 2-0 ponderosa pine seedlings each on late March of 1966. Six replications of four treatments were randomly assigned to the plots. The treatments were: (1) untreated, (2) spring atrazine spray (March 1966), (3) spring and fall atrazine spray (March and November 1966), and (4) spray 1966 (March) and fall 1966 and 1967 (November) atrazine spray. Spring treatments were ineffective, but one or two fall applications doubled survival (55 vs. 25 percent) and greatly increased heights (222 vs. 150 centimeters) of pines after 10 years. Atrazine reduced grasses and forbs the year after fall application and effects persisted through the 10th year. Fall treatments reduced abundance of gopher mounds eightfold compared with no treatment or application of atrazine in spring. The chemical also ameliorated adverse impacts on height growth by other animals and insects.

Survival and height of ponderosa pine seedlings after 10 growing seasons are in Table 1.

Table 1. Effect of atrazine on survival and height growth of ponderosa pine after 10 years

Treatment	Survival (%)	Height (cm)
Untreated	25	146
Spring atrazine	25	153
Spring and fall atrazine	52	210
Spring and fall + fall atrazine	57	234

Abstract: Larry Gross

FPM83-0056

Dahms, Walter G. The effect of manzanita and snowbrush competition on ponderosa pine reproduction. Research Notes No. 65. Portland, OR: U.S. Department Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1950. 3 p.

An untreated and an adjacent 66- by 1000-foot plot were established near Pringle Butte in central Oregon. Manzanita was pulled up by hand, and snowbrush was either grubbed out or chopped off at the ground line on the cleared plot. Development of brush plants and ponderosa pine seedlings was followed on 20 milacre plots along the center line of each strip.

Examination of the plots for 13 years (1934 to 1947) after clearing showed seedling height in Table 1.

Brush did not significantly affect early establishment of pine seedlings but sharply reduced growth of established seedlings. Manzanita was a more severe competitor than snowbrush--seedlings existing at the time of treatment averaged 1.79 feet tall under snowbrush after 13 years but only 0.78 feet under manzanita.

Table 1. Effect of manzanita and snowbrush competition on ponderosa pine reproduction over a 13-year period

	Number of seedlings established	Average seedling height (feet)	
		Existing seedlings	New seedlings (after 1934)
Untreated	39	1.24	0.41
Cleared	26	3.98	0.97

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0057

Dale, Martin E. Effect of removing understory on growth of upland oak. USDA Forest Service Research Paper NE-321. Upper Darby, PA [Station now at Broomhall, PA]: U.S. Department Agriculture, Forest Service, Northeastern Forest Experiment Station; 1975. 10 p.

The amount of additional growth attributed to complete eradication of all woody understory vegetation varied for several widely scattered upland oak stands in the region. The plots were located in eastern Kentucky, southeast Ohio, southeast Missouri (2 locations), and southeast Iowa. On plots selected for eradication of understory, all woody vegetation less than 1.6 inches d.b.h. was killed in early spring after the thinning operation. Larger understory stems were cut and the stumps sprayed to prevent resprouting; foliage spray was used to control smaller trees. Two or three followup treatments in subsequent years were required. The amount of increase was related to (1) geographic stand location, (2) stand age, and (3) residual stocking of overstory trees. The greatest response to understory removal - an additional 0.75 square feet of basal area or about 12 cubic feet per acre per year (an increase of nearly one third) - was found in very young stands located in the western part of the oak range where residual density of stocking after thinning was about 50 percent. Detailed results are presented in table by stand age and stocking level.

Abstract: Larry Gross

FPM83-0058
Della-Bianca, Lino; Olson, David F., Jr. From scraggly oaks to thrifty loblolly - A successful stand conversion in the Piedmont of North Carolina. Southern Lumberman. 1970 December; 3 p.

A 6.5 acre site in Iredell County, North Carolina, containing poor quality hardwoods was converted to loblolly pine in 1960. Fifteen plots 0.4 acres in size were established to study conversion by planting and direct seeding. The area was clearcut with site preparation by disking or by scraping with a K-G blade before disking in February and April of 1960. Nine plots (3 replications of each site preparation treatment and untreated) were planted with 1-0 loblolly pine in late April, 1960. Six plots (3 replications each of the two site preparation treatments) were direct seeded at the same time. The soils were exteremely poor and weather conditions at time of planting and seeding were unfavorable so germination and survival were poor. The direct seeding plots were reseeded in May of 1961.

Average free-to-grow loblolly pine stocking trees per acre, in fall 1969 after 10 years, are in Table 1. Free-to-grow trees ranged from 10 to 24 feet high.

Table 1. Results of stand conversion, hardwood to loblolly pine, over a 10-year period

	Stems per acre				
D.b.h	Bladed and disked		Disked		Untreated
class	Planted	Seeded	Planted	Seeded	Planted
1	0	150	13	140	7
2	50	200	40	130	27
3	120	30	87	30	93
4	80	20	53	10	20
5	20	0	13	0	7
Total	270	400	206	310	154

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0059

Derr, H. J.; Mann, W. F., Jr. Site preparation improves growth of planted pines. U.S. Forest Service Research Note SO-106. New Orleans, LA: U.S. Department Agriculture, Forest Service, Southern Forest Experiment Station; 1970. 3 p.

A study was installed in central Louisiana on a Beauregard silt loam soil with good surface but slow internal drainage. Water stands in the surface during the winter, but not for as long as on more typical flatwoods soils. Seedlings of loblolly and slash pines were hand-planted on 0.4-acre plots following site preparation with one of the following: (1) check -- seedlings planted in undisturbed heavy grass rough; (2) furrowing -- furrows 3 to 4 inches deep were plowed with a conventional fire plow 11 months before planting; (3) flat disking -- strips were double-disked in the summer before planting; and (4) mound disking -- plots were cut twice with a terracing disk during the summer before planting. With each species the four site treatments were replicated three times in a randomized complete block design.

Results after 5 years are presented in Table 1.

None of the site treatments significantly influenced first-year survival of slash pine, and mortality during the following 4 years was low, averaging 2 percent. Initial survival of loblolly pine was high, averaging 92 percent for all treatments. Survival was, however, about 11 percentage points lower on mound-disked plots than on the others.

Site preparation treatments were about equally effective in promoting height growth, but the difference between treated and check plots was significant only for slash pine. Incidence of fusiform rust was greatest on mounded plots for both species.

After 5 years, trees in furrows and on beds were 12 to 16 percent taller and 17 to 42 percent larger in diameter than trees on the untreated check. The response cannot be attributed to better or to poorer moisture conditions in the immediate vicinity of the planted trees. A comparable response on flat-disked plots suggests that some of it may be due to control of grass competition.

Table 1. Effect of site preparation on growth of pines after 5 years

Site treatment and species	Average height (feet) All trees	Average height (feet) 100 tallest trees/acre	Average d.b.h. (inches)	Trees with fusiform rust stem cankers (percent)
Check				
Loblolly	9.4	11.9	1.14	23.1
Slash	10.3	13.6	1.65	34.3
Furrowing				
Loblolly	10.7	13.9	1.54	19.9
Slash	11.9	14.9	2.00	14.7
Flat disking				
Loblolly	10.2	13.0	1.46	22.2
Slash	11.6	14.4	1.96	28.7
Mound disking				
Loblolly	10.5	13.7	1.62	34.6
Slash	11.5	15.1	1.94	48.0

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0060

Derr, H. J.; Mann, W. F., Jr. Bedding poorly drained sites for planting loblolly and slash pines in southwest Louisiana. USDA Forest Service Research Paper SO-134. New Orleans, LA: U.S. Department Agriculture, Forest Service, Southern Forest Experiment Station 1977. 5 p.

See: Cain, Michael D., 1978.

FPM83-0061

DeWit, James N.; Terry, Thomas A. Site preparation effects on early loblolly pine growth, hardwood competition, and soil physical properties. In: Proceedings of the Second Biennial Southern Silvicultural Conference; 1982 November 4-5; Atlanta, GA. General Technical Report SE-24. Ashville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station; 1983; 40-47.

A study was installed on fine-textured, somewhat poorly drained soils of the Falkner and Wilcox series located in the interior flatwoods of Kemper County, Mississippi. The study site is on an upper slope position with a 2 to 3 percent slope that aids in drainage of excess surface water. A randomized block design with four replications was used to determine the response of planted 1-0 loblolly pine to three site preparation techniques: (1) tree-crushed with a Letourneau "tree crusher"; (2) K-G sheared and rootraked-piled; and (3) K-G sheared, rootraked-piled, and bedded.

Results for loblolly pine 8 years after planting are shown in Table 1.

Significant survival and stocking differences were not observed across the three treatments. The topographic positions where this study is located, an upper slope position with a gentle grade, is conducive to drainage of excess surface water which is beneficial for seedling survival. Significant pine height growth responses were found on shear-pile and shear-pile-bed plots. The growth advantages exhibited by the bedded plots were evident at an early age. Height growth differences between treatments still appear to be increasing after 8 years. Total pine volume on the bedded plots is 110 percent greater than on the tree-crush plots and 24 percent greater than on the shear-pile treatment. By increasing the early growth rate of pine, the more intensive site preparation treatments increased the proportion of trees infected with fusiform rust. Because of the growth advantage on the bedded site, the first thinning would occur earlier than on the other treatments and, except for some possible early mortality, the actual pine volume and value loss may not be too great.

Pine and hardwood basal area at age 8 are shown in Table 2.

In this study the shear-pile treatment reduced hardwood competition proportionally more than the bedding treatment. Total basal area of pine and brush was relatively constant among treatments, but the more intensive treaments appeared to redistribute basal area from brush to pine in almost a 1:1 proportion. Incremental gains in tree growth were greater between the shear-pile and tree-crush treatments. The most plausible explanation for this trend is that brush, which was reduced most by the shear-pile treatement, was limiting pine growth more than the soil physical properties that were modified by bedding.

Table 1. Effect of site preparation on growth of loblolly pine after 8 years

Growth and survival	Tree-crush	Shear-pile	Shear-pile -bed
Average height (m)	4.9	5.5	5.9
D.b.h. (cm)	6.7	7.9	9.0
Basal area (sq m/ha)	4.7	7.8	9.4
Volume (cu m/ha)	11.5	19.3	24.0
Survival (%)	72.0	82.0	71.0
Trees/hectare	1268.0	1584.0	1458.0
Incidence of bole cankers (%)	14.9	25.8	34.0

Table 2. Effect of site preparation on basal area of pine and hardwood after 8 years

	Basal area (sq m/ha)		
	Tree-crush	Shear-pile	Shear-pile-bed
Pine	4.7	7.8	9.4
Brush	5.6	2.3	1.9
Total	10.3	10.1	11.3

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0062

Dierauf, Thomas A. Research studies on response to release in the Commonwealth of Virginia. Unpublished report, on file. Charlottesville, VA: Commonwealth of Virginia, Department of Conservation and Economic Development, Division of Forestry; 1977.

Seventeen release studies were installed on various state forests throughout the Piedmont of Virginia. All areas were loblolly pine plantations established after clearcutting oak-hickory or pine-hardwood stands. Site preparation treatments included injection of residual hardwoods, prescribed burning, or mechanical clearing with a bulldozer. Treatments were usually replicated two or three times; the maximum replication was eight in the District 4 release study. Plots generally contained different numbers of trees at the start of the study with greater mortality on the unreleased plots. In several cases, basal areas of plots were adjusted by covariance analysis to account for differences in stocking. On the average, pines lost about 1 foot of height due to spray damage resulting from aerial spraying. Damage also occurred after mist blower applications. Results from the 17 studies are summarized in Table 1.

Table 1. Effect of release on development of loblolly pine

Location and release method	Age when released	Age when measured	No. pines	D.b.h. (in)	Basal area (sq ft/ acre)	Volume (std cords /acre)
HAND CUTTING						
Cumberland HQ	9	15	-	-	-	-
Released			-	6.03	91.7	15.4
Unreleased			-	5.76	78.7	12.8
District 4	2-4	10-12	-	-	-	-
Released			640	3.69	57.1	-
Unreleased			590	2.91	35.0	-
Pocahontas (Hand)	5	10	-	-	-	-
Released			902	3.67	70.6	-
Unreleased			818	3.56	61.3	-
Willis - 4	5	14	-	-	-	-
Released			750	4.22	83.7	7.9
Unreleased			596	2.98	39.2	2.1
Jamerson	5	14	-	-	-	-
Released			1075	4.49	126.0	12.6
Unreleased			1041	4.27	110.7	9.9
Bradshaw	3	8	-	-	-	-
Released			139	2.1	6.3	-
Unreleased			144	1.4	3.6	-
MIST BLOWER						
Coles Tract (1967)	4	13	-	-	-	-
Released			563	5.06	86.9	12.3
Unreleased			407	4.12	47.2	5.7
Coles Tract (1968)	2	8	-	-	-	-
Released			492	3.90	44.3	-
Unreleased			522	3.00	31.4	-
Biscoe Tract	2	13	-	-	-	-
Released			462	5.56	81.3	10.3
Unreleased			315	4.33	39.6	4.2
Pocahontas State For.	4	11	-	-	-	-
Released			702	4.65	89.0	-
Unreleased			670	4.20	70.5	-

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation of forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

Table 1. (continued)

Location and release method	Age when released	Age when measured	No. pines	D.b.h. (in)	Basal area (sq ft/ acre)	Volume (std cords /acre)
AERIAL SPRAY						
R.S. Burruss	4	8	-	-	-	-
Released			671	3.44	42.7	-
Unreleased			627	2.51	25.7	-
Headquarters Road	4	8	-	-	-	-
Released			404	3.80	33.1	-
Unreleased			428	3.68	33.0	-
Slate River Trail	4	8	-	-	-	-
Released			570	3.88	48.7	-
Unreleased			485	4.11	47.0	-
Price Tract	2	6	-	-	-	-
Released			523	1.82	10.8	-
Unreleased			457	1.00	3.9	-
HANDS VS MIST BLOWER						
Ferguson Tract	5	14	-	-	-	-
Hand			660	4.52	82.4	9.0
Mist blower			477	4.40	55.6	5.5
Unreleased			457	3.98	46.2	4.0
Gallion Tract	2	10	-	-	-	-
Hand			505	4.30	55.5	
Mist blower			654	3.44	48.0	-
Unreleased			522	3.03	34.3	-
Owens Tract	3	8	-	-	-	-
Hand			495	3.90	43.6	
Mist blower			546	3.85	47.1	-
Unreleased			498	3.62	38.3	-

Location	Age	Adjusted difference in basal area (sq ft/acre) a/
Coles Tract (1967)	13	28.0
Ferguson - Hand	14	14.9
- Mist blower	14	5.8
Biscoe Tract	9	18.1
Pocahontal (Hand)	10	3.4
Willis - 4	10	13.9

a/ Difference between treated and untreated after covariance analysis

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation of forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0063

Dimock, Edward J., II; Collard, Ernest B. Postplanting sprays of dalapon and atrazine to aid conifer establishment. Research Paper PNW-280. Portland, OR: U.S Department Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1981. 16 p.

Dalapon and atrazine alone and in combination were applied as postplanting sprays to control perennial grasses and forbs competing with newly planted seedlings of ponderosa pine and Douglas-fir.

In a series of four studies on the Wallowa-Whitman National Forest in Eastern Oregon, dalapon alone and in combination with atrazine was applied over planted ponderosa pine and Douglas-fir to control perennial grasses and forbs. Each site supported an intact randomized complete block experiment with five blocks and seven treatments per block. Each treatment within a block was randomly assigned to a single row of 25 trees planted perpendicular to the land contour.

Tree survival was similiar for all treatments and control. This is attributed to a cool, moist spring followed by above average precipitation in July and August, 1975. The dalapon-atrazine combination reduced grass and forb cover the first year by averages of 80 and 58 percent, respectively, and effective control persisted for 2 to 3 years. Dalapon alone was ineffective in controlling forbs.

To retest dalapon and atrazine sprays, two studies were initiated in 1976 on the Wallowa-Whitman National Forest in Eastern Oregon and the Wenatchee National Forest, Entiat, Washington. Both ponderosa pine and Douglas-fir were tested at each location. Each study was a randomized complete block with three blocks of seven treatments per block. Each treatment was randomly allocated to one of the seven square 1/100-acre plots. Fifteen ponderosa pine and 15 Douglas-fir seedlings were planted on each plot. In this study atrazine was substituted for the lower rate of dalapon.

Climatic factors generally favored conifers planted in 1976. First-year survival on untreated plots was 82 to 91 percent. Dalapon and atrazine, mixed at rates that were the same as the first study, reduced grasses 82 percent and forbs 48 percent the first year. Effective control persisted 2 to 4 years. Dalapon reduced grass 49 percent but did not control forbs.

Atrazine reduced grasses 47 percent and forbs 37 percent the first year with control of all herbaceous species persisting only about one year. Ponderosa pine and Douglas-fir survival and height are displayed in tables.

Abstract: Larry Gross

FPM83-0064

Dimock, Edward J., II. Herbicide and conifer options for reforesting upper slopes in the Cascade Range. Research Paper PNW-292. Portland, OR: U.S. Department Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1981. 14 p.

Nine herbicides were compared for aiding establishment of four conifer species on upper-slope forest sites dominated by sedge and beargrass. A separate study was conducted on each of three ranger districts: Mount Adams, Gifford Pinchot National Forest; McKenzie, Williamette National Forest; and Prospect, Rogue River National Forest. Site elevations of study blocks averaged 4000 feet.

Each study supported an intact split-plot (two species as sub-plots), randomized complete-block experiment replicated in 3 blocks. Each block contained 20 treatments (herbicides and rates) and 2 application times (preplanting and postplanting) randomly allocated to each of 40 square 1/100-acre main plots. Fifteen pine and 15 fir or spruce seedlings were planted on each plot. All studies were begun in 1977 and monitored for 3 years.

After 3 years the greatest gains in conifer survival were associated with glyphosate or atrazine and dalapon treatments. Third year survival is shown in Table 1.

Table 1. Effects of herbicide on reforestation over a 3-year period

	Third year survival (percent)					
	Western white pine			Noble	Englemann	Shasta
Treatment	McKenzie	Mt. Adams	Prospect	fir	spruce	red fir
Control	40	34	4	12	14	0
Glyphosate	80	77	30	56	30	14
Atrazine & dalapon	62	77	14	33	46	16

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0065
Dimock, Edward J., II; Beebe, Thomas F.; Collard, Ernest B. Planting-site preparation with herbicides to aid conifer reforestation. Weed Science. 31: 215-221; 1983.

Seven herbicides and two herbicide combinations, applied once either preplant or postplant to prepare planting sites for 2 year old ponderosa pine and Douglas-fir were evaluated for control of perennial grasses and forbs in studies at two locations: Wenatchee National Forest, Entiat, Washington and Wallowa-Whitman National Forest, Enterprise, Oregon.

Study design was the same at each location. Each study was divided into two experiments. Each experiment contained a separate untreated control and comprised a randomized complete block with 3 blocks of 13 and 7 treatments in the first and the second experiments, respectively to permit objective comparisions between experiments. Treatments from each were pooled and randomly distributed within discrete blocks of 20 square 1/250 hectare plots. Results at Enterprise, Oregon were monitored for two growing seasons. The Entiat, Washington plots were monitored for 4 seasons for weed control, and 6 seasons for conifer survival and growth.

Largely because favorable weather followed planting, no herbicide or combination significantly increased tree survival. Significant weed control up to 4 years was attained with either hexazinone or a combination of dalapon plus atrazine in Washington, where each conifer species responded with exponential growth increases over a 6-year period. For ponderosa pine and Douglas-fir, respectively, hexazinone increased tree height by 58 and 70 percent, stem diameter by 70 and 69 percent, and stem volume yield by 387 and 650 percent, as compared to untreated checks. Corresponding gains for conifers associated with dalapon and atrazine were 73 and 54 percent in height, 63 and 46 percent in diameter, and 421 and 349 percent in yield. Either preplant or postplant applications of hexazinone were highly effective, but postplant application of dalapon and atrazine injured conifers unless seedlings were protected at time of treatment.

Abstract: Larry Gross

FPM83-0066

Eckert, Richard E., Jr. Establishment of pine (*Pinus* spp.) transplants in perennial grass stands with atrazine. Weed Science. 27(3): 253-257; 1979.

Atrazine applied as a preplant treatment at rates of 2.24 to 8.96 kilograms per hectare was evaluated for the control of perennial grasses and the establishment of Jeffrey and ponderosa pine transplants on the Toiyabe National Forest west of Reno, Nevada. The most consistent and effective rates of atrazine (6.72 and 8.96 kilograms per hectare) reduced grass herbage biomass an average of 72 percent over a 3-year period and increased survival of transplants from 1 percent on the control to 66 percent with treatment. Results after 4 years appear in Table 1.

Table 1. Effect of atrazine on survival of pine transplants after 4 years

	Survival of Jeffrey and Ponderosa Pine Transplants (percent)			
	2-0 Jeffrey pine Dog Valley Planted 1969	1-0 ponderosa pine, Dog Valley, Galena Cr. Planted 1970		2-0 Jeffrey pine Galena Cr. Planted 1971
Treatment kg/ha	1972	1972	1972	1973
Check	0	0	0	3
Atrazine 2.24	41	16	29	-
Atrazine 4.48	81	33	46	79
Atrazine 6.72	86	67	41	-
Atrazine 8.96	-	66	54	79

Abstract: Larry Gross

FPM83-0067

Eis, S. Effect of vegetative competition on regeneration of white spruce. Canadian Journal of Forest Research. 11(1): 1-8; 1981.

The rate of invasion and height growth of vegetation in logged-over areas were studied on four forest site types in the white spruce--alpine fir forests north of Prince George, B.C. On Cornus-Moss, Aralia-Dryopteris, and Devil's Club site types, which generally had full stocking, vegetation that grew under the canopy of trees was replaced after logging by aggressive pioneer species. Annuals were the first to invade the logged-over area, followed by biennials and perennials. The invasion of shrubs was the slowest. After logging, 6 or 7 years elapsed before vegetation became a serious hindrance to regeneration and, by that time, white spruce seedlings planted immediately after logging were tall enough to withstand competition. On the Alluvium site type, where stocking is usually open and shrubs and grasses that thrive in the logged-over areas are present, spruce seedlings were overtopped during the first growing season and eliminated as the density of shrubs increased.

Height growth of seeded seedlings, 2+0 and plug planting stock, and competing vegetation is shown graphically for the first seven growing seasons. On the Alluvium site, while density of vegetation kept increasing for several more years, 3 years after logging the competition was already so intense that on plots where shrubs were not annually removed, height growth of spruce was usually less than 2 centimeters and mortality was severe. On these plots, practically all seedlings died within 5 years after outplanting or seeding as the shrub competition intensified. Even where competing vegetation was annually cut, the growth potential of seedlings was not approached.

Abstract: Ronald E. Stewart

FPM83-0068
Elwell, Harry M. Herbicides for release of shortleaf pine and native grasses. Weeds. 14-15: 104-107; 1966.

Ten plots were installed to test amine and ester formulations of 2,4,5-T for releasing shortleaf pine from oaks, hickory, winged elm, and other species in southeastern Oklahoma. September and May applications of both formulations were aerially sprayed with 1.5 pounds in 5 gallons per acre of spray according to the following schedule: (1) entire plot in September 1957 or May 1958; (2) 2/3 retreated 1 year later; and (3) 1/3 retreated again 2 years after the initial spray. Diameters of 30 shortleaf pine (60 trees total for two replications) in each size class of seedling, sapling, small pole, and large pole were measured at the beginning of the study and 4 years after the last application of 2,4,5-T (7 years after the initial spray). Results are in Table 1.

Seedlings responded less to treatment than the other size classes, perhaps due to relatively greater herbicide injury. There was a moderately good correlation between defoliation of undesirable hardwoods in 1960 and increased growth compared to the untreated plots. There was little, if any, increase in pine growth from repeated treatments compared to single treatments.

Table 1. Diameter growth of shortleaf pine over a 7-year period by method of release

Method of release	Diameter increase in inches (1957-64)				
	Seedlings	Saplings	Small pole	Large pole	Average
2,4,5-T ester					
May 0	0.8	1.1	1.3	0.9	1.0
1.5	1.9	1.3	1.6	1.6	1.6
1.5 + 1.5	1.0	1.4	2.0	1.8	1.6
1.5 + 1.5 + 1.5	0.9	1.3	1.9	1.6	1.4
Sept. 0	0.8	1.1	1.3	0.9	1.0
1.5	0.9	1.7	1.6	1.5	1.4
1.5 + 1.5	0.9	1.3	1.7	1.6	1.4
1.5 + 1.5 + 1.5	0.7	1.4	1.9	1.6	1.4
2,4,5-T amine					
May 0	0.9	1.2	1.6	1.7	1.3
1.5	1.5	2.0	2.4	1.8	1.9
1.5 + 1.5	1.3	1.9	2.2	2.6	2.0
1.5 + 1.5 + 1.5	1.4	2.1	2.2	2.2	2.0
Sept. 0	0.9	1.2	1.6	1.7	1.3
1.5	0.7	1.3	1.9	1.6	1.4
1.5 + 1.5	1.1	1.5	1.8	1.9	1.6
1.5 + 1.5 + 1.5	1.1	1.2	1.5	1.6	1.4

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0069

Engle, Lamont G. Releasing white pine from oak and aspen. Technical Notes No. 346. St Paul, MN: U.S. Department Agriculture, Forest Service, Lake States Forest Experiment Station; 1951. 2 p.

A study was established in lower Michigan to compare growth of white pine to hardwood sprouts after release by cutting of the hardwood overstory. Small suppressed white pine released from oak and aspen overstories often become overtopped by sprouts of these species and need to be released again. The taller the pine is at the time of release, the better it is able to compete with the sprout growth.

Observations were made of response to release on three areas. Results are presented graphically showing hardwood sprout and white pine height growth for 8 or 12 years after release. On the first area, pines were 1 foot high and 4 years old when released. They were soon overtopped. On the second area, the pines were 5.5 feet high and 19 years old when released. They were overtopped by some oak sprouts 12 years later, but were still growing well. On the third area, the pines were 8.5 feet high and 22 years old when released. They were still taller than the aspen sprouts after 8 years.

It appears that the white pine must be at least 4 to 5 feet tall and preferably 6 to 8 feet tall before it can successfully compete with hardwood sprouts. The pine usually requires 2 to 3 years after release to respond with improved height growth.

Abstract: Larry Gross

FPM83-0070

Erdmann, Gayne G. Weed control and fertilization in white pine plantings of western Iowa. U.S. Forest Service Research Note CS-36. Columbus, OH: U.S. Department Agriculture, Forest Service, Central States Forest Experiment Station; 1965. 6 p.

The study attempted to increase early seedling survival and growth by controlling weed competition with a herbicide (one application of simazine at 4 pounds per acre and two applications of simazine at 2 pounds per acre each) and black plastic mulch, by reducing soil alkalinity with an acidifying chemical, and by increasing soil fertility with fertilizers in western Iowa. Existing weeds were eliminated by disking or by plowing and disking before the seedlings were planted.

The results indicated that none of the treatments studied significantly affected survival or growth. The greater than average rainfall (4.5 and 5.5 inches more) during the first two growing seasons probably minimized the competitive effects of weeds on pine seedlings.

Abstract: Larry Gross

FPM83-0071
Erdmann, Gayne G.; Green, Leeroy. Chemical weed control in a two-year-old walnut planting. U.S. Forest Service Research Note NC-28. St. Paul, MN: U.S. Department Agriculture, Forest Service, North Central Forest Experiment Station; 1967. 4 p.

In May 1965 an experiment was established in east-central Iowa to evaluate several combined herbicide treatments for weed control around two-year-old black walnut trees.

Seven weed control treatments were replicated three times for each of three tree size classes. Treatments were randomly assigned to individual trees in each size class.

The weed control treatments were:

1. Amitrole 2 lb/acre, and simazine 4 lb/acre
2. Amitrole 2 lb/acre, and atrazine 4 lb/acre
3. Paraquat 1/2 lb/acre with Ortho X-77 spreader, and simazine 4 lb/acre
4. Paraquat 1/2 lb/acre with Ortho X-77 spreader, and atrazine 4 lb/acre
5. Dalapon 4 lb/acre, and simazine 4 lb/acre
6. Dalapon 4 lb/acre, and atrazine 4 lb/acre
7. Control--no herbicide

During May 25-28, 1965, the herbicide mixtures in water solutions and suspensions were sprayed on the foliage of the ground vegetation over a 6- by 6-foot plot around each walnut tree. The mean height and diameter growth two years after treatment are shown in Table 1.

Table 1. Effect of chemical weed control on height and diameter growth of black walnut two years after treatment

Weed control treatment	Mean height (feet)	Mean diameter (32nd inch)
Amitrole 2 lb/acre and simazine 4 lb/acre	8.4	49
Paraquat 1/2 lb/acre and atrazine 4 lb/acre	8.3	53
Paraquat 1/2 lb/acre and simazine 4 lb/acre	7.9	50
Amitrole 2 lb/acre and atrazine 4 lb/acre	7.7	48
Dalapon 4 lb/acre and simazine 4 lb/acre	7.5	46
Dalapon 4 lb/acre and atrazine 4 lb/acre	7.6	45
Control--no herbicide	7.0	39

Abstract: Ronald E. Stewart

FPM83-0072

Erdmann, Gayne G. Chemical weed control increases survival and growth in hardwood plantings. U.S. Forest Service Research Note NC-34. St. Paul, MN: U.S. Department Agriculture, Forest Service, North Central Forest Experiment Station; 1967. 4 p.

In April 1963 a study was established in east-central Iowa to evaluate the effect of 2 ground preparation and six weed control treatments on the survival and height growth of black walnut, red oak, yellow-poplar, and white ash.

A split-split plot design in randomized blocks was used. Each of five blocks was divided into two main plots. Ground preparation treatments assigned to main plots were: 1. Fall plowing plus spring disking and harrowing; 2. No ground preparation. Main plots were divided into six weed control sub-plots each 12 x 42 feet. The six weed control treatments were: (1) simazine 4 pounds per acre, (2) simazine 2 pounds per acre, (3) atrazine 4 pounds per acre, (4) atrazine 2 pounds per acre, (5) black plastic mulch (26 1/2 inches square), and (6) no weed control. Herbicides were applied in April 1963, then 14 one-year-old seedlings of each species were machine planted on each sub-plot.

The four species grew best on plots treated with 4 pounds per acre of simazine or atrazine. Neither weed control nor ground preparation treatments affected 2-year survival of black walnut or red oak trees. Survival and growth of plastic-mulched trees generally were the same as for control trees. Even the best weed control treatments failed to provide any residual weed control during the second growing season.

Average 2-year basal diameter growth and second-year height of trees by weed control treatment are presented in Table 1.

Table 1. Average two-year height and diameter growth by weed control treatment

Weed control treatment	Yellow-poplar Height (in)	Yellow-poplar Dia. (32nds)	Black walnut Height (in)	Black walnut Dia. (32nds)	Red oak Height (in)	Red oak Dia. (32nds)	White ash Height (in)	White ash Dia. (32nds)
Atrazine 4 lb/acre	48	19	40	16	17	2	31	12
Simazine 4 lb/acre	37	12	32	12	14	2	26	10
Atrazine 2 lb/acre	29	7	29	8	13	1	20	7
Simazine 2 lb/acre	29	7	23	4	11	1	17	5
Plastic mulch	17	1	14	0	8	0	13	3
No weed control	16	0	13	0	8	0	8	0

Abstract: Ronald E. Stewart

FPM83-0073

Eyre, F. H. Aspen competition in Norway pine plantations. Journal of Forestry. 31(1): 318-321; 1933.

This is a study of three adjacent plantations of Norway and white pine, south of Birch Lake, Superior National Forest, Minnesota. The area, when logged, supported a stand of approximately 50,000 board feet per acre of Norway and white pine. The area was burned several times and planted to Norway and white pine in 1915 and 1917. Second year survival of Norway pine was 85 percent. Average survival in 1924 was 76 percent and in 1931, 51 percent.

Aspen competition had become very aggressive by 1931. Information gathered in 1931 shows that the plantations have regressed. The number of planted pines is yearly decreasing because of aspen competition. The basal area growth of the pine is not keeping up with that of aspen. There has been an appreciable loss in rate of height growth of pine and more and more pines are becoming suppressed.

Heights and basal areas of pine and aspen 18 or 19 years from seed are shown in Table 1.

Table 1. Effect of aspen competition on survival of Norway pine over an 18 to 19-year period

Plantation and composition	Pine		Aspen	
	Average height (ft)	Basal area /acre (sq ft)	Average height (ft)	Basal area /acre (sq ft)
1915 Norway pine				
Pine	18.7	31.22	20.2	1.66
Pine-aspen	18.3	24.80	25.5	11.28
Aspen-pine	16.1	13.01	24.5	33.03
Aspen	9.3	4.76	29.6	52.81
1917 Norway pine				
Pine	16.2	17.85	17.5	0.85
Pine-aspen	13.4	13.44	21.6	5.95
Aspen-pine	13.6	8.41	24.4	16.48
Aspen	-	-	-	-
1917 White pine				
Pine	12.2	7.92	15.0	0.56
Pine-aspen	12.2	7.81	18.6	2.56
Aspen-pine	10.3	4.40	23.9	15.74
Aspen	9.3	0.82	24.4	31.30

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0074

Fago, Clifford E. Ponderosa pine growth response on a California Division of Forestry fuelbreak. California State Forest Notes No. 49. Sacramento, CA: California Division of Forestry; 1972. 2 p.

A study was established on a 6-year-old fuelbreak on Boggs Mountain State Forest, Lake County, California, to measure response of ponderosa pine to release from a dense brush understory and pine competition. The fuelbreak contained 4- to 8-foot high brush (primarily manzanita) and dominant pine reproduction 15 feet high and 4 inches d.b.h. at the time of construction in 1965. All brush in a 75-foot strip on each side of a road was hand cut in 1965 and brush seedlings and sprouts spot sprayed with 2,4-D and 2,4,5-T mixture in 1969. Ponderosa pine reproduction was thinned to an average 10 x 10 foot spacing. Growth of 92 dominant released trees was compared in 1971 with growth of 92 dominant trees growing with dense brush and codominant pine reproduction. Four-tree groups within and outside the fuelbreaks were paired and replicated 23 times in a paired plot design.

Five-year diameter growth of released trees was 38 1/2 percent greater than diameter growth of control trees adjacent to the fuelbreak (1.8 inches versus 1.3 inches). Five-year height growth of released trees was only 1.6 percent higher (8.25 feet versus 8.05 feet). Removal of competing vegetation substantially increased ponderosa pine diameter growth but had little effect on height growth in the first 6 years after release. Released trees were noticeably more vigorous with higher live crown to total height ratios than unreleased trees.

Abstract: Ronald E. Stewart

FPM83-0075
Ferguson, E. R. Response of planted loblolly pines to reduction of competition. Journal of Forestry. 56(1): 29-32; 1958.

Loblolly pine seedlings were planted near Nacogdoches, Texas, during two separate years in a stand of immature shortleaf pine-loblolly pine-hardwoods with a sweetgum and oak understory. These stands contained 237 pine stems with a basal area of 44 square feet and 1,028 hardwood stems with a basal area of 63 square feet per acre. Three treatments were compared for the first year of planting: (1) untreated check; (2) control of hardwoods 1 inch d.b.h. or greater by cutting or girdling and poisoning before planting; (3) clearcutting both hardwoods and pines before planting. These plots were replanted the following year and three sets of new plots were installed before planting: (4) control of hardwoods; (5) clearcutting; and (6) prescribed burning. Height after two or three growing seasons was shown in bar graphs. Trees were also planted in an open abused Bermudagrass pasture in untreated grass or in scalped spots cleared to 10 inches around each seedling. This test was installed in 1953-54 and again in 1954-55. Table 1 shows survival.

During dry seasons, first-year survival improved with increased intensity of release but there was little effect during a year when rainfall was well distributed (1955). Release from competition increased height growth --the increase was roughly proportional to degree of release. Seedlings on freshly prepared sites made better height growth than those planted on sites prepared the year before.

Table 1. Response of lobloly pine to release treatment

Method and year of treatment		Original planting 1953-54 3-yr survival (%)	Replanting 1954-55 2-yr survial (%)	Original planting 1954-55 2-yr survival (%)
Wooded area				
Untreated		13	64	--
Hardwoods controlled	(1953)	72	80	--
Clearcut	(1953)	18	76	--
Hardwoods controlled	(1954)	--	--	79
Clearcut	(1954)	--	--	42
Prescribed burn	(1954)	--	--	49
Open field				
Untreated		10	84	--
Scalped	(1953)	23	--	--
Scalped	(1954)	--	--	84

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation of forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0076

Fisher, R. T. The yield of volunteer second growth as affected by improvement cutting and early weeding. Journal of Forestry. 16(5): 493-506; 1918.

Based on experiments, computations, and experience, the expected development of a 5-, 20-, 40-, and 50-year-old mixed eastern white pine and hardwood forest type is described with and without improvement cutting and weeding. The data and information presented were gathered on or near the Harvard Forest, northern Worcester County, Massachusetts. The area is within the main white pine region of the state but is in a transition zone between northern and central forest types.

Yield computations were based on estimation of tree response for various crown classes and on height and diameter curves derived from stem analysis of normal trees. Data on existing stand conditions were obtained from four areas containing stands of the appropriate ages. The calculated yields at a rotation age of 60 years for a stand treated at age 20, 40, and 50 are estimated in Table 1.

Table 1. Effect of improvement cutting and weeding on expected yield of eastern white pine when 60 years old

Age of stand when treated (years)	Expected final volume without improvement cutting		Expected final volume with improvement cutting	
	Saw timber (fbm/acre)	Firewood (cds/acre)	Saw timber (fbm/acre)	Firewwod (cds/acre)
20	12,956	12.4	32,320	20.4
40	13,880	22.7	17,356	23.3
50	12,820	8.5	16,064	9.6

Abstract: Ronald E. Stewart

FPM83-0077

Fisher, Richard F.; Adrian, Fredrick. Bahiagrass impairs slash pine seedling growth. Tree Planters' Notes. 32(2): 19-21; 1981.

While studying the survival and growth of slash pine on sandy dredge mine tailings in North Florida it was observed that bahiagrass had a pronounced effect on the growth of slash pine. As the percent of bahiagrass increased, the height of 3-year-old pine decreased.

In two greenhouse trials it was found that bahiagrass competition not only significantly reduced growth of pine, but there was an apparent allelopathic effect of the bahiagrass mulch.

Dry weight per tree for 1-0 slash pine grown for 20 weeks in the greenhouse with and without living bahiagrass and bahiagrass mulch is shown in Table 1.

For pines growing in the presence of bahiagrass on sandy dredge mine tailings, the relationship between 3-year height (meters) and bahiagrass cover (percent) was: $Y = 1.42 - 0.0073x$ with an r^2 of 0.98. Each data point was derived from the mean value of 10 randomly placed 10 x 10 inch plots.

Table 1. Effect of bahiagrass competition on greenhouse grown slash pine over a 20-week period

	Dry weight per tree (grams)			
	High moisture		Low moisture	
Treatment	Fertilized	Unfertilized	Fertilized	Unfertilized
Peat moss mulch	7.2	6.8	4.4	7.1
Bahiagrass mulch	4.2	3.8	1.0	2.8
Living bahiagrass	1.4	2.6	0	1.7

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0078

Fitzgerald, C. H.; Richards, R. F.; Selden, C. W.; May, J. T. Three-year effects of herbaceous weed control in a sycamore plantation. Weed Science. 23(1): 32-35; 1975.

A series of 0.04-hectare plots was established in the flood plain of Long Creek, Wilkes County, Georgia. The study was established in a randomized complete block design to include 5 replications of simazine, atrazine, and ametryne alone at rates of 4.5 and 9.0 kilograms per acre and mixtures of simazine at 4.5 kilograms per acre plus dalapon at 5.6 kilograms per acre. Check plots without herbicides included both 10-10-10 fertilizer broadcast at 350 kilograms per acre and no fertilizer. All plots were planted to 1-0 sycamore seedlings the winter of 1969-1970 and herbicides were then applied on May 3, 1970.

Growth during the 3-year observation period was positively correlated with weed control obtained in the first months of the initial growing season. Results after 3 growing seasons appear in Table 1.

Table 1. Effects of herbaceous weed control on three-year sycamore growth

Treatment (kg/ha)	Tree volume (cubic cm)	Tree height (cm)	Tree diameter (cm)
Atrazine 4.5	5065	373	6.3
Atrazine 9.0	4901	358	6.2
Atrazine 4.5 + Dalapon 5.6	5375	347	6.2
Simazine 4.5	2972	348	5.1
Granular Simazine.4.5	3226	350	5.4
Simazine 9.0	4438	380	6.0
Simazine 4.5 + Dalapon 5.6	4865	390	6.2
Ametryne 4.5	4882	395	6.4
Ametryne 9.0	5052	384	6.2
Fertilizer 350	1890	327	4.4
Check	1223	275	3.6

Abstract: Larry Gross

FPM83-0079

Fitzgerald, Charles H.; Selden, Charles W., III. Herbaceous weed control accelerates growth in a young yellow-poplar plantation. Journal of Forestry. 73(1): 21-22; 1975.

A site, on an alluvial sandy loam, in Wilkes County, Georgia, was mechanically site prepared in the spring of 1970 and planted to 1-0 yellow-poplar in January 1971. Plots were superimposed in a randomized factorial block design and assigned five replications of the following treatments: atrazine, 4 pounds per acre as a wettable powder; simazine, 4 pounds per acre as a wettable powder; simazine, 4 pounds per acre as a granular formulation; and checks. All herbicides were applied March 28, 1971.

Table 1 shows results after three seasons.

A single treatment of atrazine applied immediately after planting tripled wood volume production. Volume growth on plots treated with simazine was twice the checks.

Table 1. Effect of herbaceous weed control on growth of young yellow-poplar after 3 seasons

Treatment	Herbaceous vegetation control (%)	Tree survival (%)	Mean tree height (cm)	Mean tree diameter (cm)
Atrazine WP	80	76	247	3.5
Simazine WP	70	68	184	2.9
Simazine G	40	61	202	3.0
Check	0	67	167	2.5

Abstract: Larry Gross

FPM83-0080

Freeman, Phillip C.; Van Lear, D. H. Performance of eastern white pine and competing vegetation following two methods of stand conversion. Southern Journal of Applied Forestry. 1(3): 7-9; 1977.

A 2x2 split-plot experiment in a randomized complete block design with three replications was installed in a 100-year-old unevenaged stand of upland oaks and hickories with scattered yellow-poplar and shortleaf pine in the Piedmont of South Carolina on the Clemson Experimental Forest. Two conversion methods, clearcutting and planting versus residual overstory with underplanting, were the main treatments. The secondary treatment was control of competing vegetation with foliage and stump sprays of 2,4,5-T. Plots were hand-planted with 2-0 eastern white pine (the study area is near the limits of the range of this species). Table 1 shows diameter and leader growth the second season after planting.

Analysis of variance showed a significant interaction between overstory and herbicide effect, which was indicative of a positive diameter response to herbicide treatment only in the clearcut. No significant difference in leader growth was detected. Seedling diameters were increased by herbicide treatment in the clearcut but not under the residual overstory. Intensive competition from tall hardwood sprouts in unsprayed clearcut plots apparently inhibited diameter growth of white pine seedlings.

Table 1. Diameter and leader growth of white pine by method of treatment after two growing seasons

Treatment		Diameter (inches)	Leader growth (inches)
Clearcut	Unsprayed	0.32	8.8
	Sprayed	0.41	9.4
Residual	Unsprayed	0.28	8.3
	Sprayed	0.29	8.4

Abstract: Ronald E. Stewart

FPM83-0081

Freese, Frank, Jr. Pine growth doubled by improvement cutting. Southern Forestry Notes No. 67. New Orleans, LA: U.S. Department Agriculture, Forest Service, Southern Forest Experiment Station; 1950. 4 p.

Two years after they were released from overtopping hardwoods, young shortleaf and loblolly pines near Birmingham, Alabama, have nearly doubled their annual height growth.

A heavy improvement cutting in 1947 removed all undesirable trees more than 1.5 inches d.b.h. Shortleaf and loblolly pine responded about equally well to release. Average height growth was 8.5 inches before treatment, 8 inches one year after treatment, and 16 inches the second year after treatment.

Abstract: Larry Gross

FPM83-0082

Fritz, Emanuel; Rydelius, James A. Response of suppressed redwood and Douglas-fir seedlings after release from over-topping brush. In: Redwood reforestation problems. An experimental approach to their solution. 130 p. Buena Park, CA: Foundation for American Resource Management; 1966: 97-104.

Suppressed 16- to 19-year-old redwood and Douglas-fir seedlings under a canopy of blue blossom ceanothus, tanoak, and madrone were released on a 1/4-acre square plot located in a 23-year-old Site III clearcut, 12 miles east of Fort Bragg, California. In April 1962, all hardwood stems greater than one inch d.b.h. on half the plot were frilled and basal sprayed with 2-2/3 pound acid equivalent 2,4-D and 1-1/3 pounds acid equivalent 2,4,5-T (Weedone Brush Killer 64) in 25 gallons diesel oil while on the other half, all hardwood stems were basal sprayed only. In August 1962, remaining live stems over the entire plot were frilled and treated with ammate at 7 pounds per gallon of water. Most of the brush was dead or dying by the end of the year.

A total of 148 redwood and 428 Douglas-fir seedlings ranging in height from less than 3 inches to more than 18 feet were found on the plot. The majority of redwoods were in the lower and medium height classes (up to 5 feet) while Douglas-firs were more uniformly distributed. The smaller seedlings of both species were generally spindly and relatively sparsely needled; most were making no measurable height growth and only limited lateral extension of branches. Yearly height growth measurements for each seedling between 1961 and 1965 were taken. Growth rate of almost all redwood and on Douglas-firs less than 3 feet tall increased the first growing season. Height growth of taller Douglas-firs initially declined. Growth rates for both species increased in succeeding years with taller trees responding less to release than shorter trees. Falling dead brush caused retarded height growth and affected redwood and shorter Douglas-firs (less than 3 feet tall) to a greater extent.

The mortality due to falling brush and the height growth response in 1961 (before release) and for 5 years after release are in Table 1.

The study provides promising evidence of accelerated height growth for both redwood and Douglas-fir seedlings when released from dominating hardwood brush. The impact of falling dead brush suggests, however, that chemical treatments be undertaken before brush attains large sizes but after conifer seedlings have become established.

Table 1. Effects of brush release on mortality and average growth of redwood and Douglas-fir over a 5-year period

Height class (feet)	Mortality due to falling brush (percent)	Average height growth (inches)					Growth ratio
		1961	1962	1963	1964	1965	1965/1961
Redwood							
Up to 1.0	30	1.18	1.82	4.02	3.71	3.73	3.2
1.1-2.0	10	1.41	2.03	3.67	2.76	2.73	1.9
2.1-3.0	9	3.10	3.52	5.96	3.34	4.50	1.4
3.1-5.0	0	4.34	4.68	7.35	5.73	7.74	1.8
5.1-10.0	0	5.72	7.80	10.30	9.92	7.88	1.4
Douglas-fir							
Up to 1.0	40	0.98	1.24	2.28	3.47	4.24	4.3
1.1-2.0	41	1.11	1.32	2.82	3.38	4.25	3.8
2.1-3.0	10	2.18	2.63	5.44	8.85	9.78	4.5
3.1-5.0	7	3.70	2.50	6.60	9.41	10.40	2.8
5.1-10.0	10	5.69	4.57	6.02	8.19	6.73	1.2

Abstract: Ronald E. Stewart

FPM83-0083
Glover, Glenn A.; Knowe, Steven A.; Gjerstad, Dean H. Fayette site preparation study - 22 year results, June 1981. Silvicultural Herbicide Cooperative Note No. 1. Auburn, AL: Auburn University, Department Forestry; 1981. 8 p.

See: Whipple, Sherman D; White, Edwin H., 1965.

A study was initiated to test the effects of seven methods of conversion on survival and early growth of planted pine on Alabama's upper Coastal Plain. The study is located on the Fayette Experimental Forest, north of Fayette, Alabama. A randomized block design consisting of 7 treatments with 5 replications per treatment, was established under comparatively uniform stand conditions. Treatment plots were square, 132 feet on each side, with a 46.2 feet x 46.2 feet permanent sample plot located in the center of each treated plot. The treatments were: (1) untreated check, (2) scarification by bulldozer, (3) injector-applied herbicide, (4) girdle without herbicide, (5) ax frill and herbicide, (6) chain girdle and herbicide, and (7) foliage spraying plus ax frill and herbicide.

The scarification was accomplished in January 1959, all planting of loblolly pine in January 1959, and remaining treatments in spring 1959 after the hardwood leaves were fully developed. Results 6 years after planting are in Table 1.

High mortality in first year after treatment resulted from herbicide spray applied to area in the spring. Results 22 years after planting are in Table 2.

All treatments increased survival and growth of pines over the untreated control. After 22 years, mean d.b.h. of treated plots were not statistically different from each other, but significant differences in survival had a marked effect on basal area and volume growth per acre.

Table 1. Effect of site preparation on survival and growth of pine over a 6-year period

Treatment	Survival (%)	Average d.b.h. (in)	Basal area (sq ft)	Volume (cu ft)
Check	69.7	0.5	0.857	10.4
Scarification	87.4	2.5	24.410	421.5
Injection	84.0	1.9	13.532	207.8
Girdle	74.9	1.6	9.062	131.0
Ax frill	85.1	2.2	18.226	308.0
Chain frill	81.7	2.1	14.552	230.6
Foliar spray	53.7	1.6	6.715	108.4

Table 2. Effect of site preparation on survival and growth of pine over a 22-year period

Treatment	Survival (%)	Average d.b.h. (in)	Basal area (sq ft)	Volume (cu ft)
Check	13	1.3	6	23
Scarification	68	7.4	145	3667
Injection	54	7.3	117	2702
Girdle	32	7.1	66	1652
Ax frill	62	8.1	218	3886
Chain frill	66	7.1	133	3233
Foliar spray	28	7.8	73	1822

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0084

Goebel, N. B.; Cool, B. M. Releasing white pines after 20 years of suppression in the Upper Piedmont of South Carolina. Forest Farmer. 27(12): 9, 22; 1968.

A severely suppressed underplanting of eastern white pine was released from a heavy overstory of oaks, hickories, dogwood, sourwood, and other hardwoods 20 years after planting. A total of 57 pines in the released and 56 pines in an adjacent unreleased area were measured for response. Results after nine growing seasons are in Table 1.

Table 1. Survival rate and height growth of released and unreleased white pine after nine growing seasons

	No. of trees	Survival (percent)	Height growth after release (ft)
Not released	56	64	4.3
Released	57	86	12.1

Abstract: Ronald E. Stewart

FPM83-0085
Gordon, Donald T. Growth response of east-side pine poles to removal of low vegetation. Pacific Southwest Forest and Range Experiment Station Research Note No. 209. Berkeley, CA: U.S. Department Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station; 1962. 3 p.

A study was established in a stand of isolated ponderosa pine poles near the Black Mountain Experimental Forest in northeastern California. The only possible competition for these widely spaced trees was a fairly dense low cover of perennial bunchgrass, sedge, and broad-leaved plants, especially sagebrush and bitterbrush. The study consisted of 9 replications of randomized blocks with 4 trees within each block. A 12 x 12 foot area around each tree was treated with one of the following: (1) untreated; (2) spraying with 2,4-D to control shrubs; (3) spraying with a mixture of 2,4-D and dalapon to control herbaceous and woody plants.

Results after 5 years are shown in Table 1.

Combinations of all low vegetation in this experiment adversely affected growth of the pines, and perennial grasses had a greater effect than shrubs.

Table 1. Effect of vegetation removal on growth of pines after 5 years

Treatment	Initial basal area (sq ft)	5-year basal area increment (sq ft)
Control	0.110	0.093
Grass removed	0.153	0.129
Shrubs removed	0.114	0.101
All vegetation removed	0.098	0.114

Abstract: Ronald E. Stewart

FPM83-0086
Gottfried, Gerald J. Control of New Mexican locust and the effect on planted ponderosa pine in central Arizona. Research Note RM-386. Fort Collins, CO: USDA, Forest Service, Rocky Mountain Forest and Range Experiment Station; 1980. 6 p.

A study of New Mexican locust control and ponderosa pine plantation survival was initiated in April 1967 on the Sierra Ancha Experimental Forest, about 30 miles north of Globe, Arizona. The overstory of ponderosa pine with some Douglas-fir, white fir, and large Gambel oak was eliminated by a wildfire in 1957. The locust cover was about 10 feet tall with stem diameter at 6 inches above ground averaging 1.25 inches when the studies began. Five locust control treatments were established in a randomized block design with three blocks and 25- by 25-foot plots. Treatments were: (1) cut stems during dormant season, paint stumps with 2,4-D amine, and spray sprouts with 2,4,5-T ester; (2) cut stems during growing season and paint and spray as in (1); (3) spray foliage during growing season with 2,4,5-T ester and spray sprouts as in (1); (4) cut stems during dormant season, paint stumps with 2,4-D amine, and spray sprouts with 2,4,5-T ester in September; and (5) cut stems during dormant season, no herbicide treatment. Unfortunately amitrole was substituted for 2,4,5-T on two occasions, the June 1969 and 1970 applications for treatments 1, 2, and 3. Also, the initial herbicide application for treatment 3 was applied with a backpack mistblower; all other broadcast treatments were applied with a trunk-mounted high volume sprayer. Further, the original plots for treatment 5 (no herbicide) were accidently treated and the plots were relocated in an adjacent area. This relocation compromises the randomized block design criteria.

All plots were planted in March 1970, 3 years after the initial treatment, with thirty-six 2-0 ponderosa pine seedlings. Trees were grown from seed collected at the same elevation in an adjacent tree seed-zone. Survival was observed in April, May, July, and October of 1970. Seedlings in very poor condition were counted as dead.

Data on locust control and first-year pine survival were not summarized in tabular form. By October 1970, overall pine survival for all treatments was only 9 percent; however, survival was significantly greater in treatment 5 (24 percent) than in the other four treatments (5 percent where herbicides were used). Pine mortality appeared to be almost equally caused by drought and by pocket gophers. Seedlings growing in partial shade apparently do best, but too much shade is detrimental. Managers should take advantage of the temporary benefits of a partial locust cover by delaying brush control until the locust impedes pine development.

Abstract: Ronald E. Stewart

FPM83-0087
Grano, Charles X. Mortality of loblolly pine planted under small hardwoods. Tree Planters' Notes. 48: 1-2; 1961 October.

Loblolly pine was planted in 1957 on twelve 1/3-acre plots occupied by small hardwoods in Drew County, Arkansas. Hardwood cover ranged from 25 to 87 percent and dominant stems were 4 to 8 feet in height. Fifty 1-0 pines were planted in each plot. Soil moisture during the first two growing seasons was abundant and the weather was favorable for good survival. Analysis of the relationship between total mortality of pine 24 months after planting and original hardwood cover yielded a correlation coefficient of +0.736, which was significant at the 1 percent level. The relationship was: $y = 18.19 + 0.9303x$, where y is percent mortality and x is percent of plot overtopped. The standard error of regression estimate is 2.86 percent.

Abstract: Ronald E. Stewart

FPM83-0088
Grano, Charles X. Understory hardwoods reduce growth of pine sawtimber. Forest Farmer. 29(12): 9; 1970.

See: Grano, Charles X., 1970, Research Paper SO-55.

FPM83-0089
Grano, Charles X. Small hardwoods reduce growth of pine overstory. U.S. Department of Agriculture Forest Service Research Paper SO-55. New Orleans, LA: U.S. Department Agriculture, Forest Service, Southern Forest Experiment Station; 1970. 9 p.

See: Grano, Charles X., 1970.

Hardwood understories in a 53-year-old loblolly--shortleaf pine stand in Bradley County, Arkansas, and a 47-year-old stand near Crossett, Arkansas, were either left untreated or were cut and sprayed with 2,4,5-T. Each treatment was replicated three times in a randomized block design. Plots were 0.25 acres in size. Results after 14 years (Bradley) or 11 years (Crossett) appear in Table 1.

In the 14-year study in Bradley County, Arkansas, the total growth advantage attributable to understory control in a 53-year-old stand was 200 cubic feet or 1720 board feet. Gross differences in the 11-year study in a 47-year-old stand near Crossett were even more pronounced, totaling 359 cubic feet or 3760 board feet per acre.

Table 1. Growth of shortleaf pine by type of release

Study site and treatment	MAI after treatment (cu ft/acre/yr)	Basal area growth (sq ft)	Volume growth (cu ft/acre)	Total volumes (cu ft/acre)
Bradley (14 yr)				
Untreated	70.6	27.3	989	3,319
Treated	84.9	33.2	1,189	3,517
Crossett (11 yr)				
Untreated	75.6	23.1	832	--
Treated	108.2	33.0	1,190	--

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0090

Gratkowski, H.; Lauterbach, P. Releasing Douglas-fir from varnishleaf ceanothus. Journal of Forestry. 72(3): 150-152; 1974.

Growth of young Douglas-firs released from varnishleaf ceanothus was measured for 5 years on two sites in the Cascade Range of Oregon. One site was aerially sprayed with 2 pounds acid equivalent per acre 2,4,5-T when shrubs were about 6 feet tall and conifers were 1/2 to 7 feet; 93 trees in the sprayed and 85 trees in the unsprayed plots were measured. Small plots of 10-foot tall varnishleaf were treated with one of three treatments on the second site: (1) no treatment; (2) ceanothus lopped and sprayed with 2,4,5-T (complete release); and (3) ceanothus basal sprayed with 2,4,5-T (basal spray). Twenty-five trees were measured on each plot. Table 1 shows the results after 5 years.

Aerial spraying effectively released Douglas-firs, and their growth was 1.7 to 2.5 times that of comparable trees under unsprayed ceanothus. Response on basal spray plots was similar but less dramatic. The data suggest that release will save about 8 years in growing 2-foot tall trees to a height of 20 feet.

Table 1. Effect of release from varnishleaf ceanothus on growth of Douglas-fir over a 5-year period

Release treatment	Height of trees when released (feet) 1	2	3	4	5	6
	Percent growth over 5 years					
None	100	100	100	100	100	100
Complete release	185	185	185	184	184	185
Basal spray	130	136	140	144	147	149
Aerial spray	255	217	200	188	181	171

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0091
Gratkowski, H.; Jaszkowski, R.; Armstrong, L. Survival of planted Douglas-fir seedlings sprayed with atrazine, terbacil, and 2,4-D. Research Paper PNW-256. Portland, OR: U.S. Department Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1979. 8 p.

Grass control with atrazine increased survival of Douglas-fir seedlings when applied as a broadcast spray over new plantations on three summer-dry sites in southwestern Oregon.

The study was designed as a randomized complete block experiment with one complete set of treatments on each of seven sites. On each site, five 21- by 105-foot plots were planted during late February and early March with 125 2-0 Douglas-firs. After planting, four plots received one of five spray treatments: atrazine, 2,4-D, atrazine and 2,4-D, and terbacil. The fifth plot was left unsprayed as a control. Terbacil and 2,4-D were less effective than atrazine. Conifer survival was excellent on four typical coastal sites in or near the fog belt along the southwest Oregon coast.

Survival of Douglas-fir seedlings after one application of herbicides for grass and forb control after two growing seasons is shown in Table 1.

Table 1. Effect of grass control treatments on growth of Douglas-fir seedlings after 2 growing seasons

	Percent survival by grass control treatment				
Type of site	Control	Atrazine	2,4-D	2,4-D & Atrazine	Terbacil
Cool coastal sites	88	86	87	88	87
Dry inland sites	23	48	32	34	37

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0092
Gratkowski, H. Growth of Douglas-fir after release from snowbrush ceanothus. Unpublished manuscript submitted to Forest Science, on file. Corvallis, OR: U.S. Department Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station, Forestry Sciences Laboratory; 1979.

Height and diameter growth of young Douglas-firs following three degrees of release from snowbrush were followed for 5 years on five clearcut areas on the west slope of the Cascade Range in Oregon. One study area on the Umpqua National Forest was measured for 10 years following treatment. Release treatments were: (1) snowbrush lopped and removed and stumps sprayed with 2,4,5-T (complete release); (2) snowbrush lopped and allowed to resprout (lopped); and (3) snowbrush basal sprayed with 2,4,5-T (basal spray). Results after 5 years are shown in Table 1.

Release from snowbrush ceanothus did not increase total height growth during the first 5 years after treatment; released trees were no more than 1 foot taller than trees in undisturbed snowbrush. A year-by-year analysis showed that annual rates of height growth were about equal for 1 or 2 years after release. Then, however, growth of released trees exceeded that of trees in snowbrush and this difference increased each succeeding year. The unreplicated 10-year results suggest that this trend continues through the second 5-year period. In fact, released trees were significantly taller than unreleased trees at the end of 10 years. Growth of Douglas-firs that were 2 feet tall at time of treatment was 1.7 to 2.8 times the growth of similar trees that were not released. Trees 8 feet tall at time of release grew only 1.2 to 1.4 times than of similar trees in mature ceanothus. This indicates that release has a cumulative beneficial effect resulting in greater average annual growth each year for at least 10 years after treatment.

In contrast to height growth, diameter growth response to release occurred during the first 5 years. Release was most beneficial for the smallest trees heavily shaded beneath snowbrush; diameter growth of trees 2 feet tall when released was 1-3/4 to 3 times more than that of similar trees that were not released. Although brush control was less effective for trees with tops emerging above the brush canopy, even trees 8 to 10 feet tall increased diameter growth by 13 to 31 percent. The unreplicated 10-year results suggest that the initial diameter response continues for at least 10 years.

Table 1. Response of Douglas-fir to release from snowbrush ceanothus

Five-year diameter and height growth a/

Height when released:	2 feet		4 feet		6 feet		8 feet		10 feet	
Release method	dia. (mm)	hgt. (ft)	dia. (mm)	hgt. (ft)	dia. (mm)	hgt. (ft)	dia. (mm)	hgt. (ft)	dia. (mm)	hgt. (ft)
None	8.1	2.5	15.5	3.6	23.0	4.8	30.4	5.9	37.9	7.0
Lopped	14.1	2.9	21.3	4.0	28.5	5.1	35.7	--	43.0	7.3
Basal sprayed	20.9	3.5	26.1	4.3	31.3	5.2	36.5	6.0	41.7	6.8
Complete release	25.2	3.6	30.1	4.6	35.0	5.6	39.9	6.7	44.8	7.7

Ten-year diameter and height growth

Height when released:	2 feet		4 feet		6 feet		8 feet		10 feet	
Release method	dia. (mm)	hgt. (ft)	dia. (mm)	hgt. (ft)	dia. (mm)	hgt. (ft)	dia. (mm)	hgt. (ft)	dia. (mm)	hgt. (ft)
None	35.2	5.4	50.1	9.5	64.9	13.6	79.8	17.7	94.6	21.8
Lopped	54.6	9.0	68.1	13.3	81.7	17.5	95.3	21.8	108.7	26.0
Basal spray release	63.5	10.1	71.1	14.5	78.7	18.9	86.3	23.3	93.9	27.7
Completed release	74.7	14.9	87.1	18.1	99.5	21.2	112.0	24.4	124.4	27.6

a/ Height growth is based on a regression.

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0093
Grelen, Harold E. Mechanical preparation of pine planting sites in Florida sandhills. Weeds. 7: 184-188; 1959.

In 1955, a site preparation study was installed to compare site preparation treatments for establishing 1-0 slash pine seedlings in the Florida sandhills on sites dominated by turkey and bluejack oaks and wiregrass. Three single and three double mechanical treatments (Marden brush chopper, rootrake-scalper, and BSW brush cutter), plus no-treatment and burn-only checks, were applied to three blocks of eight 2-acre plots--a total of eight treatments, replicated three times. Plots were first burned in May 1955 and the first mechanical treatments applied in June. Repeat treatments were applied in September with identical machines, except on plots initially treated with the rootrake-scalper where a Rome disk harrow was used. Plots were planted with slash pine seedlings in January 1956. Survival and height growth were followed on 100 seedlings enclosed in the center of each 2-acre plot. Results are shown in Table 1.

Growth was best on the double-chopped plants, where trees averaged 3.4 feet in height. The next best height growth was on plots treated twice with the rootrake-scalper. Both treatments provided completely bare sites at planting time, with very little oak resprouting. The difference in height growth between these two treatments was attributed to the removal of topsoil by the rootrake-scalper. Poor pine growth on the BSW plots was also thought to be due to topsoil removal rather than plant competition.

Table 1. Effect of mechanical site preparation on height and survival of pine after 2 growing seasons

Treatment	Height (ft)	Survival (%)
Double treatments		
Marden chopper	3.4	83
Rootrake-scalper	2.4	83
BSW	1.1	86
Single treatments		
Marden chopper	2.3	78
Rootrake-scalper	1.3	75
BSW	1.4	73
Checks		
No treatment	1.2	58
Burn only	1.2	63

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0094
Grelen, Harold E. May burns stimulate growth of longleaf pine seedlings. Southern Forest Experiment Station Research Note SO-234. New Orleans, LA: U.S. Department Agriculture, Forest Service, Southern Forest Experiment Station; 1978. 5 p.

The study was installed in March 1973 in an 80-acre ungrazed unit of the Palustris Experimental Forest, 30 miles south of Alexandria, Louisiana. The soil is a poorly drained Acadia silt loam with abundant wax myrtle and sprouts of blackjack oak, sweetgum, black tupelo, and other moist-site hardwoods. Longleaf pine was seeded in 1968 and in 1970 stocking averaged over 3000 seedlings per acre. Most of these seedlings were in the grass stage when the study began. The unit was last burned and grazed in 1973. Three replications of the following treatments were randomly assigned to a block of 1/4-acre square plots; unburned control, annual March 1 burn, biennial March 1 burn, annual May 1 burn, and biennial May 1 burn. All fires were set within 4 days of the target dates. Plots were burned with headfires except when hazardous burning conditions made backfires necessary. In each plot, 25 grass-stage longleaf pine seedlings and five older seedlings that had begun height growth but were less than 1 foot high in March 1973 were selected and marked for observation. Survival and height growth by treatment are shown graphically for four growing seasons.

The most obvious result of burning was the control of hardwoods. Some unburned plots were almost impenetrable by the end of the fourth year because of the hardwoods. Compared with unburned plots, burned plots were significantly higher in percentage of surviving seedlings beginning height growth, total height growth of both classes of seedlings, and seedlings with less than 50 percent brown spot infection. Height of surviving seedlings after four seasons was significantly greater on May-burned plots than on March-burned or control plots.

Benefits of May burning may be related to the eradication both of brown-spot needle blight and of woody and herbaceous competition at a critical growth period. Another factor may be the timing of the fire in relation to the development of longleaf pine buds and twigs.

Abstract: Ronald E. Stewart

FPM83-0095

Grelen, Harold E. May burns benefit survival and growth of longleaf pine seedlings. In: Proceedings of the Second Biennial Southern Silvicultural Conference; 1982 November 4-5; Atlanta, GA. General Technical Report SE-24. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station; 1983: 70-73.

A seasonal burning experiment was installed in 1973 on a moist, clay-loam soil located in the Palustris Experimental Forest about 30 miles south of Alexandria, Louisiana. The site was in an open pine-hardwood stand that had been direct-seeded to longleaf pine in 1968. The area had not been burned since 1970 and grass-stage longleaf seedlings were abundant. Southern bayberry was the dominant shrub, and young blackgum, sweetgum, and blackjack oak were common hardwoods. An abundance of accumulated herbage, predominantly bluestem grasses, provided fuel for first-year burning treatments. The following treatments were applied at random to three replications of contiguous 1/4-acre plots: March 1 annual burn, March 1 biennial burn, May 1 annual burn, May 1 biennial burn, and unburned control. Treatments began when most grass-stage seedlings were 5 years old. All large pines and hardwoods in study plots were removed or girdled to prevent overstory influences on treatment comparisons. Annual fires were applied seven consecutive years, 1973-1979, and biennial fires in the four odd-numbered years. Before burning began, 25 grass-stage longleaf seedlings and five seedlings already in height growth were permanently tagged in each plot for response measurement.

Survival and heights of sample grass-stage seedlings and seedlings already in height growth after 7 growing seasons are presented in Table 1.

Results from this and an earlier study (Grelen 1978) indicate that prescribed burning as frequently as feasible on or near May 1, will improve survival and early height growth of longleaf pine seedlings. Throughout the study, the May annual burn led all treatments in tree height. The final height was not significantly greater than that of the March and May biennial burn treatments, but greater than the March annual burn and the unburned control.

Table 1. Effect of burn treatments on survival and growth of longleaf pine after 7 years

Burn treatment	Grass-stage seedlings		Height-growth stage	
	Survival (percent)	Height (feet)	Survival (percent)	Height (feet)
March-annual	52	2.5	80	6.2
March-biennial	48	1.6	53	13.0
May-annual	71	4.8	93	16.1
May-biennial	53	5.3	47	12.8
Unburned	45	0.67	33	8.8

Abstract: Ronald E. Stewart

FPM83-0096

Groundwork, Inc. Preliminary report: September 12, 1978. Willamette herbicides study project. Unpublished. Eugene, OR: Groundwork, Inc., Forest Workers Research Team; 1978.

Results of a survey from five clearcut units on the Willamette National Forest on the west slope of the Cascade Mountains in Oregon were summarized. A systematic random sample of 1/100-acre plots, one plot per acre, was used to measure conifer height, leader growth, first and second whorl growth, age, species, condition, and position in relation to competing vegetation. One cutting had been sprayed the year of sampling and the other four were scheduled for spraying to release the conifers, mostly Douglas-firs, from vine maple, ceanothus, and associated brush species.

Although the data were not analyzed statistically, the study concludes that: (1) the majority of crop trees were vigorous even when growing in the presence of brush; (2) release sprays may damage the conifers; (3) trees growing at the edge of the ceanothus crown grow faster than similar aged trees growing in the open; and (4) overtopped trees are not necessarily suppressed since many are vigorous. However, trees growing in the open or under the brush were not necessarily adjacent. Further, the response to release has not yet been measured.

Abstract: Ronald E. Stewart

FPM83-0097

Haines, L. W. Integrated pest management and competing forest vegetation. In: Proceedings: 1981 John S. Wright Forestry Conference. Weed control in forest management. West Lafayette, IN: Purdue University; 1981: 1-9.

An integrated approach to vegetation control and to pest management can help make forestry more profitable. In a study at Southlands Experimental Forest, Decatur Co., Georgia, 4 annual spring burns controlled hardwood brush better than either chopping or herbicide treatments in a site preparation study. Treatments consisted of burning or not burning followed by one-pass chopping or an application of 2 pounds per acre of silvex. Results after 17 years are in Table 1.

Total planted slash pine cubic foot volume inside bark at 17 years was much greater on the burned than unburned areas regardless of other treatments. Effects of combining treatments were additive with the best growth occuring on plots that had been both burned and chopped. Sixty percent of the slash pine yield variation was explained by the hardwood basal area at age 17.

Table 1. Effect of integrated pest management and vegetation control on growth of slash pine after 17 years

	Unburned			Burned		
	Check	Unburned	Chop	Check	Herbicide	Chop
Planted slash pine						
D.b.h. (in.)	4.8	5.2	5.9	5.7	5.8	6.3
Trees/acre	299	351	394	448	451	449
Basal area (sq ft/acre)	47	59	79	91	106	113
Merchantable cu ft/acre	748	953	1368	1457	1588	1857
Total cu ft/acre	1095	1376	1911	2051	2214	2544
Hardwoods						
D.b.h. (in.)	5.1	4.9	4.0	4.8	5.0	4.4
Trees/acre	140	107	81	58	52	25
Basal area (sq ft/acre)	32	19	11	9	9	3
Merchantable cu ft/acre	577	333	206	167	162	58
Total cu ft/acre	1216	765	624	441	410	208

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0098

Hall, Dale O.; Curtis, James D. Planting method affects height growth of ponderosa pine in central Idaho. USDA Forest Service Research Note INT-125. Ogden, UT: U.S. Department Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 1970. 8 p.

A 5-year planting test that incorporated three site preparation treatments and three nursery stock handling methods was initiated in the 1931 Quartzburg Burn near Idaho City, Idaho, on the Boise National Forest in 1954. Planting sites, three 8-foot-wide lanes, were contoured around the slopes. A D-7 tractor was used to strip dense brush, dominated by snowbrush ceanothus, from two of the lanes. Two furrows made by Talledega plows were added to one lane and the third was left in its natural state; i.e., no brush was removed before planting. Three nursery stock classes were compared: 2-1 stock transported by common carrier and planted by the slit method; 2-1 "special" transported by Forest Service truck and planted by the dug-hole method; and 2-0 "special" handled like the 2-1 "special" stock.

Nine treatment combinations were compared and randomly assigned to nine parallel lines. About 90 acres were planted each spring from 1954 to 1958. Two aspects, easterly and westerly, were sampled in each of the five annual plantings. The entire aspect was systematically sampled by measuring 15 trees on each lane.

In every case but one, careful planting and handling resulted in increased growth each period, regardless of site preparation. No stock treatment nor site preparation method affected survival and height more than brush removal. Five years after planting, survival in brush was 42 percent or less, survival on stripped rows exceeded 71 percent. Mean seedling height, ten years after planting, appears in Table 1.

The results suggest that the influence of brush competition on ponderosa pine seedlings is similar to the height-retarding influence of overstocking as described by Lynch (Lynch, D. W. USDA Forest Service Research Paper 56. Ogden, UT: U.S. Department Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 1958. 36 p.).

Table 1. Effect of site preparation on height growth of ponderosa pine over a 10-year period

Site preparation	Height (feet)
No site preparation	3.18
Stripped	5.06
Stripped and furrowed	5.05

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0099

Hall, Dale O. Ponderosa pine planting techniques, survival, and height growth in the Idaho Batholith. USDA Forest Service Research Paper INT-104. Ogden, UT: U.S. Department Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 1971. 28 p.

From 1962-1964, ponderosa pine seedlings were outplanted in four different tests at Zena Creek, Payette National Forest and in one test (1964) at Boise Basin Experimental Forest, Boise National Forest. All tests appear to have been in the Douglas-fir/ninebark habitat type. A variety of techniques to reduce or eliminate competition were tested. Site preparation tests included scalps (from 2 to 6 feet wide), pits, furrows, burning, and natural undisturbed areas. For the mulch tests, black polyethylene film, glass fiber blankets, and straw were used. Simazine, a pre-emergence herbicide, was also tested. Five-year survival from five different tests are shown in Table 1.

General conclusions:

1. All the practices which reduce vegetative competition improved survival. The relative improvement increased with time.

2. The better the survival the taller the trees in the fifth year when other factors are held constant.

3. The greater the summer precipitation (with good distribution over a period of time), the better the survival.

Recommendations:

1. Initial seedling stocking standards should take into account the onsite differences. Survival rates vary with the onsite environment, i.e., specific cover species, aspect, soil depth, animal populations, and summer precipitation.

2. Site preparation and vegetation control should be used to improve seedling survival and growth. On steep slopes in habitat types similar to this study, 3 to 4 foot scalps with simazine herbicide treatment in the fall should lead to reasonable survival levels.

Table 1. Effect of planting techniques and competition control on survival and growth of ponderosa pine after 5 years

Test and treatment	Five-year survival (percent)	
Test I	Zena Creek	Boise Basin
No mulch	SW slope	SW slope
Scalps	36.2	30.0
Pits	25.3	16.0
Furrows	20.0	20.0
Straw mulch		
Scalps	22.7	37.8
Pits	27.4	36.6
Furrows	21.4	34.7
Test II	East slope	West slope
2' scalps	27.3	41.4
4' scalps	60.0	50.8
6' scalps	33.3	40.7
Burned spots	55.6	58.5
Test III	East slope	West slope
Scalped	16.1	31.1
Glass fiber	43.3	47.9
Polyethylene	22.0	30.1
Test IV	East slope	West slope
Scalped	27.5	61.0
Glass fiber	41.5	60.0
Polyethylene	54.5	66.0
Simazine	43.5	70.0
Test V	South slope	SW slope
Weeded	76.0	76.0
Glass fiber	80.0	76.0
Polyethylene	76.0	68.0
Undisturbed	64.0	60.0

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0100
Harrington, T. A. Release doubles shortleaf seedling growth. Southern Forestry Notes No. 113. New Orleans, LA: U.S. Department Agriculture, Forest Service, Southern Forest Experiment Station; 1958. 4 p.

See: Harrington, T. A., 1960.

FPM83-0101
Harrington, T. A. Immediate release pays off. Southern Forestry Notes No. 127. New Orleans, LA: U.S. Department Agriculture, Forest Service, Southern Forest Experiment Station; 1960. 4 p.

See: Harrington, T. A., 1958.

Underplanted shortleaf pine seedlings on the Cumberland Plateau in Tennessee were released from overstory hardwoods with one of the following: (1) control; (2) cut small stems and girdle larger stems prior to the first growing season; (3) spray stumps and girdles with 15.4 pounds acid equivalent 2,4,5-T prior to the first growing season; and (4) silvicide prior to the second growing season. Results for the first two growing seasons are in Table 1.

Underplanted shortleaf pine seedlings, released from low-grade hardwoods prior to the first growing season, grew twice as fast the first season and four times as fast the second season as did unreleased seedlings. Approximately 88 percent of all seedlings were living after two seasons regardless of whether or not they were released.

Table 1. Height growth of shortleaf pine in first two growing seasons by method of release

Method of release	Height growth (inches) First year	Second year
Untreated	3.4	3.0
Cut and girdled	5.8	11.8
Sprayed first year	8.3	14.2
Sprayed second year	3.4	6.6

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0102
Hatchell, Glyndon E. Immediate release needed for maximum growth of seeded loblolly pine. Tree Planters' Notes. 66: 19-22; 1964 July.

Repellent-treated loblolly pine seed was sown in three consecutive years on freshly burned 0.4-acre plots under stands of upland hardwoods near Alexandria, Louisiana. Hardwoods were injected with 2,4,5-T in diesel oil in the spring of the first and second growing season. In a third study, hardwoods were also injected at the time of sowing. Results after 2, 3, or 4 years are shown in Table 1.

Time of release had no significant effect on survival in any of the studies but delaying release for one or two years substantially reduces height growth regardless of site or cover conditions.

Table 1. Survivial rate and height growth of loblolly pine by timing of release

	Study 1 after 4 years		Study 2 after 3 years		Study 3 after 2 years	
Timing of release	Survival (%)	Height (in)	Survival (%)	Height (in)	Survival (%)	Height (in)
No release	31	11	33	9	71	4
Immediate release	--	--	--	--	71	15
Release first year	32	60	39	39	61	16
Release second year	35	51	41	25	62	7

Abstract: Ronald E. Stewart

FPM83-0103
Hatchell, Glyndon E. Site preparation and fertilizer increase pine growth on soils compacted in logging. Southern Journal of Applied Forestry. 5(2): 79-83; 1981.

A study was installed in a 30-acre clearcut in the Santee Experimental Forest near Charleston, South Carolina. The site is located on a Coxville soil series, a clayey, kaolinitic soil that is poorly drained and is found on nearly flat land with low topographic position. The area was burned during the spring of 1972 prior to clearcutting during the summer. After harvest, a split-plot experiment was established with combinations of soil compaction (compacted and uncompacted) and site preparation treatments tested on 30 x 198 foot major plots. Major plots were replicated twice in randomized complete blocks. The three site preparation treatments were: (1) herbicide - spraying woody vegetation with herbicide during the summer of 1972; (2) disked - shearing trees at ground line, rootraking debris into windrows, and flat disking; and (3) bedded - shearing trees at ground line, rootraking debris into windrows, and then preparing beds at 10-foot intervals. Each major plot was subdivided into three subplots and randomly assigned the following fertilizer treatments: (1) unfertilized check; (2) medium level of fertilizer - 200 pounds N, 50 pounds P, and 100 pounds K; and (3) high lever of fertilizer - 400 pounds N, 175 pounds P, and 175 pounds K, with 3/4-inch depth of sawdust. Fertilizer and sawdust were broadcast and mixed with soil during flat disking and bedding. A total of 99 loblolly pine seedlings per subplot were hand planted during March 1973. Measurements of pine biomass after the fourth growing season were based on 31 trees.

Survival and growth of the pine after four growing seasons are presented in Table 1. Table 2 shows aboveground biomass.

Site preparation and fertilizer application affected survival of loblolly pine seedlings but soil compaction did not. Grasses and herbs were 3 to 6 feet tall during the first year and competition from them appeared to cause most of the mortality. Site preparation increased pine survival, apparently by reducing competition during seedling establishment, but fertilizer application at planting time reduced survival, probably by increasing competition from grasses and herbs.

Table 1. Effect of site preparation and soil compaction on growth of loblolly pine after 4 years

Method of site preparation and level of fertilizer	Survival (percent)		Height (feet)		Root collar diameter (inches)	
	Uncompacted	Compacted	Uncompacted	Compacted	Uncompacted	Compacted
Herbicide						
Zero	82	76	6.7	5.5	1.3	1.1
Medium	56	62	8.1	8.6	1.5	1.7
High	47	64	8.0	10.0	1.5	2.0
Disked						
Zero	82	82	5.2	4.3	1.0	0.8
Medium	62	78	6.6	8.2	1.3	1.7
High	66	69	7.7	7.9	1.5	1.6
Bedded						
Zero	94	97	11.3	9.6	2.2	1.9
Medium	86	86	11.6	12.5	2.3	2.4
High	70	78	10.2	11.6	1.9	2.2

Table 2. Effect of site preparation and soil compaction on aboveground biomass of loblolly pine after 4 years

Method of site preparation and degree of fertilizer	Aboveground biomass (pounds/acre)	
	Uncompacted soil	Compacted soil
Herbicide		
Zero	2900	2000
Medium	2500	3800
High	3000	5600
Disked		
Zero	2100	1100
Medium	2700	4700
High	4300	3900
Bedded		
Zero	9900	6800
Medium	10400	11000
High	7700	8800

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0104
Hawkes, Carl. A report on plantation release. Blodgett Tract, Siuslaw National Forest. Unpublished report, on file. Corvallis, OR: Siuslaw National Forest; 1950 November. 26 p.

See: Hawkes, Carl, 1953.

FPM83-0105
Hawkes, Carl. Planes release tree plantation. Journal of Forestry. 51(5): 345-348; 1953.

See: Hawkes, Carl, 1950.

Between 1948 and 1951, experiments to compare cutting and girdling with sprays or dusts of 2,4-D to release 2 to 8 feet tall planted Sitka spruce, Douglas-fir, and Port-Orford-cedar from 10 to 20 feet tall red alder were installed on the Siuslaw National Forest between Waldport and Yachats, Oregon. Results from the first tests conducted on about 120 acres during the winter and spring of 1948 showed that mechanical treatments were effective but spraying with 2,4-D from an airplane was the most satisfactory and least expensive. Height growth of released and unreleased trees from the 2 years immediately before and after release spraying are shown in Table 1.

The growth of all three species increased following release spraying despite some herbicidal damage to exposed trees. Douglas-fir saplings grew twice as fast after release and four times the rate of trees still under the red alder. Over 60 percent of the Douglas-fir under the alder had lost their leaders at some time, initially from rodents and deer and recently from being whipped by alder branches.

Table 1. Effect of release on growth of Sitka spruce, Douglas-fir, and Port-Orford-cedar over a 2-year period

		2-year height growth (inches)	
		Before release	After release
Sitka spruce	--not released	21	11
	--released	21	33
Douglas-fir	--not released	21	10
	--released	21	40
Port-Orford-cedar	--not released	8	14
	--released	8	17

Abstract: Ronald E. Stewart

FPM83-0106
Haywood, James D. Planted pines do not respond to bedding on an Acadia-Beauregard-Kolin Loam Site. Research Note SO-259. New Orleans, LA: U.S. Department Agriculture, Forest Service, South Forest Experiment Station; 1980. 4 p.

A study to evaluate the effect of bedding on wet, poorly drained, sandy flat-woods soil on the survival and yields of planted loblolly and slash pines was established in central and southwest Louisiana. Treatments were replicated three times with each species in a randomized block design. Treatments were check, disked, bedded, and furrowed. Plots were 0.166 hectare in size and were planted with 1-0 stock. Results at stand age 15 are in Table 1.

Average height and volume of loblolly and slash pines were not affected by site treatment or soil differences 15 years after planting. Slash pine averaged 2.04 meters more in height and yielded 22 percent more volume per hectare than did loblolly pine.

Table 1. Effect of bedding on Acadia-Beauregard-Kolin Loam site on survival and growth of pine after 15 years

Species and site treatment	Survival (%)	D.b.h. (cm)	Total height dominant and codominant (m)	Volume per hectare outside bark (cu m)
Loblolly				
Grass rough	80.8	13.97	11.80	150.01
Disked	81.8	14.14	11.95	152.28
Bedded	64.2	15.16	12.37	145.03
Furrowed	83.1	13.29	11.77	141.17
Average	77.5	14.14	11.97	147.12
Slash				
Grass rough	58.9	15.92	13.72	171.02
Disked	67.6	15.75	14.68	200.05
Bedded	52.6	16.09	14.08	163.93
Furrowed	73.8	14.73	13.55	185.29
Average	63.2	15.62	14.01	180.07

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0107

Haywood, James D. Discontinuous mounding as a site treatment on a flatwoods soil. In: Barnett, James P., ed. Proceedings of the First Biennial Southern Silvicultural Research Conference. General Technical Report SO-34. New Orleans, LA: U.S. Department Agriculture, Forest Service, Southern Forest Experiment Station; 1981: 88-91.

The study area is located in central Louisiana on a Caddo and Messer silt loam complex. The area was divided into two topographic classes - an elevated flat of Caddo and Messer soils and a depression of Caddo soil. After prescribed burning, rectangular, 15.25 x 61 meter plots were established in a randomized complete block design with two blocks in each topographic class. Two discontinuous mounding treatments and an untreated check were established in each block. The first mounding treatment included mounds that were 1.2 x 1.8 meters at the base and 38 centimeters high. The second mounding treatment was 75 centimeters high. The mounding was done in October 1975. In February 1976, three slash pine were planted on each mound. After one growing season one tree was rogued from each mound.

Table 1 shows results after four growing seasons.

Discontinuous mounding improved the growth of slash pine, but size of mounds made no difference. Slash pines average 38 percent greater diameter and had 25 percent greater height per tree on mounds than did trees planted on check plots.

Table 1. Effect of discontinuous mounding as site treatment on growth of slash pine after 4 growing seasons

	Pine survival and growth		
Treatment	Survival (%)	Diameter (cm)	Total height (m)
Caddo-Messer flat			
Check	86	3.58	1.84
Low mound	94	4.95	2.25
High mound	90	4.83	2.18
Caddo depression			
Check	92	3.86	1.96
Low mound	92	5.31	2.56
High mound	91	5.46	2.51

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0108
Haywood, J. D.; Thill, R. E.; Burton, J. D. Intensive site preparation affects loblolly pine growth on upland sites. In: Proceedings of the American Society of Agricultural Engineers Symposium on engineering systems for forest regeneration. March 1981: 224-231.

Growth through 7 years after planting was compared among loblolly pines planted at a 1.83- by 2.44-meter spacing on five soil-texture groups that had received six types of mechanical site preparation and an underplant-hardwood release treatment. Seventy 29.3- by 43.9-meter plots were established in central and northern Louisiana and southern Arkansas on sites that had at least 1,200 hardwoods 2.5 centimeter d.b.h. or larger with a combined residual basal area of more than 4.6 cubic meter per hectare left after clearcutting. The five soil-texture groups were: loamy; gravelly, silty, clayey, slowly permeable; and clayey, very slowly permable.

The following seven site preparation treatments were repeated twice in separate years on each soil group (1) burn if possible, underplant and inject hardwoods over 2.5 centimeter d.b.h. (2) chop-burn; (3) chop-burn disk; (4) chop-delay several weeks-chop again; (5) shear-burn; (6) shear-windrow; and (7) shear-windrow-disk. Not all burns were successful. Each plot was planted with 288 1-0 loblolly pine seedlings.

Loamy soils were more productive through stand age 7 than the gravelly or silty soil groups, while the two clayey soil groups were as productive as the loamy soils.

The mean density, height, and volume of free-to-grow pines for all soil groups after 7 years appear in Table 1.

The chemical site preparation treatment used was clearly inferior to mechanical site preparation when the number of free-to-grow pines and volume per hectare among free-to-grow pines were compared.

A reduction in woody plant density alone is no guarantee of greater pine yields. Rather, control of woody plants often results in greater abundance of herbaceous plants which can have an equally adverse affect on young pine growth. Failure to reduce both woody and herbaceous competition may explain why treatment responses have not varied more.

Table 1. Effect of intensive site preparation on growth of loblolly pine over a 7-year period

Site preparation	Stems per hectare	Mean height (m)	Mean volume (cu m)
Underplant-inject	1210	5.40	13.36
Chop-burn	1534	5.59	18.36
Chop-burn-disk	1788	5.99	26.47
Chop-delay-chop	1748	5.75	24.48
Shear-burn	1661	5.56	21.81
Shear-windrow	1741	5.28	20.96
Shear-windrow-disk	1673	5.38	21.37

Abstract: Larry Gross

FPM83-0109

Haywood, James D. Response of planted pines to site preparation on a Beauregard-Caddo soil. In: Jones, Earle P., Jr., ed. Proceedings of the Second Biennial Southern Silvicultural Research Conference. Atlanta, GA: November 4-5, 1982. General Technical Report SE-24. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station; 1983: 14-17.

A study was established on somewhat poorly to poorly drained silt loam flatwoods in Rapides Parish, Louisiana. After harvesting of a longleaf pine stand, a cover of bluestem and scattered post oak, blackjack oak, and southern bayberry had developed. Prior to initiation of site preparation treatments, the area was burned to reduce the grass rough, and the woody vegetation cut down and removed. Treatments were replicated three times with each species in a randomized block design. Site treatments were: burn-only, burn-harrow, and burn-harrow-bed. Harrowing was done twice, in the fall of 1960 and in July 1961. Graded, bare-root, 1-0 loblolly and slash pine seedlings were hand-planted on 0.36 acre plots during February 1962. Measurements were taken on the center 100 trees per plot, and the plots were thinned after the 13th growing season.

Pine survival, height, and quadratic mean d.b.h. at age 13, before thinning are shown in Table 1. Response at age 20, after thinning is shown in Table 2.

Loblolly pines planted on mechanically treated plots had a higher survival rate at age 2 and a 2-foot height advantage at age 8 over loblolly planted on plots not mechanically treated. This higher survival and improved early height growth on mechanically treated plots was translated into greater yields at thinning, an added 535 cubic feet per acre at age 13. After the first thinning, the method of site preparation did not influence the growth rate of pines. Since treatments were thinned to similar basal areas, volume production at age 20 was also similar among treatments. Slash pine survival and yields were not influenced by site treatment.

The silt loam flatwoods of Louisiana are inherently productive sites. Site preparation beyond the level needed to insure adequate pine stocking will only produce modest gains in pulpwood yields at first thinning.

Table 1. Effect of mechanical site preparation on survival and height growth of pine after 13 years

Species and method of treatment	Survival rate (percent)	Height (feet)	Diameter (inches)
Loblolly pine			
Burn-only	71	46	6.2
Burn-harrow	82	48	6.1
Burn-harrow-bed	87	48	6.0
Slash pine			
Burn-only	76	43	5.9
Burn-harrow	73	43	5.9
Burn-harrow-bed	76	45	5.9

Table 2. Effect of mechanical site preparation on pine yield after 20 years

Species and method of treatment	Total stem volume per acre (cubic feet)		
	Harvested age 13	Standing age 20	Total production age 20
Loblolly pine			
Burn-only	1,010	3,420	4,430
Burn-harrow	1,450	3,460	4,910
Burn-harrow-bed	1,640	3,350	4,990
Slash pine			
Burn-only	1,110	3,380	4,490
Burn-harrow	1,040	3,320	4,360
Burn-harrow-bed	1,240	3,070	4,310

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0110

Hebb, Edwin A.; Burns, Russell M. Slash pine productivity and site preparation on Florida sandhill sites. USDA Forest Service Research Paper SE-135. Asheville, NC: U.S. Department Agriculture, Forest Service, Southeastern Forest Experiment Station; 1975. 8 p.

This paper discusses the suitability of sandhill sites for slash pine and the effect of site preparation on site quality. Ninety-one slash pine plantations growing on a variety of sandhill soils from Tallahassee to Pensacola, Florida were examined. Plots were located in plantations established on well to excessively drained soils having a sandy surface soil at least 30 inches thick. Each plot was limited to a nine by nine tree rectangle. In addition to soil profile, cultural history (including site preparation), type of natural vegetation, spacing of trees, and other factors were recorded for each plot.

It was found that a fine textured layer of material in the soil profile retards water percolation and in itself retains moisture much longer than sand. Thus it apparently acts in the manner of a water table. The higher the layer in the profile, the more moisture is available to the roots above.

Average total tree height adjusted by covariance for differences in soil depth for 11 to 26 year old trees from 54 plots appears in Table 1.

Site preparation affected both survival and growth. By lessening or virtually eliminating established competition, site preparation improves survival and gives conifers an early growth advantage on the planted trees.

After adjustment for differences in site, comparative differences between various site preparation treatments were still the same. Pines were largest on the more intensively prepared sites, burning by itself was of little benefit, and the heaviest equipment did the best job, though lighter equipment could have been used more economically and with equally good effect for the second half of the treatment.

Table 1. Effect of site preparation on growth of slash pine

Site treatment	Average tree height[1] (feet)
None	6.4
Fire	7.4
Mathis fire plow	9.5
Fire + heavy chopper	12.9
Fire + disk harrow + disk harrow	14.6
Fire + heavy chopper + disk harrow	17.1
Fire + rootrake + disk harrow	17.3
Heavy chopper + heavy chopper	17.5
Fire + heavy chopper + light chopper	18.2
Fire + heavy chopper + medium chopper	17.7

[1]Average tree height adjusted by covariance for differences in soil depth for 11 to 26 year old trees

Abstract: Larry Gross

FPM83-0111
Hollis, C. A.; Smith, J. E.; Fisher, R. F. Allelopathic effects of common understory species on germination and growth of southern pines. Forest Science. 28(3): 509-515; 1982.

The influence of fetterbush debris and coppice on growth of 1-0 planted slash pine was examined on prepared flatwood sites. These trees were grown in plantations that were site prepared 3 months prior to planting. Three intensities of site preparation were evaluated: chopped and bedded (minimum); chopped, burned, and bedded (intermediate); and chopped, burned, K-G bladed, harrowed, and bedded (maximum). The soil type on which fetterbush was predominant was Mascotte.

The mean annual height growth increment for the year following outplanting was compared for 200 pairs of trees. One member of each pair was growing within 0.5 meters of residual debris or coppice of fetterbush while the other member was growing at a distance greater than 0.2 meters from any such influence. Each pair was selected on the basis of similarity of soil type and adjacent competitive influences, and in all cases were located within 10 meters of each other. Results after one growing season are in Table 1.

First season growth of seedlings planted within 0.5 meters of residual debris or coppice of fetterbush was significantly less than the growth of slash pine planted more than 2.0 meters away.

Table 1. Allelopathic effects of understory on growth of southern pine after one growing season

Distance from fetterbush	Height growth increment by degree of site preparation (cm)		
	Minimum	Intermediate	Maximum
>2.0	13	17	16
≤0.5	10	14	14

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0112
Horsley, Stephen B. Control of herbaceous weeds in Allegheny hardwood forests with herbicides. Weed Science. 29(6): 655-662; 1981.

The dense, herbaceous ground cover commonly found on many Allegheny Plateau forest sites in northwestern Pennsylvania interferes with the development of hardwood reproduction. Bromacil, glyphosate, picloram, simazine, and hexazinone were evaluated at four application rates and five application dates for their ability to control seven herbaceous forest ground covers without residual effects on black cherry seed stored in the forest floor or on survival and growth of natural or planted black cherry seedlings.

Field layout utilized the split plot method with three replications. Experiments to evaluate control of hayscented and New York fern and short husk grass were installed in two forest stands on the Kane Experimental Forest near Kane, Pennsylvania. Control of bracken fern, wild oat grass, rough goldenrod and flattop aster was evaluated at a third site located a short distance from the Kane sites.

Control of most of the target species depended on the date and rate of application. None of the herbicides interfered with germination of black cherry seed stored in the forest floor or with establishment of seedlings. Glyphosate was the most economical herbicide that met the control criteria.

Application of herbicides increased seedling survival at all sites. Survival of black cherry seedlings 30 months after planting are shown in Table 1.

Table 1. Survival of black cherry seedlings 30 months after planting

Site and species	Application rate	Survival rate by type of herbicide (percent)				
		Bromacil	Glyphosate	Picloram	Simazine	Hexazinone
Forest stand Short husk grass	Control	78	73	87	71	88
	Low	94	98	88	77	98
	Medium	94	93	87	64	100
	High	94	98	90	75	90
Hayscented and New York fern	Control	18	19	19	14	12
	Low	79	88	56	8	88
	Medium	83	92	88	29	94
	High	75	92	75	31	81
Forest opening Bracken	Control	88	81	77	90	92
	Low	88	94	88	90	81
	Medium	90	92	90	90	73
	High	69	90	77	90	58

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0113

Hu, Shih-Chang; Ditthavong, Voradeth. The effects of site preparation on growth of loblolly pine in southeastern Louisiana. In: Barnett, James P., ed. Proceedings of the First Biennial Southern Silvicultural Research Conference; 1980 November 6-7; Atlanta, GA. General Technical Report SO-34. New Orleans, LA: U.S. Department Agriculture, Forest Service, Southern Forest Experiment Station; 1981: 92-95.

The basic objective of this study was to determine the effects of site preparation on the growth of hand-planted loblolly pine. The study was established on the Louisiana State University Idlewild Experiment Station near Clinton, Louisiana. The seedlings were regular and genetically improved 1-0 loblolly pine stock, planted in February and March, 1979. The area consisted of three 0.80 hectare rectangular blocks which received the following site preparation treatments: chopped only; chopped and burned; and chopped, burned, stumps removed, and double disked. Each block was divided into two 0.40 hectare plots, one of which was planted with regular and the other with genetically improved seedlings at a spacing of 2.4 x 2.4 meters. The first year survival and height increments are in Table 1.

Table 1. Effect of site preparation on growth of hand-planted loblolly pine after one growing season

	Regular seedlings		Genetically improved seedlings		Average	
Site preparation treatment	Survival (%)	Height increment (cm)	Survival (%)	Height increment (cm)	Survival (%)	Height increment (cm)
Chopped	82.0	23.1	73.5	21.6	77.8	22.35
Chop & burn	90.8	33.0	82.3	24.6	86.5	28.95
Chop, burn, stumped, and, disk	78.0	21.1	64.8	17.8	71.4	20.06
Average	83.7	25.7	73.7	21.7	78.6	23.70

Abstract: Larry Gross

FPM83-0114
Huckenpahler, B. J. Poisoning versus girdling to release underplanted pines in north Mississippi. Journal of Forestry. 52(4): 266-268; 1954.

An 8-year-old underplanted loblolly pine stand was released from overstory blackjack, white, post, red, and black oak, hickories, and black gum (228 trees per acre more than 1 inch d.b.h.) in Panola County, Mississippi. Three replications of three treatments were randomly assigned to nine quarter-acre plots containing an average of 628 pines per acre: (1) small hardwoods (0.5 to 3.5 inch d.b.h.) felled and stumps treated with ammate, large hardwoods treated by the ammate crystal-in-notch method; (2) small hardwoods felled and large hardwoods girdled; and (3) untreated. Results after 2 years appear in Table 1.

Single-hack frill girdling gave a more complete crown kill on upland oaks and hickories and costs less but was slower in killing than ammate poisoning. Ammate poisoning was more effective in preventing sprouting although the pines were large enough to withstand competition from sprouts. Diameter, height, and basal area growth of released trees were significantly greater than that of unreleased trees. Diameter growth and basal area growth was about twice and height growth about 1 1/2 times that of unreleased trees. Differences between release by poisoning and girdling were not significant. Almost one-tenth of the underplanted pines were killed or severely damaged by falling debris from deadened overstory trees. This heavy damage is believed to be largely due to the 8-year delay in release.

Table 1. Diameter and height growth of loblolly pine by method of release after 2 years

Method of release	D.b.h. increase (in)	Height increase (ft)	Basal area increase (sq ft/acre)
Average all pines:			
Unreleased	0.6	4.0	5.5
Released by poisoning	1.0	5.2	11.2
Released by girdling	1.1	6.1	15.8
100 tallest pines per acre:			
Unreleased	0.7	5.5	1.8
Released by poisoning	1.3	5.9	3.6
Released by girdling	1.5	7.2	4.9

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0115

Hunt, Ron; Cleveland, Glenn. Cultural treatments affect growth, volume, and survival of sweetgum, sycamore, and loblolly pine. Southern Journal of Applied Forestry. 2(2): 55-59; 1978.

A study was installed in the southeastern Coastal Plain to determine the feasibility of growing sycamore and sweetgum on accessible upland sites and to compare their survival and growth to loblolly pine given a range of cultural treatments on various levels of site productivity. The study was designed as a split-split plot with varying degrees of cultural treatments used on the four main plots. Each of these plots was then split into three subplots (species); each of these was further split into two subplots (fertilizer). Four replications were planted on each of four levels of site productivity: 80, 90, 100, and 110 site index for loblolly pine. Cultural treatments were: (1) shear, burn, root-rake, and disk prior to planting and disk cultivate between and across rows of seedlings after planting (disk); (2) shear, burn, root-rake prior to planting and mow between and across rows of seedlings after planting (mow); (3) shear, burn, double chop with rolling drum chopper (chop); and (4) shear, burn (burn). Seedlings were 1-0 stock planted at an 8- by 10-foot spacing. The study was installed at six locations in the Coastal Plain of South Carolina, Georgia, Florida, Mississippi, Arkansas, and Louisiana.

Volume index (d.b.h. x height) is shown graphically for loblolly pine. Total height at age 5 for sweetgum, sycamore, and loblolly pine is shown in Table 1. Mean d.b.h. of loblolly pine at age 5 by location, treatment, and site index is shown in Table 2.

Disk cultivation significantly increased height and volume index of all species. Generally, the more intensive the cultural care, the greater the volume index of loblolly pine. Unless the hardwoods on most upland sites are disk-cultivated, they have no chance to become established and grow. Fusiform rust incidence on loblolly pine increased with cultural intensity and with site index. Sycamore growth has slowed dramatically since year three, while that of sweetgum and loblolly pine has increased.

Table 1. Effect of cultural treatments on height growth of loblolly pine, sweetgum and sycamore after 5 years

Site index and cultural treatment	Height (feet)			
	Sycamore	Sweetgum	Loblolly	All species
SI 80-disk	14.2	10.3	17.7	14.1
-mow	8.8	5.5	11.6	8.6
-chop	7.0	4.7	11.8	8.6
-burn	6.2	4.6	12.4	7.7
SI 90-disk	15.3	10.6	16.7	14.2
-mow	8.6	7.0	13.2	9.6
-chop	6.2	5.2	12.7	8.0
-burn	6.8	5.0	13.9	8.5
SI 100-disk	12.0	7.9	18.1	12.7
-mow	8.2	5.7	12.7	8.9
-chop	7.2	5.5	11.8	8.2
-burn	7.4	4.5	13.1	8.3
SI 110-disk	14.9	10.2	17.2	14.1
-mow	7.9	7.5	15.3	10.2
-chop	6.4	6.8	16.9	10.0
-burn	7.3	7.6	15.7	10.2

Table 2. Effect of cultural treatment on diameter growth of loblolly pine at age 5

Site index	Cultural treatment	D.b.h. by location (inches)					
		SC	GA	FL	MS	MS	AR, LA
80	disk	--	3.1	4.2	3.0	3.0	3.2
	mow	--	2.4	3.7	--	2.7	--
	chop	--	2.0	3.2	--	2.7	--
	burn	--	1.9	3.3	2.0	2.5	1.8
90	disk	--	3.1	3.5	3.2	2.9	2.7
	mow	--	2.3	3.6	--	2.5	--
	chop	--	2.6	3.0	--	2.6	--
	burn	--	2.2	2.7	2.4	2.4	1.3
100	disk	--	3.0	4.0	--	3.8	3.7
	mow	--	1.9	4.0	--	2.3	--
	chop	--	2.3	3.3	--	2.0	--
	burn	--	1.9	3.4	--	2.3	2.3
110	disk	3.7	--	3.7	4.2	3.2	3.7
	mow	2.4	--	2.9	--	2.3	--
	chop	2.0	--	3.6	--	2.5	--
	burn	2.1	--	3.4	3.7	2.8	2.6

Abstract: Ronald E. Stewart

FPM83-0116
Jaciw, P. How silvicides gave 10-year assist to conifer regeneration. Canadian Forest Industries. 92(2): 30-36; 1972 February.

Growth and survival of eastern white pine seedlings growing on an area in the Timagami Provincial Forest, Sheppard Township, Ontario Province, were followed for 10 years after release spraying in August 1958. Aerial sprays containing 0.5 pounds and 1.5 pounds acid equivalent of 2,4,5-T or silvex were applied in an oil-in-water emulsion at 2 gallons and 4 gallons per acre. About 96 percent of the almost 2,000 white pine seedlings per acre were suppressed by mountain maple, hazel, hardwood regeneration (white birch, red maple, pin cherry), and grasses and forbs. In October 1969, 242 white pine seedlings were measured from the August 1958 1.5 pounds 2,4,5-T,2 and 4 gallons per acre treatments plus controls. Of this total, 47 sample trees had been permanently marked at the time of spraying in the aerial spray plots and 69 seedlings were located in the controls. Results after 10 years appear in Table 1.

From 1958 to 1968, the average height of released trees increased more than seven times (729 percent) while trees growing in unsprayed brush increased only three times (319 percent). White pine survival 10 years after treatment was 66 percent with rabbit browsing causing most of the mortality. In contrast, animal damage was less on the controls and only 17 percent of the trees died, however, most of the trees were spindly and of low vigor with 16 percent dying from suppression. The greater mortality on sprayed plots was partly compensated by additional recruitment of conifers.

Table 1. Effect of silvicide release on survival and growth of white pine after 10 years

	Total height (inches)		Total annual growth (inches)		Suppression class - 1968 (percent)		
	1958	1968	1958	1968	Open	Top suppressed	Side suppressed
Control	16.5	52.6	36.1	3.6	8	88	4
Released	7.7	56.1	48.4	4.8	10	29	61

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0117
Johnston, William F. Broadcast burning slash favors black spruce reproduction on organic soil in Minnesota. Forestry Chronicle. 47(1): 1-3; 1971.

Two methods of slash burning, (1) broadcast burning in the summer and (2) progressive burning of piled slash in the winter, were compared to no slash disposal for preparation of seed beds for regeneration of black spruce. The test sites were near Big Falls in north-central Minnesota. The test areas consisted of 7 broadcast areas, 6 progressive treatment areas and 6 control areas.

It was concluded that broadcast burning is superior to both progressive burning and no disposal of slash for reproducing black spruce on clearcut, organic-soil areas. Broadcast burning is superior because: (1) it exposes moist sphagnum moss and consumes dry mosses, (2) it kills all residual conifers over the entire clearcut area thus eradicating dwarf mistletoe, and (3) assuming slash disposal is prescribed, it is much cheaper than progressive burning.

Black spruce reproduction 2 to 6 years after various methods of slash burning and clearcutting are recorded in Table 1.

Table 1. Effect of seed bed preparation methods on reproduction of black spruce 2 to 6 years after treatment

Type of treatment: Burning	Type of treatment: Clearcutting	Years since treatment	Spruce reproduction: Trees per acre	Spruce reproduction: Milacre stocking (percent)
Broadcast	Large patch	2	7,200	80
	Wide strip	2-4	12,900	91
Progressive	Small patch	4	13,900	97
	Narrow strip	4	9,900	86
None	Small patch	4-6	3,700	62
	Narrow strip	4-6	2,200	48

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0118

Kaszkurewicz, A.; Keister, T. Effects of intensive cultural treatments and seedling size on juvenile growth of sweetgum. Tree Planters' Notes. 26(3): 5-8, 26; 1975.

An experimental sweetgum plantation was established near Clinton, Louisiana, in the spring of 1964, to determine if certain cultural treatments could cause a significant improvement in early growth. The cultural treatments tested included three mulching methods: No treatment (M1), black polyethylene pads (M2), and bedding of the soil in a double furrow (M3). Three weeding methods used were: No weeding (W1), weed mowing (W2), and amizine spray (W3). Four dibble planting methods were tested: The standard method in undisturbed soil (P1) and in mixed soil of auger-prepared holes 12(P2), 21(P3) and 30(P4) inches deep and 9 inches in diameter.

The test area was divided into 8 blocks, with a 3 x 3 x 4 factorial design used to apply all 36 combinations to each block. Each combination in a block was represented by one 4-tree plot.

Adjusted treatment means of sweetgum heights and d.b.h. at age four appear in Table 1.

At the end of the fourth year, sweetgum trees were significantly taller when they were mulched with the polyethylene pads and appeared taller when weeded with amizine spray. Fourth-year d.b.h. was largest when trees were mulched with polyethylene pads and weeded by amizine spray. The shortest trees with the smallest d.b.h. were those that received no weeding or mulching, regardless of planting method used.

Table 1. Effect of cultural treatments and seedling size on juvenile growth of sweetgum after 4 years

Treatment		Tree height (ft)	D.b.h. (in)
Mulch	- M1	9.62	0.91
	- M2	10.83	1.08
	- M3	10.10	1.01
Weeding	- W1	10.02	0.98
	- W2	10.12	0.99
	- W3	10.42	1.04
Planting	- P1	10.06	1.00
	- P2	10.09	0.98
	- P3	10.16	1.01
	- P4	10.42	1.02

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0119

Kennedy, Harvey E., Jr. Foliar nutrient concentrations and hardwood growth influenced by cultural treatments. Plant and Soil. 63: 307-316; 1981.

This paper reports on soil and foliar nutrient levels, soil moisture, and growth and survival of six hardwoods as influenced by three intensities of cultural treatment: uncultivated, mowed, and cross-disked. The study occupied about 4 hectare on the Delta Experimental Forest near Stoneville, Mississippi. A split-split-plot design was used. Blocks (0.67 ha) were split into three equal-sized plots. One of three cultural treatments was randomly assigned to a plot. Plots were divided into 6 subplots with one species randomly assigned to a subplot. The species were cottonwood, sycamore, green ash, sweetgum, Nuttall oak, and sweet pecan. There were six replications of each cultural treatment.

After four growing seasons, trees in disked plots were significantly taller than trees on mowed or control plots. There was no real difference between mowed and control. Disking increased heights from 42 percent for green ash to 130 percent for sycamore over trees in control plots.

Diameters at groundline in disked plots were also significantly larger than in other plots. Increases ranged from 144 percent for cottonwood to 240 percent for Nuttall oak.

Survival was significantly higher in disked plots (91 percent) than mowed (80 percent) and control (76 percent). Disked plots ranged from a low of 84 percent survival for sweetgum to 99 percent for sycamore. Diameter and heights are shown in bar graphs after four growing seasons.

By eliminating competition, disking directly or indirectly increased nutrients and soil moisture for uptake by trees, as evidenced by their larger nutrient accumulations and better growth. Anything less than the degree of site preparation and disking used in this study results in lower survival and reduced growth. There were no significant reductions in soil nutrient levels because of cultural treatments during the study.

Abstract: Larry Gross

FPM83-0120
Kirchner, W.; Bradley, B.; Griffin, S. The effect of brush competition on conifer plantation growth on the Sequoia National Forest and recommended release schedules. Unpublished report on file. Porterville, CA: U.S. Department Agriculture, Forest Service, Sequoia National Forest; 1978.

During 1977, a series of 182 plots were taken as part of a field survey of 4- to-10-year-old plantations on the westside of the Sequoia National Forest in the central Sierra Nevada of California to determine when a plantation should be released from brush competition. One-fiftieth acre plots were taken in plantations or portions of plantations where conifers were free of brush competition and where conifers had varying degrees of brush cover. The following information was collected: for the crop tree; species, height, d.b.h.; brush height, percent of plot occupied by brush, and species.

Based on the survey, the effect of brush competition on conifer growth in plantations at age 10 is recorded in Table 1.

Data indicate that, on the average, when brush cover reached 30 percent, the average height of brush was starting to exceed the average height of planted trees. Where planted trees were growing with only 0-10 percent brush crown cover, d.b.h. growth equaled or exceeded board foot growth expected under intensive forestry. At 60 percent or more brush cover, d.b.h. growth fell far below the amount needed to meet intensive forestry growth objectives.

From height growth data and mortality data it appears that release should be performed when brush crown cover on plantations reaches the 30 percent level.

Table 1. Effect of brush competition on conifer growth after 10 years

	Conifer growth	
Percent brush cover	Average height (feet)	Average d.b.h. (inches)
0-10	10.2	3.2
20-30	7.8	-
60-80	3.5	0.8

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0121
Kittams, Jay A.; Ryker, Russell A. Habitat type and site preparation affect survival of planted Douglas-fir in central Idaho brushfields. USDA Forest Service Research Note INT-198. Ogden, UT: U.S. Department Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 1975. 6 p.

The objective of this study was to compare survival and growth of Douglas-fir planted under shade on an unprepared site with Douglas-fir planted on prepared sites with all above ground vegetation removed. The study area is on the Boise Basin Experimental Forest in Idaho. Twenty blocks, each containing two 8- by 8-foot plots were established in June, 1971. One plot in each block randomly selected, had all above ground vegetation and litter removed. Each plot had two rows of 5 trees each, 3-0 Douglas-fir, planted on it.

Table 1 shows third-year survival and height growth of planted Douglas-fir.

Results indicate that third-year survival increased from 18 percent on untreated plots to 42 percent on the scalped plots. Trees on the scalped plots had 30 percent more height growth than trees on the unscalped plots. Although site preparation increased survival and growth of planted Douglas-fir, the degree of response appeared to differ between habitat types.

Table 1. Effect of site preparation on survival and growth of Douglas-fir over a 3-year period

Preparation method	Survival (%)	Height growth (cm)
8 x 8 ft scalp	42	6.5
No scalp	18	5.0

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0122
Klawitter, Ralph A. Diameter growth of mature loblolly pine unaffected by understory control. Southern Lumberman. 213: 154-155; 1966.

A 17-year-old test of prescribed fire in a 60-year-old stand of loblolly pine on the Santee Experimental Forest near Charleston, South Carolina, provided an opportunity to study soil water and pine growth where the understory was controlled and where it was not. The stand was located on a poorly drained Coxville soil. Annual summer fires eradicated all understory hardwoods and shrubs with the exception of a few of the larger hardwoods. On the unburned plots, the number of understory stems exceeded 10,000 per acre composed of sweetgum, blackgum, mixed oaks, southern bayberry, pepperbush, and gallberry. Diameters of 30 trees were measured on three pairs of burned and unburned plots at the beginning and end of the 1964 and 1965 growing seasons.

Tree diameter averaged 16 inches on both burned and unburned plots at the beginning of the 1964 growing season. Two growing seasons later, average diameter had increased about 0.3 inches with no meaningful differences between treatments. Water loss and recharge were comparable for both the burned and unburned plots, which could explain the similarity in diameter growth as well. Further, when trees reach advanced age, their growth rates slow and they become less responsive to treatment. The 60-year-old trees in this study may not have shown much response even with reduction of understory that is competing for space, moisture, and nutrients.

Abstract: Ronald E. Stewart

FPM83-0123

Korstian, C. F.; Bilan, M. Victor. Some further evidence of competition between loblolly pine and associated hardwoods. Journal of Forestry. 55(11): 821-822; 1957.

Sixty 7-year-old loblolly pine seedlings were selected from an even-aged stand of loblolly pine and hardwoods on an upland site of the Duke Forest in the North Carolina Piedmont Plateau. Twenty pines were randomly selected for each of the following treatments: (1) crown and root competition reduced by killing all woody plants within 33 inches of the pines with ammate; (2) crown competition reduced by tying back all woody plants capable of shading the pine; and (3) no treatment. Analysis after two growing seasons showed that released trees grew faster than unreleased trees but that there was no difference between release treatments. Therefore, all woody plants within 12.5 feet of the pines in treatment 1 were killed with ammate for the final 2 years of study. Table 1 shows results 4 years after the initial treatment.

Treatment means were adjusted for pretreatment differences. Both height and diameter growth of released pines were significantly greater than that of unreleased pines. Further, trees released by poisoning grew faster than those released by tying the hardwoods back.

Table 1. Effect of hardwood release on growth of 30-year-old loblolly pine after 4 years

Method of release	Adjusted mean growth: Height growth (inches)	Adjusted mean growth: Diameter growth 1 inch above ground (inches)
Untreated	60.9	0.94
Hardwoods poisoned	98.7	2.34
Hardwoods tied back	84.5	1.67

Abstract: Ronald E. Stewart

FPM83-0124
La Bonte, George A.; Nash, Robley W. Cleaning and weeding paper birch: A 24-year case history. Journal of Forestry. 76(4): 223-225; 1978.

This paper reports a 24-year case history of silvicultural treatments in a 7-year-old paper birch -- quaking aspen stand in the township of Salem, Maine.

The site burned in 1944. Natural seeding produced a thick stand in 1945. By fall 1951, 40 to 45 thousand stems per acre, mostly paper birch and quaking aspen remained. In the fall 1951, aspen averaged 20 feet in height and 1.5 inches in diameter. Paper birch averaged 6 feet tall and 0.5 inches in diameter. A 1.67-acre area was selected for study. In the fall of 1951, 1.17 acres were cleaned and weeded and a 0.50-acre area was left as a control. In 1958, the cleaned and weeded areas were recleaned.

In 1975 the check plot supported a pure aspen stand averaging 72 feet in height, 7 inches in d.b.h. and containing about 25 cords of pulpwood per acre. The cleaned and weeded plots consisted of pure paper birch averaging 64 feet in height, 6 inches in d.b.h. and containing about 15 cords per acre.

Abstract: Larry Gross

FPM83-0125

Lambert, J. L.; Boyle, J. R.; Gardner. W. R. The growth response of a young pine plantation to weed removal. Canadian Journal of Forest Research. 2: 152-159: 1972.

In May, 1969, the weed vegetation on one plot in a 7-year-old red pine plantation was killed with herbicides. Two 15- by 30-meter plots were established. One plot was sprayed in May with 4 pounds per acre of simazine and retreated in June with 1 pound per acre dalapan and 1.5 pounds per acre of 3,4-D. The plot was sprayed again with 4 pounds per acre of simazine and broadleaf weeds with 2,4-D the following spring (1970). The second plot was left untreated. The site was a glacial outwash plain in Adams County, Wisconsin. Tree diameter growth was 30 percent greater on the plot without weeds in the summer of 1969 and 8 percent greater during the first half of the 1970 growing season. Based on relative height growth of the previous year, weed removal increased height growth by 13 percent in 1970. Growth differences were attributed to increased available water resulting from weed removal because needle water potentials were lower and stomatal resistances much higher in the presence of weeds during dry conditions in the plantation.

Total diameter and height growth of seedlings for the first two years after treatment appear in Table 1.

Diameter growth response to weed removal occurred within 3 weeks after treatment, even though the weeds showed no signs of injury during this period. Diameter growth reductions were functionally related to the soil water potential. The response of height growth to water stress was somewhat masked by a time lag due to the preformed elongation pattern of red pine.

Table 1. Effect of weed removal on growth of young pine during first two growing seasons

	Total 2-year growth	
	Diameter (cm)	Height (cm)
Untreated	1.52	106.7
Treated	1.81	108.9

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0126

Langdon, O. Gordon; Trousdell, Kenneth B. Increasing growth and yield of natural loblolly pine by young stand management. In: Proceedings symposium on management of young pines. Atlanta, GA: U.S. Department Agriculture, Forest Service, Southeastern Area State and Private Forestry; 1974: 288-299.

See: Balmer, William E.; Utz, Keith, A.; Langdon, O. Gordon, 1978.

FPM83-0127

Lange, Keith D. Effects of clearcutting understory hardwoods on the growth of a shortleaf--Virginia pine stand. Journal of Forestry. 49(3): 176-178; 1951.

Three 1-acre plots were established in an old-field stand of 26-year-old shortleaf and Virginia pines with a heavy hardwood understory near Norris, Tennessee. All hardwoods over 0.5 inches d.b.h. were cut with an axe and suppressed pines were removed on two of the plots; hardwood sprouts were cut again 4 years later. The third plot was left untreated. Results after 11 years are in Table 1.

The 11-year growth of the pine stand was not affected by cutting of the understory. Pine basal area over 0.5 inches d.b.h. increased 35 percent on the treated plots and 32 percent on the untreated plots in 11 years. Merchantable volume increased 107 percent on treated and 113 percent on untreated plots.

Table 1. Effects of clearcutting hardwood understory on growth of shortleaf pine over an 11-year period

Treatment	Pine basal area (sq ft/acre)	Pine volume (fbm/acre)	Volume growth (fbm/acre/yr)
Untreated	97	10,800	520
Treated (2 plots)	95	11,400	540

Abstract: Ronald E. Stewart

FPM83-0128
Lantagne, D. O.; Burger, J. A. First-year survival and growth of loblolly pine (Pinus taeda L.) as affected by site preparation on the South Carolina and Georgia Piedmont. In: Jones, Earle P., Jr., ed. Proceedings of the Second Biennial Southern Silvicultural Research Conference; November 4-5, 1982; Atlanta, GA. General Technical Report SE-24. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station; 1983: 5-10.

Studies were installed on 12 study sites on the South Carolina (Fairfield and Newberry counties) and Georgia (Wilkes and Oglethorpe counties) Piedmont, to determine the effects of several site preparation methods, following clearcutting of pine-hardwood stands, on loblolly pine survival and growth. The soils of the study sites were Appling, Pacoulet, Cecil, or Hiwasee which have only minor differences in the depth, color, and texture of the subsoil. Treatments included: (1) control; (2) 1 gallon of glyphosate per acre, aerially applied followed by burning 6 weeks later; (3) chop and burn; (4) shear, rake and pile; (5) shear and disk; (6) shear, V-blade, and disk (two pass); and (7) shear, rake-pile, and disk (three pass). Treatments were applied within study sites on 3 to 5 acre plots during the summer and fall of 1980. All treatment areas were machine planted with 1-0 genetically improved loblolly pine, with the exception of the control and herbicide plots which were hand planted. Five 0.1 acre subplots, with about 64 seedlings each, were randomly located within each treatment plot for measurement of effects.

In addition, subsoiling was tested on the four Georgia sites in a 2 x 2 factorial arrangement of treatments in a split-plot design. Each of the four replicates was 0.8 acre in size and contained the following four 0.2 acre treatments: (1) control, (2) subsoil, (3) disk, and (4) disk and subsoil. Subsoil furrows were made across the disked and un-disked main plots. The sites were machine planted with 1-0 genetically improved loblolly pine seedlings, within and between furrows.

The first-year survival and growth of loblolly pine seedlings as affected by site preparation treatments are shown in Table 1.

Seedling survival in the five mechanical treatment plots was significantly better than seedling survival in the herbicide-burn and control plots. The differences among mechanical treatments were not significant with the exception of the shear-pile-disk which had better survival than the chop-burn treatment. The mechanical treaments, with the exception of the shear-pile prescription, improved height growth by a significant 11 percent over that of the herbicide-burn and control plots. Except for the shear-pile treatment, seedling volumes (D^2 H volume index) were significantly improved by mechanical prescriptions. The shear-V-blade-disk and shear-pile-disk prescriptions improved volume about 60 percent over that of the herbicide-burn and control treatments and 40 percent over the shear-pile prescription.

First-year survival and growth of loblolly pine seedlings as affected by subsoiling and disking are shown in Table 2.

Subsoiling and disking significantly increased seedling survival by 22 and 12 percent, respectively, and seedling volume by 13 percent for both treatments. The disk/subsoil interaction was also significant for survival and seedling volume meaning there was an additive effect for these two treatments.

Table 1. Effect of site preparation on first-year growth of loblolly pine

Site treatment	Survival (%)	Height (cm)	Diameter (mm)	Volume index (cu cm)
Control	45	27.5	5	9
Herbicide and burn	47	28.3	5	11
Chop and burn	58	30.6	6	20
Shear, rake-pile	59	28.7	6	15
Shear and disk	65	30.9	7	20
Shear, V-blade, disk	59	30.9	7	26
Shear, rake-pile, disk	67	32.5	7	24

Table 2. Effect of subsoiling and disking on first-year survival and growth of loblolly pine

Site treatment	Survival (%)	Height (cm)	Diameter (mm)	Volume index (cu cm)
Control	72	31.6	7	20
Disk	82	31.7	7	23
Control	68	30.9	7	20
Subsoil	87	32.3	7	23

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0129

Larson, M. M.; Schubert, Gilbert H. Root competition between ponderosa pine seedlings and grass. USDA Forest Service Research Paper RM-54. Fort Collins, CO: U.S. Department Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station; 1969. 12 p.

The study was conducted in two environments: glass-faced planter boxes set in the ground at the Fort Valley Nursery near Flagstaff, AZ and field plots in a nearby old clearcut in a ponderosa pine stand. Both locations were at an elevation of about 7,400 feet. Dormant ponderosa pine, Arizona fescue, and mountain muhly seedlings were planted on April 12, 1963 in nine glass-faced boxes to study root development. These boxes, 2 feet x 3 inches and 2 feet deep, were slid into wooden frames that had been buried in the ground at a 30° angle from vertical. On the field plots, 2-year-old ponderosa pine seedlings were planted between April 25-28, 1964, in six replications each containing six plots - two each of Arizona fescue, mountain muhly, and denuded cover types.

Average growth of ponderosa pine seedlings in field plots after two growing seasons is in Table 1.

Results of the study indicate that ponderosa pine seedlings grew best on well-prepared plots. Root and top growth were both significantly greater when pines were grown without competition from grass. The pine seedlings on denuded plots showed an elevenfold net gain in dry weight than those grown in competition with grass. Dry weights of roots and tops of pines grown on bare soil were over four times more than for pines grown in grass.

Grass roots grew faster than pine roots. Main roots of the grass elongated at a rate 50 percent greater and thereby occupied a given volume of soil sooner than pine roots.

Table 1. Effect of root competition from grass on growth of ponderosa pine seedlings after two growing seasons

Cover type	Dry weight (grams) Roots	Tops
Fescue	0.95	1.10
Muhly	1.79	2.76
Bare ground	3.73	6.98

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0130

Lauterbach, P. G. Chemical weeding and release of conifers in western Oregon and Washington. In: Proc. Herbicides and vegetation management. Corvallis, OR: Oregon State University, School of Forestry; 1967: 148-151.

Plots were established to follow response of Douglas-firs to release from red alder and associated brush on two operational aerial spray areas in western Washington. The Toledo Cutoff area was sprayed with phenoxy herbicides on June 10, 1957, and the Doty-Dryad area was sprayed in mid-July of 1956. Both areas are estimated to be Site Class II for Douglas-fir. Table 1 shows results after 5 or 6 years.

Initial terminal damage appeared to be greater following the June spraying but the trees grew considerably faster than trees sprayed in July during the year after release. In fact, trees sprayed in mid-July did not grow faster than unsprayed trees until the third year. Released trees had longer needles and more dense, darker green foliage than trees growing in the shade of alder. Diameter increase of released trees was two to two and one-half times that of unreleased trees of the same height at the time of spraying.

Table 1. Effect of release on development of Douglas-fir over a 5- and 6-year period

Toledo Cutoff plot

Height class (feet)	Treatment	No. of trees	Initial height (feet)	5-year growth (feet)	Growth ratio sprayed/un-sprayed trees (percent)
5	Unsprayed	9	5.7	4.4	--
	Sprayed	36	5.0	9.6	118
10	Unsprayed	15	9.3	4.8	--
	Sprayed	19	9.3	10.8	125
15	Unsprayed	5	13.8	6.3	--
	Sprayed	5	13.8	12.1	92
20	Unsprayed	1	20.0	8.0	--
	Sprayed	--	--	--	--
Average	Unsprayed	30	9.3	5.1	--
	Sprayed	60	7.3	10.2	100

Doty-Dryad plot

Height class (feet)	Treatment	No. of trees	Initial height (feet)	6-year growth (feet)	Growth ratio sprayed/un-sprayed trees (percent)
2	Unsprayed	3	2.0	8.4	--
	Sprayed	5	2.2	9.8	17
5	Unsprayed	19	4.4	6.8	--
	Sprayed	22	5.4	10.8	59
10	Unsprayed	9	9.2	9.2	--
	Sprayed	7	9.8	12.3	34
15	Unsprayed	--	--	--	--
	Sprayed	2	14.2	12.0	--
20	Unsprayed	--	--	--	--
	Sprayed	1	19.0	11.2	--
Average	Unsprayed	31	5.8	7.8	--
	Sprayed	37	6.6	11.0	41

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0131
LeBarron, Russell K. Silvicultural management of black spruce in Minnesota. Circular No. 791. Washington, D.C.: U.S. Department Agriculture; 1948. 60 p.

Black spruce germinates rather promptly when temperature and moisture conditions are favorable. Germination and early survival under natural conditions are strongly influenced by the kind of soil surface material. On a recently cleared upland forest in northeastern Minnesota, mineral soil, from which vegetation and organic had been stripped, was found to be the best of four kinds of surfaces that were tested and natural undisturbed duff the poorest. First year survival is recorded in Table 1.

The same principles apply in swamps although the surface materials are quite different. Peat that has been exposed either mechanically or by burning makes a very favorable seedbed if its surface is not subject to flooding. Natural seedling stocking after 6 years in a swampy area dominated by Labrador tea and sphagnam moss are shown in Table 2.

Black spruce seedlings grow most rapidly when they are wholly free from vegetative competition. Seedlings on upland soil that had been continuously weeded averaged 12 inches in height at 3 years as compared to controls that averaged 3 inches. Early growth in better quality swamps was similiar.

Table 1. Effect of soil surface material on germination of black spruce

Soil surface	Germination (percent)	Seedlings germinated (percent)	Sown (percent)
Mineral soil	47	66	31
Scarified and shaded duff	30	19	6
Burned duff	30	15	4
Undisturbed duff	9	8	1

Table 2. Effect of swampy seed bed and treatment on seedling stocking development after 6 years

Treatment	Seedlings per acre
None	0
Shrubs cut with brush hook	544
Shrubs uprooted by pulling	3049
Shrubs, litter, and moss stripped off with hoe	8385

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0132

Lees, J. C. Release of white spruce from aspen competition in Alberta's spruce-aspen forest. Department of Forestry Publication No. 1163. Calgary, Alberta: Canada Department of Forestry; 1966. 15 p.

Spruce-aspen stands of varying age were selected within a 30-mile radius of Smith, Alberta on gently rolling terrain in the B-18a Mixedwood Section of the Boreal Forest Region. The stands were of fire origin with aspen as the main component. The aspen was generally 10 to 20 years older than the understory. In 1951 and 1952, 333 white spruce stems were individually released from aspen and 323 were left as controls covering the same age and diameter range. These trees were selected from 25 different stands. Individual spruce trees having only aspen competition were subjectively selected and all competition within a radius of twice the crown width of treated spruce trees was removed by cutting. A minimum radius of 8 feet regardless of crown width was applied. To prevent aspen suckering and root competition, all aspen stumps were treated with ammate crystals. In each stand, control trees comparable to the treated spruce in d.b.h., age, and height were selected. By 1962, at time of final measurement, some of the stands had been lost to road construction and fire. However, a total of 461 stems, 235 treated and 226 control, were located in 20 stands and remeasured.

Periodic annual diameter, height, and volume increments of released and unreleased white spruce for the first 10 years after treatment are shown in Tables 1, 2, and 3.

Ten-year remeasurement of white spruce stems released from aspen competition in Alberta's spruce-aspen forest indicated that over a wide diameter and age range, growth of spruce increased significantly after treatment. Trees above a 5-inch d.b.h. limit increased in mean merchantible cubic foot volume by 20 to 40 percent. Release should be carried out before the spruce grows into the aspen overstory.

Table 1. Effect of release on height and diameter growth of white spruce by diameter class after 10 growing seasons

Diameter class (inches)	Diameter increment (inches/year)		Height increment (feet/year)	
	Released	Unreleased	Released	Unreleased
1	0.23	0.14	1.27	0.87
2	0.27	0.17	1.35	1.06
3	0.29	0.19	1.66	0.97
4	0.40	0.24	1.54	0.38
5	0.39	0.23	1.50	1.20
6	0.37	0.26	1.71	1.08
7	0.44	0.26	1.56	1.20
8	0.44	0.32	1.38	0.85
9	0.40	0.24	1.21	0.99
10	0.39	0.26	1.38	0.80

Table 2. Effect of release on diameter and height growth of white spruce by age class after 10 growing seasons

Age class (years)	Diameter increment (inches/year)		Height increment (feet/year)	
	Released	Unreleased	Released	Unreleased
20-30	0.27	0.18	0.94	0.62
30-40	0.26	0.16	1.18	0.82
40-50	0.35	0.22	1.37	0.87
50-60	0.42	0.28	1.42	1.24
60-70	0.39	0.25	1.34	0.84

Table 3. Effect of release on volume of white spruce by age after 10 growing seasons

Age	Volume per tree (cubic feet)	
	Released	Unreleased
40	19.3	15.7
50	30.3	21.7
60	26.7	15.2
70	18.9	14.7

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0133
Lehala, Ago. Benefits of herbicide control of unwanted vegetation in the boreal mixedwood forest. Manuscript for Proceedings Boreal Mixedwood Symposium, on file. Thunder Bay, Ontario: Ontario Ministry of Natural Resources; 1981.

Between 1975 and 1978, seven cutovers were examined in the Ontario Ministry of Natural Resources districts of Hearst, Terrace Bay and Thunder Bay on sandy, silt and clay loam sites in northern Ontario. Areas had been aerially sprayed with 2,4-D and 2,4,5-T up to 20 years previously. A total of 6,967 milacre plots were examined for brush species and tree stocking and 1,665 milacre plots were examined to obtain 789 balsam firs for stem analysis. Balsam firs from sprayed and unsprayed areas were sampled for each of five consecutive 50 centimeters spray-time height classes for trees less than 2.5 meters in height at time of spraying. Standard metric stem analysis procedures were used to obtain height, diameter, and age information. Differences in total heights and height increments between sprayed and unsprayed trees are shown in Table 1.

Sprayed trees increased in diameter, height, and volume significantly more than unsprayed trees. Volume gains 5 years after spraying were 153 percent on sandy, 51 percent on clay loam, and 165 percent on silt loam sites. The declines in height growth are artifacts caused by the formula used to calculate percent difference which uses total tree size as the denominator, a value that increases with time.

Data are also presented from two shorter term studies of response of spruce (Picea spp.) to release using 2,4-D. Tables from one study presented by the author show that trees over 50 centimeters tall benefited from spraying but benefits lasted only 3 years before a decline began. On the average, 6 years after spraying dominant, codominant, and suppressed spruce were 16, 7, and 15 percent taller in the sprayed then in the unsprayed area. The other study was inconclusive due to sampling and study design problems.

Table 1. Differences in total height and height increments between sprayed and unsprayed trees after 5 years

	Percent difference in height of sprayed versus unsprayed trees in post-spray years				Percent difference in 5-year height increments of sprayed versus unsprayed trees			
Soil type	Yr +5	Yr +10	Yr +15	Yr +20	Yrs 1-5	Yrs 6-10	Yrs 11-15	Yrs 16-20
Sandy loam	47	--	--	--	158	--	--	--
Clay loam	19	60	--	--	29	156	--	--
Silt loam	51	73	74	66	163	127	75	42

Abstract: Ronald E. Stewart

FPM83-0134

Lennartz, Michael R.; McMinn, James W. Growth of two varieties of slash pine on prepared sites in south Florida: 10-year results. USDA Forest Service Research Paper SE-103. Asheville, NC: U.S. Department Agriculture, Forest Service, Southeastern Forest Experiment Station; 1973. 10 p.

A study was established in south Florida to evaluate the influence of selected site treatments on the survival and growth of typical slash pine (Pinus elliottii var. elliottii) and South Florida slash pine (Pinus elliotti var. densa Little and Dorman). The study was established on flatwoods sites near Corkscrew, Frostproof, and Pierce, Florida. The soils were nearly level, acid sands with poor surface drainage and underlain either by marl or an organic pan. Site preparations included (1) prescribed burn with no additional treatment; (2) strip-chopping on 10-foot centers over unburned plots with a crawler tractor; (3) double-chopping, the second chopping immediately after the first and perpendicular to it; (4) clearing including prescribed burning, bulldozing stumps, rootraking, and harrowing with offset-disk harrow; and (5) bedding - plowing fireline furrows at 10-foot intervals on unburned plots then chopping furrows to prepare smooth beds. Four replications of each site treament were established for each location and year for three years from 1958 through 1960. Plots measured 4.2 acres and were planted with both typical slash pine and South Florida slash pine in a split-plot arrangement.

Average height and diameter of the slash pine after 10 years are presented in Table 1.

Site preparation improved height and diameter growth but did not improve survival in plantations of either typical slash pine or South Florida slash pine. Bedding provided the most favorable site for early growth (through the first 5 years), whereas clearing appears to have provided the most favorable environment for growth from the fifth through the tenth years. Although South Florida slash pine showed the most marked response to site preparation, typical slash pine exhibited superior survival and height growth relative to the performance of the South Florida variety.

Table 1. Effect of site preparation on height and diameter growth of typical slash pine and South Florida slash pine after 10 years

Site treatment	Height (feet) Typical	Height (feet) South Florida	Diameter (feet) Typical	Diameter (feet) South Florida
Control	22.8	16.9	3.5	3.4
Burning	22.2	19.2	3.6	3.8
Strip-chopping	23.2	17.8	3.7	3.5
Double-chopping	23.9	20.1	3.8	4.0
Clearing	24.1	21.1	3.9	4.3
Bedding	25.1	22.0	4.0	4.2

Abstract: Ronald E. Stewart

FPM83-0135
Liming, Franklin G. Response of planted shortleaf pine to overhead release. Technical Paper No. 105. Columbus, OH: U.S. Department Agriculture, Forest Service, Central States Forest Experiment Station; 1946. 20 p.

Three separate studies involving 78 plots were installed in 1938 and 1939 in Howell and Reynolds Counties, Missouri, to test four methods of release at three seasons, three methods of release of three ages of planted pine, and three methods at four intensities of release to increase survival and growth of 1-0 shortleaf pine planted under oak-hickory stands. The four release methods were: (1) shallow or peel girdle; (2) deep or notch girdle; (3) felling; and (4) no treatment. The five seasons and ages of pine when released were: (1) March - prior to planting; (2) May - 2.5 months after planting; (3) August - 5 months after planting; (4) March - 1 year after planting; and (5) March - 2 years after planting. The four degrees of release were: (1) 0 percent (81 square feet basal area in overstory); (2) 33 percent (54 square feet basal area); (3) 67 percent (27 square feet basal area); and (4) 100 percent (0 square feet basal area).

Data on survival, height growth, competition by advance hardwood reproduction and new sprouts from treated hardwoods, and damage from falling tops and branches were recorded for 3 or 4 years after release. Tables of shortleaf pine survival and bar graphs of tree height are presented.

The survival of planted pine 3 or 4 years after overhead release averaged about 82 percent and was quite variable. Of the combinations of release treatments tested, only complete release by cutting 1 or 2 years after planting resulted in a significantly lower survival than on the untreated plots.

Survival on untreated plots was as good as on released plots during the first 4 years and appears to be equally good after 8 years.

The great increase in height growth was the most significant effect of overhead release on planted shortleaf pine. Of the combinations of three methods, five ages, and four degrees of release tested, all except those involving a 33 percent release resulted in a significant increase in the height growth of pine compared with those given no release. Response was essentially the same for trees released by cutting, deep girdling, or shallow girdling. Therefore, the method of release can be chosen on the basis of cost, convenience, and utilization of the overstory trees.

The 4-year height data presented in Table 1 show that delaying overhead release into and after the first growing season decreased the response, but all completely released trees made significantly greater growth than unreleased trees.

Height growth after 3 years for delayed release appears in Table 2.

From the stand point of good growth and survival, pine planted in low-value hardwood stands should be released from above as soon as feasible. Release at the time of planting is much better than no release. As the data in Table 3 show, height growth for the 4 years after planting increased directly with the degree of overhead release.

Table 1. Height growth after four years by time of release treatment

Timing of release	Total height (in)
No release	15.7
March - prior to planting	70.7
May - 2.5 months after planting	59.9
August - 5 months after planting	53.5

Table 2. Height growth after three years for pre-planting and delayed release treated trees

	Total height (in)
March - prior to planting	58.0
March - 1 year after planting	52.1
March - 2 years after planting	48.2

Table 3. Height growth after four years by degree of release

Degree of release (%)	Total height (in)
0	16.5
33	19.1
67	32.8
100	64.7

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0136
Little, S.; Moore, E. B. Mechanical preparation of seedbeds for converting oak-pine stands to pine. Journal of Forestry. 50(11): 840-844; 1952.

In 1939 an experiment was initiated to test six different methods of seedbed preparation for the establshment and growth of pine seedlings on the Lebanon and Belleplain State Forests in Burlington, Ocean, and Cape May Counties, New Jersey. Six seedbed treatments are shown in Table 1. Two blocks of plots were established in each of the two areas, one in two-aged stands and the other in even-aged stands. For each treatment, eight plots were used, two in each of the four blocks. The plots were 1/2-acre each in the two-aged stands, and 1 acre each in the even-aged stands. When the sites were prepared, about ten pine seed trees per acre were left standing. Shortleaf pine were chosen whenever possible. The stands were cut and slash burned in 1939-1940. In August 1941, the sprouting brush was cut on one plot of each treatment in each block. On the Lebanon two-aged stand plots the brush was recut in 1942.

In 1947 the average ripped plot had more than 2,600 pines per acre; 83 percent of the milacre quadrats were stocked. Disked and broadcast burned plots had about 1900 pines per acre; about 70 percent of the milacre quadrats were stocked. Plots where slash was lopped and scattered had 48 percent of their quadrats stocked, control plots 38 percent quadrats stocked. Competition from hardwood sprouts affected the height growth of the pine seedlings. Seedlings grew 0.7-1.3 feet more between 1941 and 1947 in the areas where hardwood sprouts were cut in 1941. Where the hardwoods were cut in 1941 and 1942 the difference in height growth was 4 feet during the 6 years. Although every treatment except lopping and scattering of slash resulted in more than two-thirds of the quadrats being stocked with pine reproduction, by 1947, most of this reproduction was overtopped by hardwoods. Data on height growth after 7 growing seasons are presented in Table 2 for site preparation and in Table 3 for release by cutting hardwood sprouts.

Table 1. Six mechanical seedbed treatments

Mechanical Treatment	Slash Disposal
1. Ripping	Piling and burning
2. Disking	Piling and burning
3. Ripping	Broadcast burning
4. Disking	Broadcast burning
5. None	Broadcast burning
6. None	Lopping and scattering

Table 2. Average height of tallest pines on stocked milacres after 7 years

		Average height (feet)			
		Lebanon		Belleplain	
Mechanical treatment	Slash disposal	Two-aged stand	Even-aged stand	Two-aged stand	Even-aged stand
Ripped	Piled and burned or broadcast-burned	1.5	2.3	7.6	5.3
Disked	Piled and burned or broadcast-burned	1.4	1.7	6.7	6.5
None	Broadcast-burned	4.0	1.8	8.2	6.4
None	Lopped and scattered	4.9	1.4	8.0	6.9
None	None	0.5	0.4	1.7	0.9

Table 3. Effect of cutting hardwood sprouts on height growth of pines 6 years after release

	Height growth (feet)			
	Lebanon		Belleplain	
Treatment	Two-aged stand	Even-aged stand	Two-aged stand	Even-aged stand
Released	7.0	4.3	8.9	7.8
Unreleased	3.0	3.0	8.0	7.1

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0137
Little, Silas; Mohr, J. J. Disking to convert hardwood-loblolly pine stands to pine in eastern Maryland. U.S. Forest Service Research Paper NE-20. Upper Darby, PA [Station now at Broomhall, PA]: U.S. Department Agriculture, Forest Service, Northeastern Forest Experiment Station; 1964. 17 p.

In August 1956, three treatments for converting mixed stands to pine were tried in a hardwood-pine stand on Maryland's Eastern Shore: (1) blading with a D-4 bulldozer, with the blade carried 1 to 2 feet above ground which broke off or uprooted the smaller trees and larger shrubs; (2) single disking with an Athens disk drawn by the same bulldozer with blade as in treatment 1; and (3) double disking, done as in treatment 2, but twice over, with the second pass made crossways to the first one. Each treatment was applied on two 1.2-acre plots. After these mechanical treatments, residual hardwoods larger than 3 inches d.b.h. were frill-poisoned on all plots.

Much of the effect in all treatments was from the action of the blade and tracks of the bulldozer. The bulldozer was responsible for most of the uprooting and breakage of hardwood trees and shrubs taller than 3.5 feet and it also had some effect on smaller vegetation and the forest floor. The disking eliminated some more of the hardwoods, but its main effect was to reduce the density and height of stems in the 3.5 foot and shorter height classes. Disking also greatly increased establishment of pine seedlings. Double disking had still more effect, but not enough to warrant the additional expense.

So many hardwood trees and shrubs survived, and their regrowth was so rapid, that treatment effects in reducing competition to small pines were very temporary. Except on some drier sites, disking alone is inadequate preparation for establishment of nearly pure pine stands; it has to be supplemented by later selective release.

Amount of pine reproduction, milacre quadrats stocked with pine seedlings, and quadrats with pine free to grow five years after treatment appear in Table 1.

Table 1. Effect of disking on conversion of hardwood stands to loblolly pine after 5 years

Disk treatment	Pine reproduction: Pine seedlings per acre	Stocked quadrats (%)	Quadrats with pine free to grow (%)
Blade	3,190	63	20
Single disking	7,250	94	36
Double disking	6,170	91	47

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0138

Loftis, David L. Preharvest herbicide control of undesirable vegetation in Southern Appalachian hardwoods. Southern Journal of Applied Forestry. 2(2): 51-54; 1978.

The deadening of undesirable stems with herbicides, before timber harvest was studied on three blocks in the Bent Creek Experimental Forest near Asheville, North Carolina. Each block (7 x 10 chains) was divided into four 3.5- by 5-chain plots. In each block one of four treatments was randomly assigned to each plot: 1) No preharvest treatment; 2) Preharvest treatment in 1969; 3) Preharvest treatment in 1970; 4) Preharvest treatment in 1971. All areas were clearcut in 1972-73. In the check plots all residual stems taller than 4.5 feet were cut. The preharvest treatment consisted of killing with herbicides all stems of undesirable species over 1 foot tall and all stems of desirable species taller than 4.5 feet which would not be harvested.

Four years after logging, the number of undesirable stems per acre was significantly higher on the check plots than on the plots that received the preharvest treatment. It is statistically significant and visually apparent that sprouts of undesirable species are far more prevalent on check plots than on plots receiving a preharvest treatment. In terms of the effect on development of desirable species, this reduction in number of sprouts of undesirable species is the most important consequence of preharvest treatment. Stocking of desirable species by preharvest treatment was 64.7 percent for the 1969 treatment, 56.8 percent for the 1970 treatment, 55.5 percent for the 1971 treatment, and 28.2 percent for the no preharvest treatment.

Abstract: Larry Gross

FPM83-0139
Lohrey, Richard E. Site preparation improves survival and growth of direct-seeded pines. U.S. Forest Service Research Note SO-185. New Orleans, LA: U.S. Department Agriculture, Forest Service, Southern Forest Experiment Station; 1974. 4 p.

Stand densities, heights, and diameters at age 10 years are compared for loblolly and slash pines established by planting and direct seeding on a grass rough and by direct-seeding on several seedbeds by different sowing methods in central Louisiana. The seven treatments tested were:

1. Planting 1-0 nursery stock at spacing of 6 x 8 feet on a 1-year grass rough.
2. Broadcast sowing 1.0 pound of seed per acre on a 1-year grass rough.
3. Broadcast sowing 1.0 pound of seed per acre on an area with flat-disked strips 6.9 feet wide and alternate undisked balks of equal width.
4. Broadcast sowing 1.0 pound of seed per acre on an area with mound-disked strips 7.0-feet wide and alternate undisked balks of equal width.
5. Sowing at a rate of 0.5 pounds per gross acre with seed confined to flat-disked strips.
6. Sowing at a rate of 0.5 pounds per gross acre with seed confined to mound disked strips.
7. Machine sowing at a rate of 0.6 pounds per acre in plowed furrows spaced at 8-foot intervals.

The site was burned in May 1961 and disked 5 months later. Furrowing was done at the time of sowing in February 1962. Planted and seeded trees were from the same seed lots. The two species were tested in separate experiments. All treatments were replicated 3 times in randomized block designs. Gross treatment plots were 0.4 acre and measurements were confined to the central 0.1 acre. Table 1 shows the results after 10 years.

After 10 years on a Beauregard silt loam soil, loblolly pines direct-seeded on flat-disked strips, mound-disked strips, and in furrows survived better and were 2 to 4 feet taller than trees established on a grass rough. Slash pine tree to seed ratios were better on prepared sites, but the trees were about the same height and diameter in all seeding and planting treatments.

Table 1. Effect of site preparation on stocking and growth of direct-seeded pines after 10 years

Seedbed and sowing method	Trees per acre	Tree Ratio (%)	Tree Height (ft)	Diameter 100 largest trees (in)
Loblolly pine				
Grass rough, broadcast	1920	8	25.9	4.8
Flat-disk, broadcast	3423	14	27.5	4.8
Mound-disk, strip sown	2623	11	28.2	5.2
Flat-disk, strip sown	1953	16	28.8	5.2
Mound-disk, strip sown	1480	12	30.0	5.8
Furrow-strip sown	1917	13	28.2	5.5
Planted-grass rough	815	90	30.7	6.1
Slash pine				
Grass rough-broadcast	963	7	27.4	5.5
Flat-disk, broadcast	1410	10	26.1	5.1
Mound-disked, broadcast	1283	9	26.4	5.3
Flat-disked, strip sown	900	13	28.5	5.6
Mound-disked, strip sown	807	12	27.2	5.4
Furrow-strip sown	930	11	26.7	5.2
Planted-grass rough	595	66	28.1	5.7

Abstract: Larry Gross

FPM83-0140

Lotan, James E.; Dahlgreen, Allen K. Hand preparaton of seedbeds improves spot seeding of lodgepole pine in Wyoming. United States Department of Agriculture Forest Service Research Note INT-148. Ogden, UT: U.S. Department Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 1971. 6 p.

This paper reports regeneration success of lodgepole pine three growing seasons after seeding four different seedbeds. The test was conducted in the Greys River drainage of the Wyoming Range in western Wyoming. All sites are on northerly slopes at an elevation of 7900 feet. The areas were logged and broadcast burned in 1966. Seeds were sown in June, 1967 on sites prepared as follows: (1) On approximately 1/2 to 1 inch of ash and duff, (2) on scalped 5-inch squares, (3) on scalped 12-inch squares, and (4) on scalped 12-inch square benches. Each set of treatments was replicated systematically 50 times on each of three sites. Rodents were controlled by means of poison baits. Percent of stocked seed spots 2 years after sowing are in Table 1.

It was observed that the largest and most vigorous seedlings in the field were those that grow free of competing vegetation. Seedlings that grow in or near a clump of grass were stunted and spindly.

Table 1. Effect of hand preparation of seed beds on seed spot stocking after 2 years

Site preparation	Stocked seed spots (percent)
Ash and duff	10
5-inch scalp	38
12-inch scalp	64
12-inch scalp and bench	72

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0141

Loyd, R. A.; Thayer A. G.; Lowry G. L. Pine growth and regeneration following three hardwood control treatments. Southern Journal of Applied Forestry. 2(1): 25-27; 1978.

Loblolly pine, longleaf pine, and shortleaf pine response in six southeastern Texas counties was studied after applying one of three hardwood control treatments: (1) injection of all hardwoods over 4 inches d.b.h. with 2,4-D amine; (2) mist-blowing understory species with 2 pounds acid equivalent per acre 2,4,5-T in 10 gallons; and (3) prescribed burning for control of small hardwoods and seedbed preparation. Most burns were moderately hot but considerable portions of the burning area were not covered. All stands were second-growth pine of site index 80 to 100 that had been managed under selective cutting practices. Twenty sampling points in four stands each of five type-site categories were selected for representative treated and untreated areas (80 points total per treatment). Establishment of regeneration, number of living trees per acre over 0.5 inches d.b.h. 3 years after treatment, and radial growth 3 years before and after treatment were measured on each plot. Table 1 shows the results.

Untreated areas exhibited a slight decline in radial growth during the second 3-year period while growth increased on all treated areas. The average increase was 59 percent for injection, 16 percent for prescribed burning, and 11 percent for mist-blower. The high post-treatment growth rate of the injection treatment is consistent with the hypothesis that pretreatment suppression had been largely due to the larger hardwoods (above 3.5 inches d.b.h.) removed by this treatment. Prescribed burning and 2,4,5-T mistblower treatment were most effective in promoting new seedling establishment, although this may be offset in some cases by losses of existing small pines.

Table 1. Pine growth and regeneration following hardwood control treatment

Treatment	Trees per acre			Radial growth 3 years before and after treatment (in)	
	Pine	Hardwood	Pine regeneration	Before	After
Untreated	391	821	1151	0.189	0.170
Injection	411	797	2818	0.237	0.319
Mist-blower	244	374	5119	0.282	0.290
Prescribed burn	343	236	4709	0.196	0.243

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0142
MacArthur, J. D. Planting methods to overcome strong competition from dense, herbaceous vegetation. Tree Planters' Notes. 66: 25-28; 1964 July.

A major obstacle to the reforestation of moist, rich sites is the dense, herbaceous vegetation that occupies them completely. Six methods of planting 2-2 Norway spruce were tested on a low-lying plain on the south shore of the St. Lawrence River, near Nicolet, Quebec. The site was characterized by deep, rich, moist soil and a dense growth of herbaceous vegetation. The six planting methods were: mound and ridge-used to reduce smothering by elevating the trees; the scalp, single furrow, and double furrow methods to reduce competition by removal of part of the sod; and the control.

Of the six methods tested, only mound planting yielded acceptable survival after four growing seasons; trees planted by this method had grown more than those planted by other methods. Table 1 shows survival. Evidently raising the planted trees in relation to the ground line significantly reduces mortality caused by competition and smothering, while lowering the trees below it increases losses.

Table 1. Effect of planting methods on survival of Norway spruce after 4 growing seasons

Planting method	Average survival rate (percent per method)
Mound	85
Ridge	68
Scalp	49
Control	53
Single furrow	36
Double furrow	44

Abstract: Larry Gross

FPM83-0143
Mann, W. F., Jr. Quick returns from releasing pine. Southern Forestry Notes No. 67. New Orleans, LA: U.S. Department Agriculture, Forest Service, Southern Forest Experiment Station; 1950. 4 p.

See: Mann, W. F., Jr., 1951.

On a study site on the Crossett Experimental Forest, Crossett, Arkansas, low grade hardwoods were suppressing pine seedlings, most of them less than 7 feet high. In 1939, three degrees of release were tested: (1) remove hardwoods 6 inches d.b.h. and over, (2) remove hardwoods 2 inches d.b.h. and over, and (3) remove hardwoods down to 5 feet tall. Only hardwoods overtopping or almost overtopping pines were removed. Results of the study are in Tables 1 and 2. In treatments 2 and 3, the pines grew so fast that they needed thinning in 1949, only 10 years after release.

In this study, the removal of hardwoods 6 inches d.b.h. and over did not release enough seedlings to justify the treatment. Because of greater original stocking of seedlings on plots where all hardwoods down to 5 feet tall were removed and small differences in stand growth and development, it is difficult to judge which of the two intensive treatments was more profitable. However, since the results are so similar, it does not seem necessary to remove harwoods down to 5 feet in height in these stands.

Table 1. Comparison of returns obtained from use of various release methods over a 10-year period

Figures/returns per acre	Removal of hardwood 6 inch D.b.h. and over	2 inch D.b.h. and over	to 5 feet tall
Hardwoods removed (number)	15	136	431
Removal costs, 1949 rates	$0.53	$1.84	$2.43
Volume thinned, 1949 (cords)	.19	1.51	1.62
Stumpage value of thinning at $2.00 per cord	$0.38	$3.02	$3.24
Returns-thinning less release	-$0.15	+$1.18	+$0.81

Table 2. Pine stand development by treatment 10 years after hardwood control

D.b.h. (inches)	Hardwoods over 6 inches d.b.h. removed	Hardwoods over 2 inches d.b.h. removed	Hardwoods over 5 feet tall removed
0-1.5	-191	-371	-683
2	75	103	112
3	26	71	78
4	13	42	49
5	4	26	28
6	4	14	16
7+	36	40	45

Abstract: Larry Gross

FPM83-0144
Mann, William F., Jr. Profits from release of loblolly and shortleaf pine seedlings. Journal of Forestry. 49(4): 250-253; 1951.

See: Mann, William F., Jr., 1950.

FPM83-0145

Mann, W. F., Jr.; Derr, H. J. Response of planted loblolly and slash pine to disking on a poorly drained site. USDA Forest Service Research Note SO-110. New Orleans, LA: U.S. Department Agriculture, Forest Service, Southern Forest Experiment Station 1970. 3 p.

See: Cain, Michael D., 1978.

FPM83-0146
Maple, William R. Shortleaf pine stands five years after seedfall on prepared sites. U.S. Forest Service Research Note SO-27. New Orleans, LA: U.S. Department Agriculture, Forest Service, Southern Forest Experiment Station; 1965. 2 p.

Three site preparation treatments and an untreated control were tested in northern Arkansas in four contiguous blocks of 0.5-acre plots. All plots had a heavy stand of hardwood brush. Treatments were: (1) brushcutter - all vegetation up to 3 inches d.b.h. was mowed at the root collar and the soil surface scarified, larger pines and hardwoods were left untreated; (2) chemical - 16 pounds acid equivalent per hundred gallons (aehg) of 2,4,5-T applied in diesel oil on the basal portion of all hardwoods less than 4 inches d.b.h. and into frills on larger stems; and (3) prescribed burn - a backing fire that consumed litter but did not destroy large hardwoods. Seedfall just after treatment was extraordinarily heavy. An average of 477 thousand viable seeds per acre was estimated from traps placed on each plot.

Stocking after five growing seasons is shown in Table 1.

Five years after an excellent seed crop, north Arkansas sites on which a seedbed had been prepared with a rotary brushcutter had seven times as many shortleaf pine seedlings as untreated check areas. Prescribed burning or chemical treatment was considerably less effective. Tree percent (yield of seedlings per hundred viable seeds) was also best on the brushcutter plots. Regardless of the method of site preparation, by the fifth year, pines on all plots needed release.

Table 1. Effect of site preparation on growth of shortleaf pine after 5 growing seasons

Treatment	Shortleaf pine: Yield per 100 viable seeds (percent)	Shortleaf pine: Stocking (no.)	Hardwood stocking (no.)
Brushcutter	2.9	13,312	4,988
Chemical	1.3	4,525	4,112
Burn	0.4	3,212	5,900
Untreated	0.4	1,788	5,475

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0147
May, Jack T.; Rahman, Shamsur; Worst, Raymond H. Effects of site preparation and spacing on planted slash pine. Journal of Forestry. 71(6): 333-335; 1973.

See: Worst, Raymond H., 1964.

Six sites in the Coastal Plain of southeast Georgia were treated in 1957 to test the effects of site preparation and plantation spacing on growth of planted slash pine. The areas were selected to represent six site indices for natural stands of slash pine based on total heights of 65, 70, 75, 80, 85, and 90 feet at age 50. Soils on the study areas were of the Chipley, Pelham, Mascotte, Olustee, and Leon soil series. Two 7-acre blocks, or replications, were assigned to each site. These were subdivided into seven 1-acre plots, that were further divided equally into four subplots for the random assignment of site treatments. Site preparation treatments were: (1) control; (2) burn and scalp in December 1957; (3) burn and plow strips in May 1957, followed by pulling in of furrowed strips with a fire line maintenance harrow in June and again in August 1957; and (4) burn and harrowed in May and reharrowed in August 1957. Variations tested on the 1-acre plots were square spacings of 6, 8, 10, and 12 feet and rectangular spacings of 6 x 10, 6 x 12, and 8 x 12 feet of slash pine seedlings dibble-planted in January and February 1958. Subsequent measurements were obtained from 50 mechanically selected planting spots in each 1-acre plot.

The results after 10 growing seasons are presented in Table 1.

Areas, site treatments, and spacing significantly affect height and diameter growth, total cubic foot volume and fusiform rust infection of planted slash pine in the coastal flatwoods of southeast Georgia. The best growth, greater volume, and higher rust infection were on better drained sites. Site preparation involving harrowing increased height and diameter growth and cubic volume on all sites. Fusiform rust infection of dominant and codominant trees increased with an increase in spacing, site productivity, and intensity of site treatment.

Table 1. Effect of site preparation on growth of slash pine after 10 growing seasons

Treatment	Height (feet)	D.b.h. (inches)	Volume (cu ft/acre)
Control	19.2	3.3	152.1
Burn-scalp	18.6	3.2	134.2
Burn-scalp-harrow	22.7	3.8	276.7
Burn-double harrow	23.3	4.0	303.2

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0148

McClay, T. A. Loblolly pine growth as affected by removal of understory hardwoods and shrubs. Research Note No. 73. Asheville, NC: U.S. Department Agriculture, Forest Service, Southeastern Forest Experiment Station; 1955. 2 p.

Three treatments that resulted in elimination or annual removal of the understory in a loblolly pine stand were tested in the Santee Experimental Forest near Charleston, South Carolina: annual summer burning that reduced size and vigor of understory sprouts, annual winter burning that had little effect on sprout vigor, and annual summer foliage spraying after an initial burn that eliminated the understory in a few years. Each treatment, and control consisted of three replicated 1/4-acre plots in a randomized block design in an even-aged 40- to 50-year-old pine stand with a site index of 85 and basal area of 90 square feet. Table 1 shows results 5 years after treatment.

Radial growth of trees 7 to 17 inches in diameter on the control plots, where understory hardwoods were left undisturbed, was equal to that on areas where the understory had been eliminated or removed annually.

Table 1. Effect of annual understory removal on growth of loblolly pine after 5 years

Method of understory removal	Average annual growth	
	Average d.b.h. (inches)	Average radial growth (inches)
Control	12.7	0.36
Annual foliage spray	12.7	0.37
Annual summer fire	12.6	0.35
Annual winter fire	12.3	0.38

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0149
McConkey, Thomas W. Helicopter spraying with 2,4,5-T to release young white pines. USDA Forest Service Station Paper 101. Upper Darby, PA [Station now at Broomall, PA]: U.S. Department Agriculture, Forest Service, Northeastern Forest Experiment Station; 1958. 14 p.

In July of 1954, 2,4,5-T was applied to release two eastern white pine stands on the Massabesic Experimental Forest in southwestern Maine from oak and maple clump sprouts and white birch, gray birch, aspen, and pin cherry seedlings. A 15-acre area of dense hardwoods was treated with 1 pound acid equivalent (ae) per acre and a 30-acre area of less dense hardwoods was treated with 3 pounds ae per acre, both in fuel oil at a volume of 2.5 gallons per acre. Pines were not damaged at the lower application rate, but about one-fifth of the seedlings showed some injury on the area treated with 3 pounds of 2,4,5-T per acre. To determine effects, growth was measured on 44 tagged trees on the 1-pound area and on 82 trees on the 3-pound area. Table 1 illustrates total growth in 1956, 2 years after spraying.

Sprayed trees were growing about three times as much in diameter at the base as unreleased pines and were making appreciably better terminal growth.

Table 1. Effect of release on growth of white pine after 2 years

Treatment	Height growth (inches)	Diameter growth (inches)
1 lb ae/acre	20.7	0.22
Unreleased	15.9	0.07
3 lb ae/acre	12.4	0.16
Unreleased	9.9	0.06

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0150

McDonald, Philip. Brushfield ecology and growth of planted pine. Unpublished, data on file. Redding, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station; 1980.

An area near Mt. Shasta, California, was cleared with a bulldozer in 1961 and planted with 1-0 ponderosa pine during the spring of 1962. Part of the area was sprayed with various herbicide formulations, dosages, methods of application, and carriers in 1962 and part again in 1964 creating a range of brush densities. In 1966 when the plantation was 4 years old, four 66 x 132 plots were established in each of four degrees of brush cover: (1) heavy brush (untreated with herbicides); (2) medium brush: (3) light brush; and (4) almost no brush (1 or 2 sprays). Greenleaf manzanita, snowbrush ceanothus, and Sierra plum dominated the brush plots. Forty trees in each plot were sampled for survival, height, damage, and cause of damage. Results in 1978, 16 years after planting appear in Table 1.

Table 1. Effect of brush on growth of trees over a 16-year period

Brush cover	Diameter (in)	Height (ft)	Volume (cu ft/acre)
Heavy brush	1.35	5.8	35
Medium brush	2.91	9.3	184
Light brush	3.89	12.0	406
Brush free	5.08	16.5	589

Abstract: Larry Gross

FPM83-0151
McDonald, Philip M. Weeds in conifer plantations of northeastern California... management implications. In: Robson, Thomas F.; Straniford, Richard B., eds. Symposium proceedings, Management of the eastside pine type in northeastern California; June 15-17, 1982; Susanville, CA. Arcata, CA: Northern California Society of American Foresters; 1983. 70-78.

Several published and unpublished studies on the effects of herbaceous weeds and shrubs on ponderosa pine are summarized. A study to measure the effect of greenleaf manzanita, snowbrush ceanothus, and other woody shrubs on the growth of ponderosa pine is also described. The study site was located at a 5,000 foot elevation in the Lassen National Forest. The area was planted in 1977 with ponderosa pine which had an 80 percent survival in 1980. Woody shrubs, mostly from seed, numbered about 28,000 per acre. The experimental design was completely randomized with three replications of four treatments. The treatments were: untreated; hand cutting of all shrubs on the entire plot in 1979; grubbing and cutting for a 4-foot radius around each tree; and chain saw cutting of brush for a 4-foot radius.

Crown cover of ponderosa pine 2 years after treatment is presented in Table 1.

Crown cover differed among treatments. Crown cover in the control plot was significantly less than that of ponderosa pines released by grubbing and cutting to a 4-foot radius. No statistical difference in total height of pines was found after 2 years.

Table 1. Crown cover of ponderosa pine 2 years after release treatment

Treatment	Cover (%)
Untreated	2.0
Hand cut	4.0
Grub and cut for 4 feet	5.0
Chain saw cut for 4 feet	2.3

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0152
McGee, Charles E. Expanding options for reforestation of the Cumberland Plateau. Southern Journal of Applied Forestry. 4(4): 158-162; 1980.

The survival and height growth of loblolly pine, white pine and yellow-poplar were studied on a 37-acre site harvested by shearing, on the University of the South Domain near Sewanee, Tennessee. Twenty-four 1-acre plots were selected. Within each plot a central 1/4-acre measurement plot was identified. By random selection, six plots each were planted to: 1-0 loblolly pine, 2-0 white pine, 1-0 yellow-poplar or natural regeneration. Stems over 4.5 feet tall on three randomly selected plots in each category were injected with herbicides.

Species and treatment comparisions 2 years after harvest are shown in Table 1.

If all vegetation above 4 inches d.b.h. is removed during logging, acceptable early growth is achieved without additional investment. Untreated residuals, however, will become increasingly competitive.

Table 1. Effect of treating residuals on the survival and growth of reforestation plantings after 2 years

Species	Treatment of residual stems	Survival (%)	Average height (ft)	Area where planted trees are tallest (%)
Yellow-poplar	Injection	98	2.98	6
Yellow-poplar	None	99	3.18	3
Natural regeneration	Injection	92	2.75	25
Natural regeneration	None	83	3.65	37
Loblolly pine	Injection	93.6	3.68	26
Loblolly pine	None	95.7	3.72	14
White pine	Injection	95	1.55	1
White pine	None	96	1.61	1

Abstract: Larry Gross

FPM83-0153

McGee, Charles E. Response of overtopped white oak to release. Southern Forestry Experiment Station Research Note SO-273. New Orleans, LA: U.S. Department Agriculture, Forest Service, Southern Forest Experiment Station; 1981. 4 p.

This study was installed as 3 experiments to determine response of overtopped white oak to release. The study sites were located in Franklin and Marion Counties, Tennessee. Experiment I was to determine whether easily recognized characteristics of overtopped white oak are related to response after release. Experiment II compared the response of the high quality trees released in experiment I with similar high quality unreleased trees. A total of 104 white oak were studied in Experiments I and II.

Experiment III consisted of 4 treatments including 160 white oak. Treatments were: (1) removal of directly overtopping trees, (2) removal of directly overtopping trees plus cutting the sample tree, (3) no release but cut the sample tree, and (4) no release and no cutting.

Graphs and regression equations are used to display tree growth for the first two years after release. Pole sized white oaks increase in volume growth following release from overtopping trees, but the response varies by size, age and appearance of the oaks. Significant increases in epicormic sprouting, height loss by some released trees, and highly variable stem volume growth make overtopped white oak a very questionable source of future crop trees. If overtopped trees are cut, those under 8 inches d.b.h. and less than 60 years of age produce vigorous stump sprouts and provide a source of natural regeneration.

Abstract: Larry Gross

FPM83-0154
McLeod, J. W. Planting white spruce on wet brushy land. Department Forestry Publication No. 1067. Ottawa, Canada: Canada Department Forestry, Forest Research Branch; 1964. 4 p.

A site classified as Rich--Wet Coniferous in the Acadia Experiment Station in New Brunswick had been subjected to periodic flooding in the past by beavers building dams in a nearby stream. This had prevented normal regeneration of balsam fir, white cedar, and white spruce and had resulted in establishment of a nearly continuous cover of alder. In 1951, shrubs were sprayed on a 1-acre area with 2,4-D and 2,4,5-T. Brush control was excellent and lasted throughout the 10 year study. The area was then divided into eight plots and four were randomly selected for further treatment before planting. On these, a crawler tractor was used to create two parallel furrows 1 to 2 feet deep about 6 feet apart using the tracks. White spruce 2+2 stock was planted in 1952 on the untreated plots and on ridges between furrows of the treated plots.

Results 10 years after planting appear in Table 1.

Most mortality seemed to result from mats of grass that invaded the area the year of planting. Plots treated with the tractor were better drained and had less luxuriant grass cover.

Table 1. Growth and survival of white spruce 10 years after planting on wet brushy land

	Survival (percent)	Average height (feet)
Untreated	37	3.8
Treated	73	4.9

Abstract: Larry Gross

FPM83-0155

McMinn, R. G. Ecology of site preparation to improve performance of planted white spruce in northern latitudes. In: Murray M., ed. Forest regeneration at high latitudes: Experiences from Northern British Columbia. Proceedings of a Third International Workshop; 1981 August 29-September 1; Prince George, British Columbia. Miscellaneous Report No. 82-1. Fairbanks, AK and Portland, OR: School of Agriculture and Land Resources Management, University of Alaska and U.S. Forest Service, Pacific Northwest Forest and Range Experiment Station; 1982: 25-32.

This paper presents an overview of site preparation methods to improve performance of planted white spruce seedlings based on numerous trials in the Sub-Boreal Spruce Zone in the north central interior of British Columbia. The use of large stock as an alternative to site preparation has also been investigated. The tests were established east of Prince George between 1972 and 1981 in randomized blocks, using the same spruce seed lot in any one test. These tests were installed on sites with high competing vegetation potential to investigate the effects of prescribed fire, and mechanical treatment and clipping (to simulate herbicide application), as methods of site preparation.

Measurements were made of 2+0 white spruce seedlings planted where a prescribed fire had left a mosaic of severely burned, lightly burned, and unburned patches on a site with fine-textured soil. Results after 2 years based on 24 seedlings per degree of burn are presented in Table 1.

Table 1. Effect of burning on survival and height growth of white spruce planted in fine-textured soil after 2 years

Degree of burn	Survival (percent)	Height increment (cm)
Unburned	46	14
Lightly burned	100	20
Severely burned	83	28

These data suggest that prescribed fire of appropriate intensity can improve seedling survival and growth on moist, fine-textured soils with high potential for competing vegetation.

A series of trials was installed to test three basic methods of mechanical site preparation: (1) scalping with a rootrake blade, Bracke Cultivator or Leno Scarifier, which exposes batches of mineral soil at regular intervals, or TTS or MM Disc Trencher to remove roots of competing vegetation and to expose mineral soil; (2) mixing to control competing vegetation by chopping it up and to form a new mineral soil surface enriched by incorporation of chopped vegetation and surface organic matter; and (3) inverting to control competing vegetation by burying it and to expose a mineral soil surface of upturned subsurface soil.

A test of 2+0 bare-root white spruce planted on sites prepared by bulldozer blade scarification (scalping) on a medium-textured (loam) soil and seedlings planted on the same site on unprepared ground produced the results shown in Table 2.

Table 2. Effect of mechanical site preparation on survival and growth of white spruce planted in medium-textured soil after 3 years

Treatment	Number of seedlings planted	Survival (percent)	Total height (cm)	Volume (cu cm)
Untreated	238	46	39	5
Scarified	210	99	50	12

Stem volume was calculated from: height x 1/3 basal area

The results of a comparison of blade scarification, preparation of scalped trenches with the TTS Trencher, and unprepared sites in a gravelly-loam soil using Styroplug 2 white spruce are shown in Table 3.

Scalping spots formed by a Bracke Cultivator of Disc Trencher were superior to no treatment, but poorer than those formed by blade scarification. Patch size and trench width appeared to be too small to adequately protect seedlings from adverse effects of competing vegetation.

Table 3. Effect of mechanical site preparation on survival and growth of white spruce planted in gravelly loam soil after 5 years

Treatment	Number of seedlings planted	Survival (percent)	Total height (cm)	Volume (cu cm)
Untreated	166	50	32	3
Bulldozer scalped	146	97	53	18
Bracke scalped patch	157	90	52	12
TTS mineral furrow	168	91	44	8

Results from a wet site showed that even the sloping margins of scalped patches formed by a Bracke Cultivator were unsatisfactory for seedling survival and growth. Based on plantings of 400 seedlings per treatment, 2+0 white spruce survival, height growth, and stem volume (height x 1/3 basal area) after 5 years are shown in Table 4.

Performance of seedlings planted on the mound formed by material dug from scalped patches was better despite there being more competing vegetation on mounds than in hollows.

Table 4. Effects of scalping on survival and growth of white spruce planted on a wet site after 5 years

Treatment	Survival (percent)	Total height (cm)	Volume (cu cm)
Untreated	72	52	14
Bracke hollow	42	43	8
Bracke mound	90	56	17

Styroplug 2 seedlings were planted in adjacent strips prepared with blade scarification to expose subsurface soil or on untreated plots on a fine silty clay loam soil.

Results after 5 years are presented in Table 5.

These results suggest that site preparation methods other than scalping would be advisable in fine-textured soil.

Table 5. Effect of scalping on survival and growth of white spruce planted in fine silty clay loam soil after 5 years

Treatment	Number of seedlings planted	Survival (percent)	Total height (cm)	Volume (cu cm)
Untreated	130	89	74	43
Scalped	150	97	58	21

Styroplug 2 white spruce were planted on lightly scalped (areas with some surface organic matter remaining undisturbed) and deeply scalped patches on an area with moderately fine-textured soil and moderately competing vegetation potential. Based on 250 planted seedlings per treatment, 5-year results are presented in Table 6.

Table 6. Effect of scalping on survival and growth of white spruce planted in moderately fine-textured soil after 5 years

Treatment	Survival (percent)	Total height (cm)	Volume (cu cm)
Untreated	87	66	54
Deeply scalped	93	80	68
Lightly scalped	93	86	84

When competing vegetation is not too dense, seedlings planted in lightly scalped patches may perform better than seedlings in deeply scalped patches. However, results from a trial on a site with moderately coarse-textured (loamy sand) soil suggest that more thorough scalping is necessary when competing vegetation potential is high. This test compared substandard Styroplug 4 white spruce on untreated, deeply scalped, and lightly scalped plots.

Results after 5 years are presented in Table 7.

Table 7. Effect of scalping on survival and growth of white spruce planted in moderately coarse-textured soil after 5 years

Treatment	Number of seedlings planted	Survival (percent)	Total height (cm)	Volume (cu cm)
Untreated	200	40	41	61
Deeply scalped	230	67	65	29
Lightly scalped	230	89	69	40

Experimental results show that mixing vegetation and surface organic matter into underlying mineral soil to form an organic matter enriched mineral horizon improves seedling growth. The results of a test of 100 2+0 bare-root white spruce seedlings each on untreated, scalped (blade scarified), and mixing treatment plots installed on a site with moist, fine-textured soil are shown in Table 8.

Table 8. Effect of mechanical treatment of survival and growth of white spruce planted in moist, fine-textured soil after 10 years

Treatment	Survival (percent)	Total height (cm)	Volume (cu cm)
Untreated	75	204	783
Scalped	87	217	859
Mixed	90	279	1507

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

Survival, total height, and stem volume of Styroplug 2 white spruce were measured 5 years after planting in untreated plots and plots treated 2 years prior to planting by scalping (blade scarification) and mixing treatment on a site with moist, fine-textured soil. The results are presented in Table 9.

When mixing is inadequate to control competing vegetation or planting is delayed until vigorous growth of competing vegetation has re-occupied mixing treatment patches, survival and growth of seedlings may be disappointing.

Table 9. Effect of mechanical site preparation on survival and growth of white spruce planted in moist, fine-textured soil after 5 years

Treatment	Number of seedlings planted	Survival (percent)	Total height (cm)	Volume (cu cm)
Untreated	130	89	74	43
Scalped	140	97	58	21
Mixed	150	88	63	22

Survival, total height, and stem volume were measured for Styroplug 2 spruce seedlings 5 years after planting in untreated, scalped (blade scarified) and inverting (upturning of mineral soil and burying the surface organic matter beneath 10 centimeters of mineral soil) treatment plots on a site with fine-textured soil and moderately high competing vegetation potential. The results are presented in Table 10.

Table 10. Effect of mechanical treatment on survival and growth of white spruce planted in fine-textured soil after 5 years

Treatment	Number of seedlings planted	Survival (percent)	Total height (cm)	Volume (cu cm)
Untreated	130	89	74	43
Scalped	150	97	58	21
Inverted	150	99	83	51

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

An experiment was initiated in 1972 to simulate herbicide use and to determine without otherwise disturbing the site, the effect of vegetation removal on seedling performance. Competing vegetation was removed by clipping three times during each of the first two growing seasons. Survival, total height, and stem volume of 2+0 bare-root white spruce seedlings were measured 10 years after planting in untreated and clipped plots on a site with moist, fine-textured soil. The results are presented in Table 11.

Measurements showed that clipping produced greatly improved growth during the first ten growing seasons. The effect of clipping, that is reduction in height and cover of competing vegetation, was still apparent in the tenth year even though clipping had been discontinued 8 years previously.

Table 11. Effect of vegetation control on survival and growth of white spruce planted in moist, fine-textured soil after 10 years

Treatment	Number of seedlings planted	Survival (percent)	Total height (cm)	Volume (cu cm)
Untreated	120	75	204	783
Clipped	110	90	294	2266

The effects of planting stock size on site preparation requirements were also investigated. Survival, height increment, and stem volume of small and large white spruce stock were measured 10 years after planting in untreated and scalped (blade scarification) plots on a site with moist, fine-textured soil. The results based on 120 seedlings per treatment are presented in Table 12.

These results suggest that large stock of good quality can be expected to survive and grow better than small stock.

Table 12. Effect of planting stock size and site preparation on survival and growth of spruce planted in moist, fine-textured soil after 10 years

Stock size and site treatment		Survival (percent)	Height increment (cm)	Volume (cu cm)
Small stock				
Untreated	- 2+0 bare-root	75	187	783
	- Styroplug 2	76	169	528
Scalped	- 2+0 bare-root	87	201	859
	- Styroplug 2	87	187	653
Large stock				
Untreated	- 2+1 bare-root	89	213	1129
	- Styroplug 8	90	225	1331
Scalped	- 2+1 bare-root	95	230	1241
	- Styroplug 8	94	230	1141

Survival, height increment, and stem volume were measured for 2+0 bare-root white spruce seedlings from the same nursery beds, regraded into small (13 centimeters high), medium (17 centimeters high), and large (20 centimeters high) segregates, 10 years after planting in untreated and scalped (blade scarification) plots on a site with moist, fine-textured soil. Results based on 120 seedlings per treatment are presented in Table 13.

Large seedlings planted in the untreated plots grew better than small seedlings planted in blade scarified plots. More rigorous grading standards might reduce overall cost of obtaining fast growing seedlings following outplanting.

Table 13. Effect of stock size and site preparation on survival and growth of white spruce planted in moist, fine-textured soil after 10 years

Stock size and site treatment		Survival (percent)	Height increment (cm)	Volume (cu cm)
Untreated	- small	70	165	538
	- medium	75	187	783
	- large	82	221	1155
Scalped	- small	86	196	724
	- medium	87	200	859
	- large	94	221	1090

As a measure of the benefit of planting immediately after harvesting, three size classes of container-grown white spruce were planted on an untreated, recently cut site and on an untreated site harvested 2 years previously (backlog). Vegetation on the backlog site was already tall and dense by the time seedlings were planted. Survival, total height, and stem volume after 2 years based on 250 seedlings per treatment are shown in Table 14.

Growth rate of each of three size classes of container-grown seedlings planted on untreated sites was reduced when planting was delayed for 2 years after harvesting the previous stand. Moreover, the growth of Styroplug 4 seedlings in the recently cut site were comparable with the larger, more costly Styroplug 8 stock in the backlog site.

Table 14. Effect of planting time on survival and growth of white spruce after 2 years

Planting time and stock type	Survival (percent)	Height increment (cm)	Volume (cu cm)
Plot recently cut			
Styroplug 2	91	28	1.6
Styroplug 4	96	35	2.7
Styroplug 8	99	40	4.7
Backlog plot			
Styroplug 2	94	25	0.8
Styroplug 4	92	31	1.7
Styroplug 8	93	37	2.9

Abstract: Ronald E. Stewart

FPM83-0156

Michael, J. L. Long-term impact of aerial application of 2,4,5-T to longleaf pine (*Pinus palustris*). Weed Science. 28(3): 255-257; 1980.

A study was established in 1959 on 10-acre plots of longleaf pine shelterwoods near Brewton, Alabama, to compare aerial sprays of 2 pound acid equivalent per acre of 2,4,5-T as ester, acid, and amine formulations. In 1979, volumes were measured on 15 check and 15 ester treated plots (5 subplots in each of 3 blocks per treatment) using a 100 percent inventory. The results after 20 years are shown in Table 1.

Merchantable tree volumes were 40 percent greater on treated than on untreated plots; this is an 8-year growth advantage.

Table 1. Effect of release on height growth and volume yield of longleaf pine after 8 years

Treatment	Total trees (trees/ha)	Merchantable trees (trees/ha)	Height (m)	Merchantable volume (cu m/ha)
Untreated	2471	815	8.33	49.65
Released	2473	1012	9.78	69.39

Abstract: Ronald E. Stewart

FPM83-0157
Miller, Richard E.; Murray, Marshall D. The effects of red alder on growth of Douglas-fir. In : Utilization and Management of Alder. Proceedings of a symposium. USDA Forest Service General Technical Report PNW-70. Portland, OR: U.S. Department Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1978: 283-306.

See: Berntsen, Carl M., 1961; Tarrant, Robert F., 1961.

The long-term effects of off-site red alder that were interplanted in 1933 within a 4-year-old Douglas-fir plantation in southwest Washington (Wind River Experimental Forest) are described. Insufficient available nitrogen limits tree growth in this plantation. Red alder clearly increased height and diameter of the associated dominant Douglas-fir. Improved growth in diameter began when the Douglas-fir emerged through the alder canopy. This emergence occurred at about 30 years from seed at Wind River and in several even-aged, mixed stands that were also investigated. By age 48, Douglas-fir volume per acre in the mixed stand averaged 3100 cubic feet compared to 2900 cubic feet in the pure stand. Red alder volume was about 2500 cubic feet. Maintaining red alder in Douglas-fir stands can increase merchantable yields on nitrogen-deficient sites. Controlling stand density at an early age is necessary to maintain both Douglas-fir and alder in a dominant or codominant position. To provide adequate nitrogen and not seriously reduce Douglas-fir growing stock, about 20 to 40 uniformly distributed red alder per acre should be retained.

In the even-aged stands near Cascade Head, Oregon, and Delezenne Creek, and Skykomish River, Sultan, Washington, high initial densities of even-aged red alder reduced survival of Douglas-fir. An adequate Douglas-fir stocking in the final stand occurred only if the initial alder component was minimal or removed in an early liberation cut.

Abstract: Ronald E. Stewart

FPM83-0158

Miller, William D.; Tissue, Oscar C. Results of several methods of release of understory loblolly pine in upland hardwood stands. Journal of Forestry. 54(3): 188-189; 1956.

Ten one-acre plots were established in an oak-hickory stand on the Hope Valley Forest in Chatham County, North Carolina. Two replications of five treatments were installed to release a loblolly pine understory of 1,040 to 2,590 trees per acre ranging in age from 2 to 15 years. Treatments were: (1) untreated; (2) merchantable hardwood fuelwood cut (CH); (3) same as (CH) plus cutting of all hardwoods below 3.6 inches d.b.h. (CHB); (4) poison all hardwoods 3.6 inches d.b.h. and larger with ammate in notches (AH); and (5) same as (AH) plus cutting all hardwoods and brush below 3.6 inches d.b.h. (AHB). Periodic growth for about two growing seasons after treatment (between June 1952 and April 1954) is shown in Table 1.

Height growth of pines up to 9 feet tall at time of treatment was doubled as a result of release; diameter growth was quadrupled. There was little difference between release treatments but felling caused more damage to young pines than did treatments with ammate. Felling was also four to five times more expensive than poisoning but some of this cost can be recovered if the cut material was sold for fuelwood. The removal of brush had little effect on growth.

Table 1. Effect of release on height and diameter growth of loblolly pine after 2 growing seasons

Method of release	Height growth (feet)	D.b.h. growth (inches)
Untreated	0.4	0.09
CH	0.8	0.32
CHB	0.6	0.42
AH	0.8	0.39
AHB	0.8	0.39
All release treatments	0.8	0.38

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0159
Miller, William D. Development of planted loblolly pine in a poisoned hardwood stand of the lower Piedmont. Journal of Forestry. 59(3): 184-186; 1961.

Sixty 1/40-acre subplots were established in a randomized design with four replications of 12 treatments and three checks on the Hill Demonstration Forest, Durham County, North Carolina. The twelve treatments consisted of two herbicides (2,4,5-T and a mixture of one-third 2,4,5-T and two-thirds 2,4-D) applied as basal or stump sprays at 1, 2, and 4 percent acid equivalent by weight in kerosene to hardwoods less than 3.5 inches d.b.h. Check treatments included cutting without spraying, cutting and spraying with kerosene, and basal spraying with kerosene. Hardwoods larger than 3.5 inches d.b.h were treated with ammate in notches. All plots were planted with 36 1-0 loblolly pine seedlings but only the 25 interior trees in each plot were measured to avoid edge effects. Survival after 5 years and growth after 9 years are shown in Table 1.

Heights of pines on treated plots were significantly greater than heights on check plots, but differences between release treatments were not significant. A volume index (basal area x height) shows a 3-to-1 superiority for release treatments.

Table 1. Effect of hardwood control on growth of loblolly pine

		Pine growth over a 9-year period			
			Pines at least 9.5 ft high		
Method of control	5-year survival rate (%)	Average height (ft)	D.b.h. (in)	Basal area (sq ft/acre)	Height (ft)
Check	41	11.0	1.6	4.38	12.2
Stump spray					
2,4,5-T	62	15.6	2.2	14.80	15.6
Mixture	65	13.8	1.9	11.48	14.0
Basal spray					
2,4,5-T	62	12.9	1.8	10.68	13.3
Mixture	54	13.4	1.9	10.19	14.0

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0160
Minckler, Leon S.; Ryker, Russell A. Partial conversion of poor hardwood stands to conifers by planting. U.S. Department of Agriculture Forest Service Technical Paper 159. Columbus, OH: U.S. Department Agriculture, Forest Service, Central States Forest Experiment Station; 1959. 9 p.

Shortleaf pines and eastern redcedar were planted on the Kaskaskia Experimental Forest in southern Illinois: (1) under the canopy of low-quality (oak-hickory) hardwood stands; (2) in openings ranging from 15 to 120 feet in diameter; and (3) on a 17-acre recently clearcut area. In some stands, openings were deliberately cut to specified diameters (30, 60 and 120 feet) to correspond to half, once and twice the height of the trees. About 4,000 trees were planted under the canopy in 24 different places, about 4,000 were planted in 88 openings, and 15,000 were planted on the 17-acre clearcut. During the first 8 years after planting, all trees planted on the clearcut area and cut openings were released once or twice by cutting competing hardwood brush with an ax.

Mean heights of shortleaf pine and eastern redcedar 8 years after planting are presented in bar graphs. These show that trees grow faster the larger the openings and the less competition from hardwoods. Pine plantations in open fields were 4 times taller, and pine in the clearcut area 3 times taller, than pine in the 30-foot openings. The redcedars in all openings were about 1 foot shorter than pine but their relative response to reduced competition was similar

Survival in openings cut to specified size 8 years after planting appears in Table 1.

Results on the clearcut area 8 years after planting are in Table 2.

Site quality had an important effect on the success of stand conversion attempts. Generally, the better the site the faster hardwoods grow in comparison with pine or cedar, and the more difficult and costly conversion becomes. Any conversion to conifers in southern Illinois or similar areas should be confined only to the poorest ridges and upper slopes.

To convert low-quality hardwood stands having no good growing stock trees to stands of conifers, it is evident from this study that all hardwood competition on the area be killed before planting. For partial conversion, openings at least 1.5 to 2 times the height of the overstory trees are needed. The most important lesson learned about releasing conifers from hardwood brush is that the kill must include both the tops and roots, and that release must be soon enough and frequent enough to allow continued vigorous growth of the planted trees. Ax cutting of competition was not an effective release treatment. It is recommended that control of hardwoods in conversion plantings be done by poisoning.

Table 1. Survival rate after 8 years by size of opening cut in canopy

Opening diameter (feet)	Survival rate (percent)	
	Shortleaf pine	Eastern redcedar
0	48	30
30	75	41
60	42	52
120	55	46

Table 2. Trees per acre and mean height 8 years after planting on clearcut

Crown competition	Trees per acre		Mean height (feet)	
	Shortleaf pine	Eastern redcedar	Shortleaf pine	Eastern redcedar
Overtopped	58	45	6.8	2.9
Side only	135	6	8.5	7.3
None	77	13	11.4	9.5

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0161

Morrissey, Jon T.; Ezell, Andrew W. The influence of different site preparation methods on natural regeneration in bottomland stands. In: Proceedings of the Second Biennial Southern Silvicultural Conference, 1982 November 4-5; Atlanta, GA. General Technical Report SE-24. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station; 1975: 172-176.

A study was initiated to evaluate the effects of clearcutting and different site preparation techniques on bottom land hardwood regeneration in east Texas, and to correlate pre-harvest stand species composition to post-harvest first-year hardwood regeneration. Three 10-acre clearcut study units were established on a first-level terrace of the Neches River bottom in southeastern Tyler County, Texas on a Bibb soil series. After harvesting, each unit was subdivided into ten square 1-acre site preparation areas. Treatments used were: shear; shear and broadcast burn; total injection (treat all stems greater than 4.5 feet high with Tordon 101 R); partial injection (treat all stems greater than 3.0 inches d.b.h. with Tordon 101 R); and control. Each 10-acre unit consisted of two replications of the five randomly assigned treatments. Pre-harvest and 1-year post-site preparation inventories were conducted to characterize the stand and subsequent regeneration.

First-year regeneration stocking is shown in Table 1. The percentage change in pre-harvest and first-year regeneration stocking levels is shown in Table 2.

Site preparation had little significant effect on amounts of new regeneration for most species except sweetgum. Sweetgum response to partial injection was 159 percent more than control and 600 percent more than total injection. Oak regeneration appeared to decrease with an increase of site preparation intensity.

The results of this study suggest that clearcutting followed by light intensity site preparation will sufficiently regenerate a bottom land hardwood site in deep east Texas. It is important that the original stand have a high proportion of mature desirables, some of which must have prolific sprouting ability.

Table 1. Effect of site preparation on first-year hardwood regeneration

Species	Partial injection	Total injection	Shear	Shear and burn	Control
	Trees per acre by type of treatment				
All species	7855	4910	8510	4585	6875
Sweetgum	2835	460	2235	1100	1775
Oaks	745	565	345	230	775
Sweetgum and oaks	3580	1023	2580	1330	2550

Table 2. Effect of site preparation on percent change in pre-harvest and first-year regeneration stocking levels

Species	Partial injection	Total injection	Shear	Shear and burn	Control
	Percent change in regeneration stocking levels				
All species	290	100	125	75	270
Sweetgum	750	70	270	265	280
Oaks	-38	0	-50	-74	10
Sweetgum and oaks	130	25	90	10	210

Abstract: Ronald E. Stewart

FPM83-0162
Mullin, R. E. Old-field planting of white spruce. Tree Planters' Notes. 26(4): 3-4, 21; 1975.

A study was established in 1963 on an old-field site at Midhurst Nursery, about 50 miles north of Toronto, Ontario, Canada to test planting method, stock type, and site preparation for white spruce seedlings. The experiment consisted of 5 replications of 10 plots, each containing 100 trees. Each replication was split into two blocks, one for 2-0 and the other for 2-2 stock. Within each age-class block there were 5 randomized plots of the following site preparation and planting methods: (1) hollow-spade, in sod; (2) hollow-spade, in cultivated soil; (3) bare-root, in sod; (4) bare-root, in scalped spots; and (5) bare-root, in cultivated soil. The planting area was level, fresh to moist, a medium to fine sand, with a moderate to heavy cover of grass sod and low weeds. Cultivation was done using a plow followed by repeated disking. A sod of about 1-foot square was removed for the scalp planting.

Survival and total height for the two age-classes by site preparation and planting method after 10 years is given in Table 1.

Apparently, cultivation had no significant effect on survival at any age. However, from the second to the tenth year both terminal growth and total heights were statistically different, with considerable and obvious benefit from cultivation. Ten years after planting, trees on cultivated plots were about 12.6 percent taller than those on noncultivated sites.

Table 1. Effect of planting method on survival rate and total height of white spruce after a 10-year period

Method and stock type	Survival (%)	Total height (cm)
2-0 Stock		
Hollow spade, in sod	55.4	117.5
Hollow spade, in cultivated soil	55.6	141.7
Bare-root, in sod	58.8	139.2
Bare-root, in scalped spots	45.4	137.1
Bare-root, in cultivated soil	58.8	145.9
2-2 Stock		
Hollow spade, in sod	87.0	273.6
Hollow spade, in cultivated soil	88.2	300.4
Bare-root, in sod	84.0	249.8
Bare-root, in scalped spots	82.8	257.4
Bare-root, in cultivated soil	87.6	285.9

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0163
Mulloy, G. A. Cleaning of scattered young balsam fir and spruce in cut-over hardwood stands. Lake Edward-Project No. 7. Dominion Forest Service Silvicultural Research Note No. 67. Ottawa, Canada: Dominion Forest Service; 1941. 19 p.

Height growth of understory balsam fir and spruce was followed for 16 years after release from hardwoods on the Lake Edward Forest Experimental Area. The overstory of spruce, yellow birch, maple and white birch had been removed for fuelwood in 1914. In 1920-21, a 1-acre area was subdivided into four quarter-acre plots. The 2- to 6-foot tall conifers on two plots were released by either cutting the hardwoods at ground line or at a height of 3 feet. The remaining two plots were left untreated. Height growth for spruce and fir by height class is shown graphically 5 and 16 years after treatment.

Cleaning in 7-year-old hardwood sprout and seedling stands results in increased height growth of pre-established spruce and balsam fir. Effects of release last for at least 16 years. Spruce responds more than balsam fir and firs over 1.5 feet tall at the time of harvest cutting or over 7 feet tall at time of cleaning do not benefit from release.

Abstract: Ronald E. Stewart

FPM83-0164
Muntz, H. H. Converting scrub oak areas to pine plantations. Journal of Forestry. 49(10): 714-715; 1951.

Longleaf, slash, and loblolly pines were planted in a moderately dense stand of shrub blackjack and post oaks in central Louisiana. Some seedlings were released immediately after planting or one and two years later. Seedlings were released by girdling (conventional double hack) of hardwoods or application of ammate into cups or notches at the base of the tree. Two degrees of release were tested: all hardwoods over 0.5 inches d.b.h. treated (complete) and all hardwoods over 3.0 inches d.b.h. treated (partial). Longleaf pine plantings were destroyed by hogs after the first growing season. Results after 3 years for loblolly and slash pines appear in Table 1.

Loblolly and slash pine that were released immediately after planting showed much better survival and growth than those not released, or those for which release was delayed. First-year results for longleaf pine were similar: 48 percent survival for trees released immediately and 23 percent for trees that were not released. Method and intensity of release in this study were not important. The average hardwood stand diameter was 3 inches, so the partial release treatment opened the canopy considerably.

Table 1. Survival rate and height growth of pine after 3 years by method of release

Timing and method of release	Loblolly pine Survival (percent)	Loblolly pine Average height (feet)	Slash pine Survival (percent)	Slash pine Average height (feet)
Time of release				
Not released	33	2.2	27	1.6
Released immediately	86	4.3	46	3.4
Released after 1 year	62	3.2	36	2.3
Released after 2 year	39	2.5	31	2.1
Method of release				
Girdling	93	4.4	40	3.1
Ammate	80	4.2	52	3.7
Intensity of release				
Partial	86	4.3	52	3.0
Complete	85	4.2	40	3.8

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0165
Newton, Michael; El Hassan, B. A.; Zavitkovski, Jaroslav. Role of red alder in western Oregon forest succession. In: Trappe, J. M.; Franklin, J. F.; Tarrant, R. F.; Hansen, G. M., eds. Biology of alder. Proceedings of a symposium. Portland, OR: U.S. Department Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1968: 73-84.

Red alder was studied to determine influence on long-term forest succession. Juvenile growth of alder appears responsible for failure of other species, particularly conifers, to maintain positions of dominance. Success of Douglas-fir depends on delay of 4 to 9 years in establishment of alder, or occurrence of the two species at such a spacing that Douglas-fir will be from 8 to 10 years old before encroachment by alder.

Common successors to alder include salmonberry, vine maple, and hazel, in that order. Western hemlock may follow eventually, but Douglas-fir is virtually absent except where it develops concurrently with the alder in openings within the alder stand.

Abstract: Ronald E. Stewart

FPM83-0166

Newton, Michael; White, Diane E. Effect of salmonberry on growth of planted conifers. Presented at the 20th Proceedings of the Western Society of Weed Science, March 1983, Las Vegas, Nevada. Manuscript on file, Corvallis, OR: School of Forestry, Oregon State University; 1983.

Performance of eleven types of conifer planting stock was evaluated for 7 years after planting and release in salmonberry. Eighty seedlings of each type were planted immediately after brown-and-burn site preparation and in recovered salmonberry 4 years after burning. A similar experiment was established in salmonberry 2 years after burning but with 160 seedlings each of six types of stock. Half of the planted blocks in the 0- and 4-year-old salmonberry were released 6 months after planting, using glyphosate at 0.87 kilograms per hectare. Trees planted in 2-year-old brush were also released after 6 months using fosamine at 3.3 kilograms per hectare. Rainfall after fosamine application negated the effects of treatment. In contrast, use of glyphosate on the 0- and 4-year-old salmonberry resulted in nearly 100 percent kill of the shrubs.

Survival and height of Douglas-fir and hemlock seedlings for the 7-year period are presented in Table 1.

Each year of delay in planting beyond the second year increased mortality of all classes of stock, all species. Douglas-fir tolerated partial suppression better than western hemlock, but not as well as Sitka spruce trees. Larger trees tolerated suppression better than small trees. But even planting stock in the 90-centimeter height class (the tallest) sustained severe mortality when in 4-year-old brush, and suffered major growth losses when delayed two years.

Each year of delay in planting salmonberry-threat sites compounded losses from competition with those of vacant site. Competition added 0.4, 1.5, and 4.1 years to the time required to reach a height at which trees may be considered free-to-grow for those that survived planting in 0, 2, and 4-year-old salmonberry, respectively.

Heavy damage was done to seedlings by four-year-old salmonberry in the six months between planting and release. Mortality continued after release for five years as the result of six months of suppression. Trees released at six months showed no measurable effect from newly sprouting salmonberry, but showed a prolonged lack of vigor after release from four-year-old brush, despite total control of competition within six months of planting. Hemlock, normally considered tolerant of such conditions, suffered more than any other species, and small hemlock seedlings sustained proportionally more loss than small seedlings of Douglas-fir or spruce.

All planting stock types performed very well when salmonberry was removed before seedlings were overtopped. All degrees of overtopping observed were detrimental. Regardless of whether released, there was a consistently higher growth rate from large seedlings than from small, and the differences were greater between large and small stock types with increasing competition from salmonberry.

Table 1. Effect of stock height and salmonberry release on survival and growth of Douglas-fir and western hemlock over a 7-year period

Species	Stock height (cm)	Treatment	Salmonberry age 0 years		Salmonberry age 4 years	
			Survival (%)	Height (cm)	Survival (%)	Height (cm)
Douglas-fir	50-90	released	88	556	46	272
		unreleased	84	504	40	190
	25-50	released	87	533	38	198
		unreleased	86	514	10	92
	12-25	released	98	500	52	168
		unreleased	91	479	5	25
Western hemlock	50-90	released	36	592	15	358
		unreleased	27	521	10	196
	25-50	released	47	570	17	223
		unreleased	47	528	12	32
	12-25	released	85	488	30	148
		unreleased	85	409	8	13

Abstract: Ronald E. Stewart

FPM83-0167

Noste, Nonan V.; Phipps, Howard M. Herbicide and container system effects on survival and early growth of conifers in northern Wisconsin. Forestry Chronicle. 54(4): 209-212; 1978.

A study was initiated on the Nicolet National Forest in northern Wisconsin to determine how intensive cultural practices such as clean cultivation, chemical weed control, and containerized planting stock may be used to convert relatively unproductive natural stands to more productive plantations of selected species.

The planting site was prepared by clearing and leveling with a straight bladed crawler tractor. All vegetation was removed. The site was then disked. Four species of trees (jack pine, red pine, white spruce, and hybrid larch) in four container systems were planted using a randomized complete block design. Seedlings were spaced 6 x 6 feet in square 16-tree plots. Vegetation control treatments were: (1) no control, (2) a pre-emergent herbicide, (3) pre-emergent plus direct contact herbicide, and (4) direct contact herbicide. All combinations of container systems and competition control treatments were replicated by random assignment in each of 4 blocks.

Results showed that survival was significantly higher in plots treated with the direct contact herbicide alone and in plots with no herbicide treatments than in plots with the pre-emergent herbicide. Height and diameter growth response followed the same pattern as survival. Results are presented in tabular form by species, container type, and herbicide treatment.

Abstract: Larry Gross

FPM83-0168

Oliver, William W. Early results from a tree spacing-brush density study on the Mendocino National Forest. Memorandum on file. Redding, CA: U.S. Department Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station; 1979.

A ponderosa pine plantation was established in 1960 in a shallow skeletal soil (site class IV) at 4,000 feet on the Mendocino National Forest in California. A tree spacing-brush density study was installed in 1977 to evaluate the influence of spacing and brush competition on tree growth. The brush density experiment consists of 18 plots divided into thirds. Brush, principally *Arctostaphylos canescens*, was untreated on one-third, half removed by hand on one-third, and totally removed by hand on the remaining third.

Table 1 shows results 2 years after brush removal.

Table 1. Effect of brush treatment on growth of ponderosa pine after 2 years

Brush treatment	Brush crown Volume (cu ft/acre)	Brush crown Coverage (%)	Periodic annual diameter growth (in)
Full removal	0	0	0.24
Half removal	28,434	15	0.16
No removal	52,712	35	0.12

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0169
Oliver, William W. Early response of ponderosa pine to spacing and brush: observations in a 12-year-old plantation. Research Note PSW-341. Berkeley, CA: U.S. Department Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station; 1979. 7 p.

Ponderosa pine 1-0 seedlings were planted at five different spacings from 6 x 6 to 18 x 18 feet on an intensively bulldozed clearcut on a highly productive site (Site Index 110 feet) on the Challenge Experimental Forest in California. Spacing and brush effects were evaluated in two randomized blocks each allowed to develop normally on one half of each plot. The other half was kept free of brush by spraying 2,4,5-T applied by hand sprayer in the second and fourth years after planting. Newly germinated brush seedlings were grubbed out by hand. Each split plot contained 12 measurement trees; the few trees that died were replaced from surplus stock planted adjacent to the experimental site. Table 1 shows results 12 years after planting.

Spacing and brush competition emerged as strong influences on stem diameter, crown width, live crown ratio, and average branch diameter 12 years after planting. Tree crown characteristics, especially live crown ratio, were more sensitive to brush competition than were stem characteristics. Brush seeds germinated abundantly and seedlings grew rapidly on plots where they were allowed to develop. But few ponderosa pines were overtopped by brush because: (a) complete site preparation eliminated all existing brush and nearly all hardwood sprouts, and (b) the pines grew rapidly in height. However, trees competing with brush grew more slowly than trees free of brush. Diameters of tree stems in brush grew only 76 percent of those found in brush-free plots after 12 years. Plots with a light brush cover of 30 percent lost the equivalent of 1.1 year's diameter growth; on plots with dense cover the loss was equivalent to 2.6 years. Nearly one-fourth the growth potential was lost in these brush-choked plots, despite a productive site, cleared and groomed before planting, and rapid growth which kept the tree crowns above the brush. Brush competition could delay commercial thinning about 6 years.

$Y = 0.629 + 0.0166\,x$, where: Y = diameter growth loss in years at age 12; X = crown cover of brush in percent (30%); r squared = 48 percent

Table 1. Effects of spacing and brush control on growth of ponderosa pine over a 12-year period

Spacing and brush control	D.b.h. (in)	Height (ft)	Basal area (sq ft/acre)	Stem volume (cu ft/acre)
6x6 with brush	2.9	13.1	66	421
without brush	3.5	14.4	90	611
9x9 with brush	4.2	14.9	64	433
without brush	4.7	17.1	85	640
12x12 with brush	3.9	13.1	36	250
without brush	5.4	18.4	67	519
15x15 with brush	3.4	13.1	18	120
without brush	5.5	17.4	48	364
18x18 with brush	4.4	16.2	21	152
without brush	6.2	18.9	43	354

Abstract: Ronald E. Stewart

FPM83-0170

Oliver, William W. A manzanita understory reduces growth and health of ponderosa pine thinned to different spacings in northern California. Unpublished manuscript on file. Redding, CA: U.S. Department Agriculture, Forest Service, Pacific Souithwest Forest and Range Experiment Station; 1983. 22 p.

The influence of tree spacing and brush competition was evaluated at Trough Springs on a site of low productivity in California's North Coast Range. Eleven-year-old saplings of ponderosa pine were thinned to square spacings of 2.1, 2.4, 3.0, and 4.3 meters, and all, half, and none of the understory brush (principally manzanita) manually removed in a split-plot design. Each spacing was assigned to three 0.10-hectare plots in a randomized block design. Plots were grouped into three blocks on the basis of small differences in site quality. Eleven years after planting, the average tree was 2.8 centimeters in d.b.h. and 1.8 meters tall. Stand density varied from 1422 to 3407 trees per hectare. Brush crowns averaged 0.7 meters and covered 30 percent of the area. Five years after the spacing study was installed, 16 years after planting, brush density treatments were superimposed on each stand density plot - - all brush tops were manually removed from one-third of each 0.10-hectare plot, every other brush top was removed from another third, and the final one-third of each plot was left untouched. Periodic annual increments for 5 years after brush removal are shown in Table 1.

Brush crown cover in percent was significantly related to periodic annual increment in d.b.h., height, and volume of pines. Depending on spacing, brush-free trees at Trough Springs grew 45 to 140 percent faster in diameter and 62 to 170 percent faster in height than trees in dense brush. Diameter growth response was immediate but growth of trees in dense brush was exacerbated by frequent insect attacks that deformed tops and caused loss of foliage. A nonlinear equation relating brush cover in percent and trees per hectare to periodic annual increment in diameter explained 90 percent of the variation. The equation suggests that for this plantation at least, any amount of brush will restrict diameter growth. When cover is greater than 20 to 30 percent, brush competition overwhelms inter-tree competition, and trees grow at about the same rate regardless of spacing.

Table 1. Effect of spacing and brush removal on growth of ponderosa pine after 5 years

Tree spacing (sq m)	Brush removal	D.b.h. (cm/year)	Height (m/year)	Basal area (sq m/year)	Total volume (cu m/year)
4.3 x 4.3	none	0.25	0.07	0.15	0.25
	half	0.30	0.12	0.16	0.29
	full	0.61	0.19	0.36	0.63
3.0 x 3.0	none	0.28	0.08	0.30	0.60
	half	0.32	0.11	0.32	0.64
	full	0.47	0.17	0.46	0.81
2.4 x 2.4	none	0.22	0.07	0.24	0.36
	half	0.32	0.11	0.42	0.80
	full	0.43	0.16	0.65	1.06
2.1 x 2.1	none	0.27	0.09	0.50	0.75
	half	0.30	0.12	0.59	0.94
	full	0.42	0.14	0.79	1.50

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0171

Outcalt, Kenneth W. Mechanical site preparation improves growth of genetically improved and unimproved slash pine on a Florida flatwoods site. In: Jones, Earle P., Jr., ed. Proceedings of the Second Biennial Southern Silvicultural Research Conference; November 4-5, 1982; Atlanta, GA. General Technical Report SE-24. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station; 1983: 11-13

In 1971, a study was installed on a north Florida flatwoods site in the Olustee Experimental Forest in Baker County. The soil on the study site is a poorly drained Leon fine sand. Twenty-four plots, each 70 by 100 feet, were established in a randomized block design with 3 blocks, 4 methods of site preparation, and 2 types of planting stock. The site preparations were: no treatment; prescribed burn; burn and double disc; and burn, double disk, and bed. Planting stock was of two types: unimproved and genetically improved, a mixture of 10 superior families. Types of stock were included in factorial combinations with the different methods of site preparation.

Slash pine survival, growth, and yield 10 years after planting are shown in Table 1.

Site preparation had no significant effect on survival, with all treatments having good survival at 10 years of age. Burning improved neither survival nor growth of trees. Mechanical site preparation, however, increased growth of both improved and unimproved stock. Disking increased average tree diameter by 0.5 inches, average height by 3.8 feet, and volume production by over 200 cubic feet per acre (0.25 cords per acre per year) above control trees. Trees on disked and bedded plots were not significantly larger than on disked-only plots.

Table 1. Effect of site preparation on survival, growth, and yield of slash pine after 10 years

Stock type and method of treatment	Survival (percent)	Diameter (inches)	Height (feet)	Volume (cu ft/acre)
Unimproved seedlings				
Control	83	3.3	20.4	280
Burn	87	3.0	18.4	240
Burn + disk	91	3.6	22.6	405
Burn + disk + bed	90	4.1	25.6	575
Improved seedlings				
Control	82	3.5	22.4	345
Burn	83	3.5	22.3	360
Burn + disk	91	4.3	27.7	680
Burn + disk + bed	90	4.4	28.3	705
All seedling				
Control	83	3.4	21.4	315
Burn	85	3.3	20.3	300
Burn + disk	91	3.9	25.2	545
Burn + disk + bed	90	4.2	27.0	640

Abstract: Ronald E. Stewart

FPM83-0172

Pehl, C. E.; Bailey, R. L. Performance to age ten of a loblolly pine plantation on an intensively prepared site in the Georgia Piedmont. Forest Science. 29(1): 96-102; 1983.

A study was installed to evaluate the influence of site preparation on loblolly pine survival and growth in the Georgia Piedmont. The study area was located in the University of Georgia's B. G. Grant Memorial Forest, Putnam County, Georgia. The soil was a deep, well-drained Cecil series. The stand removed prior to planting was loblolly pine with scattered shortleaf, yellow-poplar, and sweetgum with little or no understory. The original experimental design consisted of six 0.15-hectare blocks each divided into seven east-west rows 6.3 meters wide and nine north-south columns 3.7 meters wide. Skidding and site preparation treatments were applied as a 4 x 5 factorial randomized complete block design to odd-numbered rows and columns; the even-numbered rows and columns were utilized as buffer strips. Following harvest, five skidding treatments consisting of 0, 1, 3, 10, and 15 trips were randomly applied to the columns using a skidder and standardized load of four logs. Four site preparation treatments -- disking, bedding, chopping, and clearcut and leave (control) -- were then randomly applied to the odd-numbered rows. This design resulted in twenty 23.3-square-meter plots per block to which both a skidding and site preparation treatment were applied. The area was hand-planted with genetically improved loblolly pine seedlings. However, after 10 years the large number of volunteer pines prevented separation of planted from naturally seeded trees.

Growth of the pine after 10 years is shown in Table 1.

Increased height growth was still evident on the disking treatment at the 10th growing season. However, height growth trends suggested that this increase may not continue through a 25-year rotation. By the 10th year, larger mean diameters and individual tree heights and volumes were found on the bedded and disked sites. However, total basal areas and volumes were similar across treatments. Therefore, although total pine production may not have varied significantly across treatments, the bedded and disked sites that showed increased control of competing vegetation, had fewer but larger trees. Further, the skewed diameter distributions associated with the intensively prepared sites indicated that more trees were breast height diameter above that of the treatment mean. Therefore, more trees on the intensively prepared sites should reach merchantible size at an earlier age than those on the chop or control treatments, provided the present diameter distributions continue.

Table 1. Effect of intensive site preparation on growth of loblolly pine after 10 years

Site treatment	Density (trees/ha)	D.b.h. (cm)	Height (m)	Pine basal area (sq m/ha)	Volume (cu m/ha)
Control	8500	6.3	6.0	13.3	51.2
Chop	8273	6.1	6.0	13.4	50.5
Bed	5713	7.5	6.3	12.8	49.8
Disk	6138	7.3	6.5	12.6	48.5

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0173

Peterson, Terry D.; Newton, Michael. Growth of Douglas-fir following release from snowbrush and forbs -- implications for vegetation management of brushfields. Rocky Mountain Timberlands Research and Development Research Note RM82-8. Milltown, MT: Champion International Corporation; 1982. 9 p.

Four 5-year-old and four 10-year-old Douglas-fir stands were selected as study sites in the upper McKenzie River drainage of the Oregon Cascades. Each site contained a moderate to heavy cover of snowbrush ceanothus. The height of Douglas-fir selected for study was equal to the height of snowbrush, about 1 meter in the 5-year-old stands and 2 meters in the 10-year-old stands. Nine trees were randomly assigned to each of three treatments in each of the 5-year-old stands, and five trees were randomly assigned to each of four treatments in 10-year-old stands. Treatments common to both ages were: (1) untreated; (2) treatment of snowbrush with 2,4-D; and (3) treatment of snowbrush with 2,4-D and forbs with glyphosate. An additional treatment was applied in the 10-year-old stands consisting of cutting all shrubs within 8 meters of each tree.

Response to treatment after 4 years is shown in Table 1.

The growth response of Douglas-fir was dependent upon the extent to which competing vegetation was eliminated and also upon the age of the trees when released. Removal of forbs in addition to the shrubs resulted in considerably greater stem diameter and volume than removal of only shrubs in both age classes. Both treatments increased growth in the 5-year-old stands. In contrast, the removal of all vegetation was the only treatment that significantly increased diameter and volume growth in the 10-year-old stands.

Release by cutting the shrubs reduced the height growth of the Douglas-fir the first few years after treatment. Chlorosis in needles of these trees was common during the first growing season after treatment due to the sudden exposure of shade-adapted leaves to full sunlight. The trees had largely recovered by the end of the fourth growing season, however, and the difference between the height of control trees and manually released trees was no longer significant in 1982. Both chemical treatments increased height growth in the 5-year-old stands after four growing seasons, while only the complete removal has had a significant effect on height after four years in the 10-year-old stands.

After four growing seasons the volume in trees that had both shrubs and forbs sprayed was more than four times as great as the control trees in 5-year-old stands and almost twice as great in 10-year-old stands. Assuming that control trees in the 5-year-old stands will follow growth trajectories similar to the control trees in the 10-year-old stands, the trees that had both shrubs and forbs sprayed have reached a volume by age nine that they would not have reached until age thirteen without any release treatment.

Table 1. Effect of release from snowbrush and forbs on growth of Douglas-fir after 4 years

Stand age at treatment	Treatment	Stem diameter (cm)	Total height (cm)	Stem volume index (cu m)
5-year-old stands	Untreated	3.4	219	2,805
	Shrubs sprayed	5.1	259	7,241
	Shrubs and herbs sprayed	6.0	279	11,616
10-year-old stands	Untreated	6.9	362	17,553
	Shrubs cut	7.8	346	22,055
	Shrubs sprayed	7.4	358	22,672
	Shrubs and herbs sprayed	8.6	393	31,200

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0174

Phares, Robert E.; Liming, Franklin G. Comparative development of seeded and planted shortleaf pine on a forest site in the Missouri Ozarks. Journal of Forestry. 58(12): 957-959; 1960.

Six 0.1-acre plots were installed during 1941 in a pole-size blackjack and post oak stand on the Mark Twain National Forest in Missouri. Overstory trees were removed by clearcutting on three of the plots and by girdling on the other three. In April 1941, seed spots were prepared and 10 filled shortleaf pine seeds were sown in each spot. However, seedlings became established only on about 30 percent of the spots. In April 1942, 1-0 shortleaf pine seedlings were planted in all the vacant seed spots. Both seeded and planted trees were 1-year-old when stocking and height growth comparisons were begun. Height growth for 5 years after release is presented graphically. Competition from hardwood reproduction influenced height growth of both seeded and planted pine--the more competition, the slower the trees grew. Intensive competition retarded the height growth of seeded trees more than that of planted trees, but the seeded trees still remained taller.

Abstract: Ronald E. Stewart

FPM83-0175
Phares, Robert E.; Rogers, Nelson F. Seasonal diameter growth in managed shortleaf pine stands in the Missouri Ozarks. Journal of Forestry. 66(7): 563-566; 1968.

See: Rogers, Nelson F.; Brinkman, Kenneth A., 1965.

FPM83-0176

Plass, William T.; Green, Alan W. Preplanting treatments for brushy old fields in southern Illinois. U.S. Forest Service Research Paper CS-1. Columbus, OH: U.S. Department Agriculture, Forest Service, Central States Forest Experiment Station; 1963. 8 p.

A study to determine effect of several preplanting treatments in short brush (averaging less than 10 feet tall) and tall brush (averaging more than 10 feet in height) types on survival and growth of planted shortleaf pine, white pine, and white oak seedlings was begun in 1955 in southern Illinois. Two replications of 5 treatments and a control were tested in the short brush type: (1) two fall diskings; (2) hand cutting all woody plants taller than 4 feet to simulate mowing; (3) hand cutting followed by a stump spray with a mixture of 2,4-D and 2,4,5-T; (4) foliage spray of 2,4-D and 2,4,5-T in water during late summer; and (5) a spring burn. The burn was neither complete nor uniform. Three replications of two treatments and a control were compared on tall brush areas: (1) basal spraying with 2,4-D and 2,4,5-T and (2) a spring burn. Forty seedlings of each species were planted on each plot.

None of the treatments had any effect on survival; survival averaged 60 percent 5 years after planting. Average total heights 5 years after treatment appear in Table 1.

The height of trees by degree of shading on the short brush area 5 years after treatment are shown in Table 2.

Mowing followed by stump spraying, disking, and basal spraying were effective for shortleaf pine. Where these treatments were used, shortleaf pine grew twice as fast as on untreated areas and fewer planted trees were shaded by brush. Because white pine and white oak are slow starters, the regrowth of brush overtopped them within 5 years. However, these species are tolerant of shade and eventually many grow through the brush cover and overtop it. Nevertheless, until a preplanting treatment can be developed that will completely eliminate the brush for a longer period, these species may benefit more from a release treatment a few years after planting.

Table 1. Effect of preplanting treatments on tree height growth after five years

Treatment	Average height of trees (feet) Shortleaf pine	White pine	White oak
Short brush areas			
Untreated	3.9	2.7	2.5
Mow-stump spray	6.2	2.9	2.8
Disc	5.7	3.0	2.5
Mow	5.0	2.8	2.2
Burn	5.0	2.1	2.1
Foliage spray	4.4	2.9	2.3
Tall brush areas			
Untreated	4.0	2.2	1.6
Basal spray	4.6	2.8	2.0
Burn	3.9	2.0	1.6

Table 2. Effect of preplanting treatment on tree height growth in short brush area by degree of shading

	Average height (feet) Not shaded	Partially shaded	Completely shaded
Shortleaf pine	6.5	5.1	3.3
White pine	3.9	3.1	2.3
White oak	2.9	2.9	2.0

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0177

Plice, M. J.; Hedden, G. W. Selective girdling of hardwoods to release young growth of conifers. Journal of Forestry. 29(1): 32-40; 1931.

Growth measurements were made during the summers of 1928 and 1929 of released young softwoods on seven separate areas on Finch, Pruyn and Company's land in the Adirondack mountain region of New York. The seven areas comprised a total of more than 5,000 acres of girdled land with measurement of more than 1,100 representative trees. Some additional data on girdling in New England and Canada were also obtained.

At the Lake Edward Experiment Station in Quebec, three plots were established in 1922. On one plot all hardwoods were girdled; on another 40 percent of the hardwoods were girdled; the remaining plot was left ungirdled as a check. Increment borings in 1928, 6 years after treatment, are shown in Table 1.

Growth was in a direct ratio to the amount of release with the exception of the 6-inch class of balsam fir and 8-inch class of spruce on the 40 percent girdled plots. These discrepancies were thought to be due to the small sample size in the particular classes.

Measurements in the Adirondacks were made in typical softwood areas-mostly spruce flats with some transitional spruce flat--northern hardwoods land, and a small amount of spruce swamp. Most of the measurements were of the growth of the terminal shoots, since they showed striking increases in length the first season after girdling of the hardwoods. In Table 2, measurements are given for reproduction that has been entirely released by girdling; for reproduction that has been only partially released, but which will be free in a few years; and for reproduction that has not yet been affected by girdling.

The growth after girdling has constantly increased while before girdling it was practically at a standstill. The growth of spruce prior to girdling was greater than that of balsam fir, since the spruce was older and of greater height. The rate of growth of balsam fir after girdling is much greater than that of spruce. Studies made on 100 trees each of spruce and balsam fir showed that the basal area of every diameter class is increased by girdling. After 5 years, spruce released by girdling increased in basal area over the unreleased spruce by 25.1 percent. Released balsam fir increased by 99.6 percent over unreleased fir. Released fir was increasing in basal area about three times as rapidly as the released spruce.

White pine, 12 to 14 inches d.b.h., response to release by girdling of competing hardwoods is shown in Table 3.

Previous to girdling, the radial growth was decreasing year by year, while immediately after it increased until, at the end of 6 years, it nearly equalled the growth of trees in a dominant position throughout life.

Table 1. Effect of hardwood girdling on radial growth of conifers after 6 years

Species and degree of girdling	Radial growth per season by diameter class (inches)				
	2	4	6	8	10
Spruce					
Plot ungirdled	0.10	0.57	0.31	0.83	--
Plot 40 per cent girdled	0.39	0.87	0.97	0.72	--
Plot 100 per cent girdled	0.59	1.09	1.54	1.04	--
Balsam fir					
Plot ungirdled	0.44	0.73	1.50	1.65	1.00
Plot 40 per cent girdled	0.67	1.50	1.16	1.71	1.40
Plot 100 per cent girdled	0.97	1.72	2.24	2.13	1.86

Table 2. Effect of release on height growth of softwood reproduction

Cedar River 1926 Area — Girdled in spring, 1926

Species and degree of release	Height growth per season (inches)					
	1924	1925	1926	1927	1928	1929
Spruce						
Freed	5.7	7.0	9.0	9.9	12.6	13.6
Partially suppressed	5.1	6.2	9.2	9.6	12.6	12.0
Suppressed	3.0	5.0	6.5	6.5	9.5	7.0
Balsam						
Freed	7.0	10.6	15.4	15.2	20.4	25.5
Partially suppressed	4.9	6.5	9.3	8.9	12.5	14.8
Suppressed	2.8	3.0	6.0	7.0	9.0	15.0

Table 2 (continued)

Cedar River 1925 Area — Girdled in spring, 1925

Height growth per season (inches)

Species (All freed)	1923	1924	1925	1926	1927	1928	1929
Spruce	4.7	4.3	6.1	9.3	10.4	13.4	14.1
Balsam	5.1	5.4	8.6	12.0	12.9	15.9	17.1

Six Mile Brook — Girdled in fall, 1926

Height growth per season (inches)

Degree of girdling	Spruce 1927	Spruce 1928	Spruce 1929	Balsam Fir 1927	Balsam Fir 1928	Balsam Fir 1929
Girdled area						
Freed	9.2	11.4	12.2	10.5	14.4	16.5
Partially suppressed	8.3	9.3	8.7	8.5	9.2	9.0
Suppressed	5.6	5.8	5.1	5.6	6.0	5.1
Ungirdled area	3.9	4.3	3.1	4.3	4.3	2.9

Township 19 — Girdled in spring, 1926

Height growth per season (inches)

Degree of girdling	Spruce 1925	Spruce 1926	Spruce 1927	Spruce 1928	Spruce 1929	Balsam fir 1925	Balsam fir 1926	Balsam fir 1927	Balsam fir 1928	Balsam fir 1929
Freed	3.2	4.3	4.5	5.0	9.7	4.2	5.1	5.9	9.3	14.3
Partially suppressed	2.5	3.1	4.2	6.2	9.0	2.6	4.4	5.3	7.5	9.7
Suppressed	2.6	3.3	3.6	5.6	8.6	--	--	--	--	--

Township 16 — Girdled in winter, 1927-28

Height growth per season (inches)

Degree of girdling	Spruce 1926	Spruce 1927	Spruce 1928	Spruce 1929	Balsam fir 1926	Balsam fir 1927	Balsam fir 1928	Balsam fir 1929
Freed	6.0	7.0	9.5	10.5	6.7	6.1	10.1	12.0
Partially suppressed	--	--	--	--	6.0	4.6	8.1	10.7
Suppressed	3.5	2.0	6.5	5.5	2.7	2.1	4.3	5.0

Table 2. (continued)

Goodenow Flat — Girdled in spring, 1927

Species and degree of girdling	Height growth per season (inches) 1923	1924	1925	1926	1927	1928	1929
Spruce							
Freed	3.4	3.0	3.2	3.2	6.4	8.4	10.6
Partially suppressed	2.0	2.3	2.3	2.7	3.7	7.0	9.0
Suppressed	2.5	2.5	2.5	1.0	2.5	4.5	5.2
Balsam							
Freed	2.8	2.9	3.1	4.1	5.2	8.5	12.8
Partially suppressed	2.0	2.0	2.0	2.9	3.5	6.9	9.0
Suppressed	--	--	--	--	--	--	--

Camp Spring — Girdled in spring, 1928

Degree of girdling	Height growth per season (inches) Spruce 1926	1927	1928	1929	Balsam fir 1926	1927	1928	1929
Girdled area	3.1	2.8	6.5	7.4	2.4	2.5	6.4	8.1
Ungirdled area	1.3	0.9	1.1	1.5	1.3	1.4	1.6	1.6

Table 3. Effect of girdling on radial growth of white pine

Condition of pine plantings	Radial growth during time period (tenths of inches) 1910-1916	1916-1922	1922-1928
Trees in dominant position throughout lives	1.01	.89	.88
Trees in location to be affected by girdling	.43	.36	.83
Trees not in location to be affected by girdling	.42	.25	.17

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C. : U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0178

Powers, Robert F.; Jackson, Grant D. Ponderosa pine response to fertilization: influence of brush removal and soil type. Research Paper PSW-132. Berkeley, CA: U.S. Department Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station; 1978. 9 p.

An 80-acre area on two contrasting soils (Mariposa and the more productive Cohasset series) was bulldozed in 1966, planted with ponderosa pine in 1967, and sprayed with 2,4,5-T in 1968. By 1975, the tallest trees on the Mariposa series were only half a meter above the brush, but more than a meter above on the Cohasset series. Eighteen 0.1-acre plots were established on each site in July 1975 in a randomized block design with three blocks of six treatments each. Agricultural grade urea was applied at 0, 200, and 400 pounds N per acre and combined with removal or nonremoval of competing brush. Brush was removed with hand tools from nine plots in each soil series. An average of 15 trees was measured in each plot. Results one growing season after treatment appear in Table 1.

First-year results show that trees testing low in foliar nitrogen (on the Mariposa series) responded strongly to fertilization where brush had been removed, but failed to respond if brush remained. Height growth was doubled by certain treatment combinations on the less fertile Mariposa soil, but was not influenced by treatment on the more fertile Cohasset series. Brush removal increased needle weight for trees on both soils. Increases in foliar biomass and nitrogen content of trees on treated plots suggest that rapid growth rates will continue.

Table 1. Effect of fertilization and brush control on growth of ponderosa pine after 1 growing season

	Mariposa series		Cohasset series	
	Height growth (cm)	Diameter (cm)	Height growth (cm)	Diameter (cm)
Brush present				
0 lb/acre N	12.5	4.5	41.1	8.5
200 lb/acre N	15.7	5.0	51.1	9.2
400 lb/acre N	14.7	4.7	42.0	9.1
Brush absent				
0 lb/acre N	16.5	4.9	45.5	9.3
200 lb/acre N	29.8	6.8	52.0	9.6
400 lb/acre N	28.1	6.2	43.2	7.9

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0179

Preest, D. S. Long-term growth response of Douglas-fir to weed control. New Zealand Journal of Forest Science. 7(3): 329-332; 1977.

The objective of this study was to determine the effects and decide the merits of different sequences of annual herbicide treatments. The trial plots were located in an old field near Blodgett in the Coast Range of Oregon. The basic experimental units consisted of 16 rectangular main plots each 40.5 meters square. Selective chemical weed control was used on half of these during the spring and summer of 1968. The following year each plot was split north-south and the western half subjected to weed control. In 1970 the plots were again split, this time east-west, and the northern half of each was subjected to weed control. Thus by the end of the summer of 1970 each plot had been divided into four sub-plots which among them had received eight different herbicide treatment sequences.

In the winter of 1972-73 the trees were analyzed for yearly height growth and diameter inside bark. Results indicated that if a single application was to be made it should be in the year the trees were planted. Although weed control in 1968 did not significantly increase height growth in 1968, it did result in significant increases in each of the following 3 years. Effects on height growth after the 1969 and 1970 weed control treatments were highly significant both in the year of application and in succeeding years. The results of repeated yearly treatments were cumulative. A rotation shortening of up to 2 years could be expected with three yearly treatments.

Abstract: Larry Gross

FPM83-0180

Radosevich, S. R.; Passof, P. C.; Leonard, O. A. Douglas-fir release from tanoak and Pacific madrone competition. Weed Science. 24(1): 144-145; 1976.

Tanoak and Pacific madrone growing as an overstory to small Douglas-firs were treated by cut-surface methods in April 1964 on an area near Ukiah, California. Herbicides used were the amines of 2,4-D and 2,4,5-T and the potassium salt of picloram. In August 1974, radial cores at breast height were obtained from released Douglas-firs, and tree age and inside bark basal area growth was measured. Growth differences between treated and untreated 232 square meter plots were subjected to a t-test for statistical analysis. Comparisons were made for only Douglas-firs at least 15 years old since younger trees were either nonexistent, very small, or subjected to competition from larger Douglas-firs. Results after 10 years are shown in Table 1.

Three trees in the picloram plot died, perhaps as a result of soil activity of the herbicide leaking from treated hardwoods. Intra-species competition among Douglas-firs explains the observed growth differences between 2,4-D and the other herbicide treatments.

Table 1. Effect of release on Douglas-fir basal area growth after 10 years

Method of release	Basal area (sq cm)	Basal area growth (percent of untreated)
Untreated	7.2	100
2,4-D	18.7	260
2,4,5-T	32.5	451
Picloram	29.2	405

Abstract: Ronald E. Stewart

FPM83-0181

Ralston, Robert A. Red pine suppressed for forty years responds to release. U.S. Department of Agriculture Forest Service Technical Note No. 408. St. Paul, MN: U.S. Department Agriculture, Forest Service, Lake States Forest Experiment Station; 1953. 2 p.

Three one-half acre plots of 40-year-old overtopped red pine planted under a dense canopy of northern red oak, white oak, and red maple on a average site in the Higgins Lake State Forest, Michigan, were manually released in the spring of 1950. Treatments were: (1) all competing hardwoods removed (complete release); (2) 40 square feet of basal area and 166 trees over 3 inches d.b.h. left per acre (partial release); and (3) 80 square feet of basal area and 462 trees over 3 inches d.b.h. left per acre. Height growth of 50 sample trees in each plot was measured every fall for 3 years after treatment. In order to compare the response to degree of suppression under which the trees grew before release, the trees were grouped into three suppression classes: (A) 17 tallest trees at time of treatment; (B) the next 17 tallest trees; and (C) the 16 shortest trees.

Results after three growing seasons are shown in Table 1.

Response to release was apparent the first growing season and was in direct proportion to the amount of overstory removed. This initial response was reflected mainly by increased needle length and foliage density. By the end of the third season, both completely and partially released trees were far ahead of the unreleased trees. Even the most badly suppressed trees in the completely released plot, which averaged only 3.3 feet tall before release, grew three times as much during the fourth growing season as the tallest, least suppressed trees in the control area and almost twice as much as the tallest trees in the partially released plot.

Table 1. Effect of release on growth of red pine after 3 years

Treatment	Suppression class	Total height (ft)	Average height growth 1950 --- 1953 (ft)
No release	A (9.3 ft)	10.6	1.3
	B (6.9 ft)	8.0	1.1
	C (4.3 ft)	5.1	0.8
	Average	7.9	1.1
Partial release	A (9.9 ft)	12.2	2.3
	B (6.2 ft)	8.0	1.8
	C (3.6 ft)	4.9	1.3
	Average	8.4	1.8
Complete release	A (10.5 ft)	13.9	3.4
	B (6.6 ft)	9.6	3.0
	C (3.3 ft)	5.7	2.4
	Average	9.7	2.9

Abstract: Ronald E. Stewart

FPM83-0182

Reynolds, R. R. Management increases growth rate. Southern Forestry Notes No. 92. New Orleans, LA: U.S. Department Agriculture, Forest Service, Southern Forest Experiment Station; 1954. 4 p.

Managed and unmanaged compartments of loblolly and shortleaf pine stands were compared on the Crossett Experimental Forest in Arkansas. The two unmanaged areas were 40-acre compartments on which no harvesting or improvement work has been done since the original timber was cut in 1915. These were contrasted with 1,000 acres of managed compartments. The management prescription was to cut less than the current growth. Merchantable hardwoods and the poor-risk or low-grade pines were given priority in cutting, while unmerchantable hardwoods were killed.

Average annual growth for the 10 years between 1942 and 1952 was 443 board feet per acre on unmanaged compartments; of this, 390 board feet was pine. In contrast, average annual growth on managed compartments averaged 551 board feet per acre, all pine. Initial growing stock in 1942 was 8,908 board feet per acre, of which 6,896 board feet was pine, on unmanaged tracts. Initial growing stock averaged 5,036 board feet per acre on managed tracts. Thus the managed forests produced pine at the rate of 10.9 percent simple interest annually, almost double the 5.7 percent on the unmanaged forests.

Abstract: Ronald E. Stewart

FPM83-0183

Roe, Eugene I. Early release from aspen improves yield of pine plantations. USDA Forest Service Technical Notes No. 353. St. Paul, MN: U.S. Department Agriculture, Forest Service, Lake States Forest Experiment Station; 1951. 1 p.

A 90-acre burn on the Superior National Forest was planted to red pine in 1915 and 1917. In 1931, 15 to 17 years after planting, plots representing two degrees of release from aspen and an untreated check were established. Cordwood volumes on the released plots and on a portion of the plantation needing no release were measured in 1949. Results 18 years after treatment are presented in Table 1.

Even a delayed release increased the volume of more valuable pine cordwood. However, the difference was less than it would have been if much of the aspen on the check plot had not been killed by a tent caterpillar epidemic. To obtain the greatest dividends from overtopped plantations, release must be done at an early age.

Table 1. Effect of release on volume growth and stumpage value of red pine after 18 years

	Volume (cords)						Total stumpage value
	1931			1949			
	Pine	Aspen	Total	Pine	Aspen	Total	($)
No release	1.9	5.9	7.9	16.2	15.6	31.8	40.20
Partial release	2.2	0.6	2.8	20.2	8.0	28.2	44.20
Full release	1.9	0.1	1.7	23.7	2.2	25.9	48.50
No release needed	1.9	- -	1.9	32.9	0.3	33.2	65.95

Abstract: Ronald E. Stewart

FPM83-0184

Roe, E. I. Understory balsam fir responds well to release. Technical Notes No. 377. St Paul, MN: U.S. Department Agriculture, Forest Service, Lake States Forest Experiment Station; 1952; 1 p.

A 5-acre understory of small balsam fir in an aspen-birch stand on the Pike Bay Experimental Forest in northern Minnesota was given complete release in 1935 by removing all hardwoods. About 15 cords per acre were removed. Growth of the cut stand for the next 15 years appears in Table 1.

During the 15 years since release, the balsam fir reached merchantable size and provided a cut of 4 to 14 cords per acre. On the surrounding uncut area, the balsam fir made fair growth but was much too small for a merchantable cut. For example, balsam firs on the cut area that were in the 4-inch diameter class before treatment became 7-inch trees with an average volume of 4.5 cubic feet after 15 years. Trees of the same size in the uncut stand grew only 1 inch in diameter in 15 years and had an average volume of only 2.5 cubic feet.

Table 1. Effect of complete release on volume yield of balsam fir

	Trees per acre		Basal area (sq ft/acre)	
	Total	Merch-antable	Total	Merch-antable
Before cutting, 1935	552	291	106	80
After cutting, 1935	134	71	25	19
After 15 years, 1949	397	245	93	76

Abstract: Ronald E. Stewart

FPM83-0185

Rogers, Nelson F.; Brinkman, Kenneth A. Shortleaf pine in Missouri, understory hardwoods retard growth. U.S. Forest Service Research Paper CS-15. Columbus, OH: U.S. Department Agriculture, Forest Service, Central States Forest Experiment Station; 1965. 9 p.

See: Phares, Robert E.; Rogers, Nelson F., 1968.

Hardwood understories in 30-year-old thinned and unthinned stands of shortleaf pine--oak on the Sinkin Experimental Forest in Missouri were left untreated (3 plots each) or were cut and sprayed with 2,4,5-T (3 plots each). Stands were established naturally in 1918; thinning and cutting occurred in 1951 with subsequent foliage spraying in 1952, 1955, and 1959. Results after 10 years are in presented in Table 1.

Killing all hardwoods increased volume growth in both thinned and unthinned shortleaf pine stands in Missouri about 40 percent in 10 years. Thinned pine without hardwoods grew nearly 6000 board feet/acre in the period, about 1700 board feet more than where hardwoods were left and about 3500 board feet more than unthinned pine where no hardwoods were killed (an increased of 72 percent).

Table 1. Growth and yield of thinned and unthinned shortleaf pine after 10 years

	Growth after 10 yr (cu ft/acre)	Yield after 10 yr (cu ft/acre)	Total yield (cu ft/ acre)	Total yield (fbm/acre)
Unthinned				
Not released	575	40	3,020	10,350
Released	810	30	3,100	10,985
Thinned				
Not released	710	545	3,030	11,340
Released	990	780	3,180	11,700

Abstract: Ronald E. Stewart

FPM83-0186

Roy, Douglass F. Douglas-fir seed production and dispersal in northwestern California. Unpublished report, on file. Redding, CA: U.S. Department Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station.

All brush (mostly tanoak and snowbrush ceanothus) was cut from one-fourth of a block of 5-year-old natural Douglas-fir in northwestern California. Brush sprouts were spot treated with herbicide the following year. Thirty released trees were paired with trees of almost the same height growing in the brush. Results 0 (6-year-old trees), 10 (16-year-old trees), and 17 (23-year-old trees) years after release appear in Table 1.

The difference in average heights between released and unreleased trees has increased significantly each year. After 17 years, the difference was 12.4 feet or 8.3 years of growth for site index 150 and a rotation age of 100 years. If volume growth is reduced by an 8.3-year period, the volume reduction would be 6715 board feet per acre. All released trees were classified as vigorous (based on needle complement, needle color, and needle length), but only 56 percent of the trees growing in the brush were vigorous.

Table 1. Effect of release on Douglas-fir height growth over a 17-year period

	Average height at year:		
	0 (ft)	10 (ft)	17 (ft)
Untreated	4.51	14.9	26.0
Released	4.52	21.8	38.4

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0187

Roy, D. F. Effects of ground cover and class of planting stock on survival of transplants in the eastside pine type of California. USDA Forest Service Research Note No. 87. Berkeley, CA: U.S. Department Agriculture, Forest Service, California Forest and Range Experiment Station 1953. 6 p.

A test was conducted at the Blacks Mountain Experimental Forest in California, an area typical of the California eastside pine type, to examine the effects of ground cover and class of planting stock on tree survival and growth. In the experiment, 1,200 trees were planted in the spring of 1951 on recently cutover land of various aspects. An equal number of ponderosa pine and Jeffrey pine were planted, half of each species being 1-0 and half 1-1 nursery stock. The tree spacing was 6 x 6 feet in a randomized block design. To secure habitat data the ground conditions and the density of cover were classified after planting for each 4- by 4-foot area surrounding the tree. The surface conditions were (a) bare mineral soil, (b) slash, (c) stones, (d) squaw carpet (Ceanothus prostratus Benth.), (e) other shrubs (including common sagebrush, Artemisia tridentata Nutt.), and (f) grass or sedge (Carex rossii Booth.). A planted spot was classified as having a light cover if only 1 to 25 percent of the area was covered; medium if 26 to 50 percent; heavy if 51 to 75 percent; and very heavy if 76 to 100 percent was covered.

Survival after two years by type of ground cover is shown in Table 1.

Survival rates for the various types of planting stock were considerably different. Ponderosa pine 1-1 stock had the best first- and second-year survival. On the average, the trees survived best on bare soil that had no stones; second best under slash; third on open stony ground. The density of the stones or ground cover also affected survival. For example, planted spots with light slash had the best survival, but spots covered with heavy slash had relatively low survival.

The study concluded that planting locations should be selected carefully. Stony and grassy areas should not be planted if more suitable places also need planting. Even in favorable planting areas, tree planters should be taught to select the best spots to plant, rather than be guided by mechanical spacing alone. Small patches of grass or other vegetation should be avoided, as well as very stony spots, or areas of heavy slash.

Table 1. Effect of ground condition and planting stock on tree survival after two years

Ground condition	Percent survival by type of planting stock: Ponderosa 1-0	Jeffrey 1-0	Ponderosa 1-1	Jeffrey 1-1	All
Bare	37	50	71	62	56
Light non-living cover or stoniness	36	41	68	55	50
Heavy non-living cover or stoniness	19	34	63	27	35
Light living cover	20	26	11	38	25
Heavy living cover	0	0	7	0	2
All conditions	30	39	60	47	44

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0188

Russell, T. E. Control of understory hardwoods fails to speed growth of pole-size loblolly. Southern Forestry Notes No. 131. New Orleans, LA: U.S. Department Agriculture, Forest Service, Southern Forest Experiment Station; 1961. 2 p.

A study was installed in a 26-year-old loblolly pine plantation near Alexandria, Louisiana, on a site with a site index of 90 feet. When the study began in May of 1954, the pines were thinned from 120 to 90 sqare feet of basal area (2800 to 2100 cubic feet) per acre and the 3800 hardwoods per acre were treated with ammate on one-half of each plot. New sprouts or seedlings were killed each year thereafter. Table 1 shows results during a 6-year period (1954-1959) after treatment.

Complete elimination of understory hardwoods in a 26-year-old pole-size loblolly pine stand near Alexandria, Louisiana, has not significantly improved growth.

Table 1. Effect of annual control of hardwood understory on growth of loblolly pine over a 6-year period

	Total growth (cu ft/acre)	MAI (cu ft/acres/yr)	Height growth (ft/yr)	Diameter growth (in)
Untreated	1034	172	1.4	13.2
Treated	1049	175	1.4	13.3

Abstract: Ronald E. Stewart

FPM83-0189
Russell, T. E. Planted shortleaf responds to prompt release. Tree Planters' Notes. 61: 13-16; 1963 October.

See: Russell, T. E., 1969.

FPM83-0190
Russell, T. E. Underplanting shortleaf pine. Forest Farmer. 29(1): 10, 17, 18; 1969.

See: Russell, T. E., 1963.

Underplanted shortleaf pines on Tennessee's Cumberland Plateau were released from the hardwood overstory by one of the following: (1) untreated check; (2) stems cut or girdled; (3) stems cut or girdled, and sprayed with 2,4,5-T in diesel oil; (4) stems cut or girdled and sprayed with 2,4,5-T in diesel oil 1 year after planting; and (5) stems cut or girdled and sprayed with 2,4,5-T in diesel oil 2 years after planting. Treatments were applied on 0.25-acre plots and replicated four times in randomized blocks. Table 1 shows results after 5 and 10 years.

On the Cumberland Plateau, release can be deferred for at least 2 years, if necessary. But about one year's growth will be lost for each year that seedlings remained overtopped by hardwoods. In the Missouri Ozarks, where summers are dry, delay in release has reduced the response of underplanted shortleaf pine after release.

Table 1. Survival rate and height growth of shortleaf pine after 5 and 10 years by method of release

	5 years		10 years	
Treatment	Survival (percent)	Total height (ft)	Survival (percent)	Total height (ft)
Untreated	55	1.5	18	3.1
year of planting-				
no herbicide		4.7	42	11.2
herbicide	67	6.2		15.2
Deferred 1 year-	to		42	
herbicide		4.9	to	12.9
	78			
Deferred 2 years-			59	
herbicide		3.7		11.4

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0191
Russell, T. E. Silvicides help to establish pine in southern hardwoods. Forest Farmer. 30(9): 8, 16, 17; 1971.

Six treatments plus an untreated check were installed on 0.25 acre plots of loblolly pine planted under an oak-hickory stand near Sewanee, Tennesse. The most intensive treatment consisted of girdling hardwoods 4 inches d.b.h. and over, cutting smaller trees, and spraying girdles or stumps with 2,4,5-T in diesel. Partial release was obtained by cutting either overstory or understory hardwoods and applying silvicide. Each degree of hardwood control was also tested without silvicide. The study was installed in a randomized block design with four replications. Results after 10 years appear in Table 1.

Existing hardwoods should be controlled thoroughly when underplanting on Tennessee's Cumberland Plateau. Removing only the larger overstory trees will not release pines sufficiently for satisfactory survival or growth on most cutover sites. Moreover, merely cutting overstory hardwoods in the year of planting is futile unless a silvicide is applied to reduce sprouting. Deferring overstory removal reduced height growth less than 1 foot for each year that pines were suppressed.

Similar results in northern Alabama suggest that a silvicide must be used throughout the region for adequate control of small hardwoods. Although pines can be released by repeatedly cutting small hardwood stems, such treatment is seldom feasible.

Table 1. Effect of hardwood control on survival rate and height growth of loblolly pine over a 10-year period

Control method	Survival (percent)	Height (feet)
Untreated	35	4.0
Overstory cut and sprayed	39	10.0
Overstory cut only	15	21.2
Understory cut and sprayed	94	18.2
Understory cut only	69	9.0
Overstory and understory cut and sprayed	86	26.0

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0192

Russell, T. E. Weeding northern red oak plantations on the Cumberland Plateau. U.S. Forest Service Research Note SO-184. New Orleans, LA: U.S. Department Agriculture, Forest Service, Southern Forest Experiment Station; 1974. 2 p.

Two test areas, near Sewanee, Tennessee, were originally set up to compare a variety of planting methods. Merchantable timber was cut from both areas, and remaining hardwoods over 0.5 inches d.b.h. were deadened with chemicals. Bare-root 1-0 oak was planted on the plateau site in 1962 and on the cove site in 1963.

Weeding was begun after planted oaks had been on the plateau 6 years and in the cove 7. Two weeding intensities were tested on both sites: (1) a single initial weeding with no further vegetation control and (2) frequent repeated weedings designed to keep crowns continuously free from overtopping or crowding vegetation. On both sites untreated plots were also observed. Plots contained six rows of six saplings each, with 5- by 8-foot spacing on the plateau and 6- by 10-foot spacing in the cove. Treatments were replicated four times on the plateau and three times in the cove, in randomized blocks.

Three year diameter-height growth of northern red oak saplings is shown in Table 1.

Weeding increased diameter growth on both sites. Repeated weedings did not produce diameters significantly larger than a single treatment. Best height growth in the cove was on unreleased plots. On the plateau height differences between unreleased and released oaks were not significant.

Table 1. Effect of weeding on growth of northern red oak after 3 years

Site and weeding intensity	Diameter growth (inches)	Height growth (feet)
Plateau		
Unweeded	0.42	3.2
One weeding	0.71	3.1
Multiple weedings	0.76	2.9
Cove		
Unweeded	0.60	6.1
One weeding	0.68	4.9
Multiple weedings	1.01	5.3

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0193

Ruth, Robert H. Plantation survival and growth in two brush-threat areas in coastal Oregon. Research Paper No. 17. Portland, OR: U.S. Department Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1956. 14 p.

Plantation development was followed on a 44-acre clearcut planted with 3-0 Douglas-fir near Florence, Oregon, and an 88-acre clearcut planted with 3-0 Sitka spruce, western hemlock, Douglas-fir, and Port-Orford-cedar in four plots each on burned and unburned areas near Otis, Oregon. The effect of five levels of shade from competing brush on seedling survival was studied on both plantations. Table 1 shows the results after 5 years.

Competition between planted trees and herbs, shrubs, and alder was intense. Although conifers continued to live under as much as three-fourths shading by competing vegetation, height growth was greatly retarded. Once trees are overtopped by brush, their chances for ultimate survival are negligible, unless released.

Table 1. Effect of shade on height growth and survival after 5 years

	Douglas-fir plantation at Florence		Mixed plantation at Otis	
	Average annual height growth (in)	Survival (%)	Average annual height growth (in)	Survival (%)
Not shaded	25.0	100	27.0	100
1/4 shaded	24.6	100	23.0	100
1/2 shaded	18.2	100	18.0	97
3/4 shaded	17.0	100	16.0	100
Overtopped	8.0	89	6.0	86

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0194

Ruth, Robert H. Ten-year history of an Oregon coastal plantation. Research Paper No. 21. Portland, OR: U.S. Department Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1957. 15 p.

A test plantation of 1,200 2-0 seedlings each of Douglas-fir, Sitka spruce, and Port-Orford-cedar was established in an old clearcut near Waldport, Oregon about 7 years after burning by wildfire. Annual mortality by shade class during the first 10 years appears in Table 1.

The study indicates that planted trees could tolerate side shade and some top shade but did not survive long when overtopped.

Table 1. Annual mortality by shade class over a 10-year period

Growing season	Annual mortality by shade class (percent) Not shaded	Side shade	Partly overtopped	Fully overtopped
1st	10	11	9	17
2nd	7	4	6	17
3rd	5	4	8	10
4th to 5th	0	2	3	7
6th to 10th	1	1	2	5
Weighted average	2.7	2.8	3.9	8.3

Abstract: Ronald E. Stewart

FPM83-0195
Sander, Ivan L. Bulldoze or disk to regenerate shortleaf pine in Kentucky. U.S. Forest Service Research Paper CS-8. Columbus, OH: U.S. Department Agriculture, Forest Service, Central States Forest Experiment Station; 1963. 12 p.

The study area is in the oak-pine stands on the Cumberland Plateau in eastern Kentucky. A seed tree harvest cut was made in 1956. Eight 2 1/4-acre plots were located on the site, site index 60. Each plot was divided into three subplots. Site preparation by bulldozing, by disking, and a control was done on each plot. Ten permanent, randomly located, milacre quadrats in each subplot were used to inventory the reproduction in the fall of 1957, 1958, and 1960. Other vegetation was measured in 1959.

Shortleaf pine seedlings and hardwood stems by site preparation method appear in Table 1.

Of the total number of pine seedlings on each treatment, the number free to grow was 4,300 on bulldozed plot, 2,000 on disked plots, and 500 on check plots.

Table 1. Effect of bulldozing and disking on regeneration of shortleaf pine

Years since treatment	Vegetation	Trees per acre		
		Bulldozed	Disked	Check
1	Pine	8700	6100	2250
4	Pine	9250	5300	2150
0	Hardwood stems	1500	3000	6600
4	Hardwood stems	5200	8900	8600

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0196

Sander, Ivan L.; Rogers, Robert. Growth and yield of shortleaf pine in Missouri: 21-year results from a thinning study. In: proceedings from Symposium for the Management of Pines of the Interior South. 1978 November 7-8; Knoxville, TN. Knoxville, TN: University of Tennessee; 1979: 14-27.

Hardwood understories were either left untreated or were controlled with herbicides in a 30-year-old natural shortleaf pine stand thinned to 70 square feet of basal area per acre. Plots were thinned again to 70 square feet at age 40 and 51. Results after 21 years appear in Table 1.

At age 51, the difference in net merchantable volume where hardwoods were controlled was 1400 board feet per acre on thinned plots and 2500 board feet per acre on unthinned plots. Hardwoods reduced growth and yield 8 to 12 percent.

Table 1. Effect of hardwood control on 30-year-old pine yield over a 21-year period

	Net periodic MAI (cu ft/acre/year)			Net periodic yield (cu ft/acre)		
Treatment	Years 31-40	Years 41-51	Years 31-51	Age 30	Age 40	Age 51
Unthinned						
Untreated	55	132	95	2,520	3,077	4,523
Treated	68	165	116	2,354	3,038	4,909
Thinned						
Untreated	60	106	84	2,446	3,050	4,213
Treated	83	125	104	2,278	3,105	4,480

Abstract: Ronald E. Stewart

FPM83-0197

Sander, Ivan L. The long term effects of releasing underplanted shortleaf pine from hardwood competition with 2,4,5-T and silvex. Unpublished progress report from a National Agricultural Impact Assessment Program study, on file. Columbia, MO: U.S. Department Agriculture, Forest Service, North Central Forest Experiment Station; 1980.

A study was established in Missouri in 1955 to test the effectiveness of 2,4,5-T and silvex for releasing shortleaf pine that had been planted in 1942 under a cull oak stand. The two herbicides were applied at 2 pounds acid equivalent (ae) per acre once (in 1955) or twice (in 1955 and 1957) by fixed-wing aircraft to four plots of about 8 acres each. An untreated plot of about 8 acres and a 1-acre plot treated with 16 pounds ae per hundred gallons 2,4,5-T as a foliage spray to plants less than 3 feet tall, as a cut stump spray to plants over 3 feet tall but less than 3 inches d.b.h., and as a frill treatment to stems over 3 inch d.b.h. were also established. All plots were thinned in 1967 and 1976.

Overstory oaks were also removed in the 1967 thinning of the untreated plot. All plots were remeasured in the fall and winter of 1979. Volume of numbered sample trees from the original study was determined. Data were also obtained to establish a d.b.h. to stump diameter relationship and to construct a local volume table. This information was used to estimate the volume of pine removed in the two thinnings from measurements of stump diameter.

Results 24 years after the initial treatment are shown in Table 1.

Yield of shortleaf pine on aerially sprayed plots is 29 to 44 percent greater than on the hand treated plot and about threefold greater than on the untreated plots. Furthermore, the remaining pine stands in treated plots contain larger, faster growing trees and should continue to yield greater volumes than the untreated plot.

Table 1. Basal area and net yield after 10 years by method of release

	Basal area per acre (sq ft/acre)		
	Pine	Hardwoods	Total
Untreated	37.6	39.2	76.8
2,4,5-T hand spray	76.6	8.4	85.0
2,4,5-T aerial spray - once	86.9	22.2	109.1
- twice	86.1	19.3	105.4
Silvex aerial spray - once	97.8	8.3	106.1
- twice	82.3	15.3	97.6

	Net yield of pine per acre (cu ft/acre)		
	Cut in thinning	1979 volume	Total volume
Untreated	87	694	781
2,4,5-T hand spraying	256	1446	1702
2,4,5-T aerial spray - once	741	1683	2424
- twice	544	1706	2250
Silvex aerial spray - once	468	1981	2449
- twice	565	1629	2194

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0198

Schlesinger, Richard C. Increased growth of released white oak poles continues through two decades. Journal of Forestry. 76(11): 726-727; 1978.

A study in pole-sized white oaks was established in 1954 on two areas in the Shawnee Hills of southern Illinois. Each area was divided into two potential productivity classes according to topographic position. The trees were further divided into two groups on the basis of their growth rate for the preceeding 10 years, as estimated from increment cores. One of three treatments -- no release, release, or release and prune -- was assigned to the individual trees within each stratum. The initial study included 196 trees, the final analysis was based on the 175 survivors.

During the first 10 years, the released trees grew from 59 to 96 percent more in diameter than unreleased trees. Although overall growth during the second decade was less, the released trees still grew from 75 to 114 percent more than those not released. The released trees accumulated almost twice as much diameter and more than twice as much basal area during the 20-year period. Pruned and released trees grew an average of 10 percent less in diameter than the trees that were released but not pruned. Results are presented graphically.

Abstract: Larry Gross

FPM83-0199

Schmidtling, R. C. Intensive culture increases growth without affecting wood quality of young southern pines. Canadian Journal of Forest Research. 3: 565-573; 1973.

An experimental plantation of 1-0 slash, loblolly, and longleaf pines from parent trees with high and average specific gravities was established about 20 miles north of Gulfport, Mississippi. The plantation was planted in a split plot design with four replications. Main plots were species, and completely randomized within each main plot were 10 subplots, five cultural treatments applied to the high and average specific gravity offspring. Cultural treatments were: untreated; cultivation only; cultivation plus 1000 pounds per acre of 10-5-5 NPK; cultivation plus 2000 pounds per acre of 10-5-5 NPK; and cultivation plus 4000 pounds per acre of 10-5-5 NPK. Dead seedlings on each plot were replaced at the end of the first growing season.

Cultural treatments strongly affected height, d.b.h. basal area, and volume after 9 growing seasons. Cultivation alone increased height of all species by about 6 feet. Results are presented in graphical form.

Abstract: Ronald E. Stewart

FPM83-0200

Schultz, Robert P. Intensive culture of southern pines: maximum yields on short rotations. Iowa State Journal of Research. 49(3, Pt.2): 325-337; 1975.

Summarizes results of published and unpublished studies of growth and yield from various intensive cultural practices including mechanical site preparation and weeding.

Abstract: Ronald E. Stewart

FPM83-0201

Schultz, Robert P. Environmental change after site preparation and slash pine planting on a flatwoods site. USDA Forest Service Research Paper SE-156. Asheville, NC: U.S. Department Agriculture, Forest Service, Southeastern Forest Experiment Station; 1976. 20 p.

The study area is a typical flatwoods site in Baker County, Florida. The soil is an imperfectly drained leon fine sand that was logged in 1968. In the spring of 1970, site preparation was accomplished in four ways: (1) no treatment, (2) burn only, (3) burn and double disk, and (4) burn, double disk, and bed. Genetically superior and unimproved commercial stock were planted after each of the four preparation treatments. Twenty-four treatment plots (each 30.5 x 21.3 meters) were established in a randomized block experimental design consisting of three replications, four site treatments, and two types of planting stock.

Site treatment significantly affected tree height which averaged 1.3, 1.1, 1.4, and 1.6 meters after 4 years for treatments 1, 2, 3, and 4 respectively. Site preparation did not influence inherent growth rate however. Table 1 shows first year survival.

Disking or bedding significantly increased tree survival when compared to the control.

Tip moth damage was significantly higher on bedded lots than in the other three treatments during the second growing season and was significantly higher in both disked and bedded plants during the third year. Overall damage was low, ranging from 2 to 8 percent with no trees killed.

Table 1. Effect of site preparation on first year survival of slash pine

Treatment	Genetically superior stock (percent)	Commercial stock (percent)
1 Control	68	55
2 Burn	81	61
3 Burn and disk	90	70
4 Burn and disk and bed	90	72

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0202
Shipman, Robert D. Pine released by various weeding methods. Southern Lumberman. 189(2369): 125-126; 1954.

See: Shipman, Robert D., 1954.

FPM83-0203

Shipman, Robert D. Release of loblolly pine by various weeding methods. Research Notes Number 65. Asheville, NC: U.S. Department Agriculture, Forest Service, Southeastern Forest Experiment Station; 1954. 2 p.

See: Shipman, Robert D., 1954.

A weeding study was conducted on 1/40th-acre plots of 3-year-old natural loblolly pine seedlings averaging 2 1/2 feet tall on the Santee Experimental Forest near Charleston, South Carolina. Several control treatments using one part 2,4,5-T in 29 parts of kerosene were compared with the conventional method of cutting back competitors with a machete. All plots were thinned to 40 pines overtopped by 3- to 12-foot high competing hardwoods and brush. Results after four growing seasons are in Table 1.

Hand cutting alone produced a satisfactory degree of release at half the cost of complete release. There is no need for a second weeding, and the cost of chemical does not appear justified in terms of increased survival and growth of released loblolly pine seedlings. Only about one out of five overtopped seedlings were able to outgrow the brush without some form of release treatment.

Table 1. Cost and effect of loblolly pine release methods on pine growth after 4 growing seasons

Method of release	Relative cost (percent)	Seedlings free to grow (percent)	Average total height (feet)
Untreated	0	22	4.9
Hand cut, no herbicide	100	71	6.7
No cutting, basal spray	124	80	7.2
No cutting, brush herbicide on stems	188	70	7.6
Hand cut and spray stumps	194	97	8.8

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0204

Shipman, R. D. Preparing planting sites with herbicides. Tree Planters' Notes. Winter: 1-4; 1974.

Eleven chemical treatments plus controls were replicated three times on 18.6-square-meter plots at each of four central Pennsylvania old-field test sites. The herbicides were sprayed or spread between May 3 and 13, 1969. Two-year-old Japanese larch seedlings and cuttings of 1-year-old hybrid poplar were hand planted from April 11 to 25, 1970. Six seedlings were planted in each plot.

Table 1 shows height growth of planted seedlings after 3 years.

Table 1. Effect of using herbicides in site preparation on growth of planted seedlings after 3 years

	Height growth of seedlings (centemeters)			
Species	Untreated	High herbicide application	Medium herbicide application	Low herbicide application
Japanese larch	-	532	224	313
Hybrid poplar	277	678	660	588

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0205

Shirley, Hardy L. Restoring conifers to aspen lands in the Lake States. USDA Technical Bulletin No. 763. Washington, DC: U.S. Department of Agriculture; 1941. 36 p.

Four plots were treated in 1927 in a 39-year-old aspen stand containing white pine seed trees and a fair stocking of pine seedlings. Aspen was treated as follows: clearcut; 50 percent cut; 30 percent cut; and not cut.

Results after 10 years appear in Table 1.

Ten years after cutting, pine seedlings were less numerous than at the beginning and, except where clearcutting and brush cutting had been practiced, still averaged only about 1 foot in height. Aspen did not act as a nurse crop to favor establishment or growth of pine seedlings; instead, it smothered and suppressed them.

In a second study, 25- to 35-year-old white pines 18 feet tall were released from 35-year-old aspen and birch in 1931. Release treatments were: (1) uncut; (2) 45 percent cut; and (3) clearcut. Results after 5 years are shown in Table 2.

The pines had grown well the first 10 to 20 years, though not so rapidly as these species grow in pure stands. During the next 10 years, however, height growth averaged less than 6 inches per year and progressively declined.

Reduced growth was due to destruction of the leaders by aspen branches. The average tree had had its terminal destroyed three times. The pines immediately thickened their crowns and resumed rapid growth after removal of the aspen in 1931.

Table 1. Effect of release from aspen on growth of pine after 10 years

Treatment	Pine seedlings per acre 1927	Pine seedlings per acre 1936	Average height (ft) 1930	Average height (ft) 1936
Uncut	200	40	0.50	0.80
30 percent cut	1320	900	0.44	1.14
50 percent cut	749	579	0.53	0.89
Clearcut	448	149	0.63	1.95

Table 2. Effect of release from aspen on growth of pine after 5 years

Treatment	Pine trees per acre 1931	Pine trees per acre 1936	Average height (ft) 1931	Average height (ft) 1936	Basal area (sq ft/acre) 1931	Basal area (sq ft/acre) 1936
Uncut	226	175	17.6	20.8	6.85	7.34
45 percent cut	231	206	18.1	21.8	7.67	10.56
Clearcut	315	259	21.3	25.0	14.48	19.37

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0206

Shoulders, Eugene. Release underplanted loblolly early. Southern Forestry Notes No. 100. New Orleans, LA: U.S. Department Agriculture, Forest Service, Southern Forest Experiment Station; 1955. 4 p.

Loblolly pine planted in central Louisiana under a hardwood stand consisting of 330 stems per acre of blackjack and post oak was released at planting or 1 and 2 years after planting. Double hack girdles or ammate applied to notches cut in the trunk at groundline were equally effective.

Results at plantation age 7 are in Table 1.

Complete release (removal of all hardwoods over 0.4 inches d.b.h.) did not give better pine survival and growth than did partial release (removal of hardwoods more than 3 inches d.b.h.). Immediate release is needed for best survival and growth of underplanted loblolly pine seedlings.

Table 1. Effect of immediate and delayed release on loblolly pine survival and height growth after 7 years

Time of release	Survival (percent)	Total height (feet)
Unreleased	46	9.5
Released at planting	82	16.0
Released after one season	46	14.5
Released after three seasons	46	13.0

Abstract: Ronald E. Stewart

FPM83-0207

Show, S. B. Some results of experimental forest planting in northern California. Journal of Ecology. 5: 83-94; 1924.

Detailed regeneration surveys were conducted on extensive plantings on unburned and burned brushfields on the Shasta National Forest in northern California. Sample rows were established 5 or 10 chains apart through ponderosa and sugar pine plantations originally planted between 1912 and 1920. Each tree on the row was marked with a numbered stake and examined three times the first year, twice the second, and once the third year after planting. Shade conditions, ground cover, species of brush forming cover, seedling condition, and cause of death or injury were recorded for each seedling.

Effect of various degrees of shading on survival of several age classes of ponderosa pine and for 1-1 sugar pine and 1-2 giant sequoia are presented in tables. Data are also shown for effect of ground cover on quality of planting, effect of shade on height growth, and effect of species of brush on success of planting.

The study conclusions were:

1. Brush cover increases survival and the benefit of shade is greater on poor sites, for less drought-resistant species, and for poorer stock.
2. The quality of work done in planting improves as the brush cover decreases.
3. The influence of different species of brush is found to vary greatly. Manzanita is least detrimental to planting success while chinquapin and snowbrush ceanothus were most detrimental.
4. Increased shading results in increased height growth.
5. Early spring planting gives the largest survival.
6. Large nursery stock within a given age class gives better survival.
7. Rodents seriously damage fall plantations and those established on areas more than 3 years after burning.

Abstract: Ronald E. Stewart

FPM83-0208

Smalley, Glendon W. Girdle or fell oaks to release pines? Southern Forestry Notes No. 122. New Orleans, LA: U.S. Department Agriculture, Forest Service, Southern Forest Experiment Station; 1959. 4 p.

Loblolly pines planted in February 1956 under southern red oak near Birmingham, Alabama, were left unreleased or were released either by girdling or felling the oaks. Ammate was applied to all girdles or stumps to reduce resprouting. Table 1 shows results after 3 years.

Table 1. Effect of release on survival rate and height growth of loblolly pine after 3 years

Release method	Survival (percent)	Total height (feet)
Unreleased	27	1.7
Girdled	91	7.5
Felled	94	7.7

Abstract: Ronald E. Stewart

FPM83-0209

Smalley, Glendon W. Development of pine-hardwood stands in north Alabama following improvement cuttings. U.S. Department Agriculture Forest Service Research Paper SO-100. New Orleans, LA: U.S. Department Agriculture, Forest Service, Southern Forest Experiment Station; 1974. 9 p.

Mixed oak, hickory, shortleaf pine, Virginia pine, and longleaf pine stands in Jefferson County, Alabama, were treated with three intensities of stand improvement: (1) a commercial improvement cut to remove all merchantable hardwoods (COM); (2) removal by cutting or girdling of all low-value trees less than 5.5 inches d.b.h. if they were competing with desirable trees (6IN); and (3) removal by cutting or girdling of all undesirable trees 1.6 inches d.b.h. and cutting of trees more than 1.6 inches if they were overtopping desirable reproduction (2IN). Uncut check plots (CHK) were also established. Ten and 14 years later, pines were released on one-half of the plots (COMREP, 6INREP, 2INREP) and the third treatment (2IN), which had produced the best response, was applied to one-half of the check plots as a deferred intensive treatment the 10th year (2INDEF). The original study consisted of eight replications of four treatments randomized in four blocks. After the repeat treatments were applied, the design consisted of eight treatments in each of four blocks. Results after 19 years (1948-66) are in Table 1.

Volume increment averaged 4 percent on the untreated check during the 19 years, 16 percent on COM plots where only low-value merchantable hardwoods were removed, 22 percent on 6INREP plots which removed culls and undesirable trees less than 5.5 inches d.b.h., and 65 percent on 2INREP plots where all undesirable trees less than 1.5 inches d.b.h. were removed.

Table 1. Development of pine-hardwood stands following improvement cutting over a 19-year period

Cutting treatment	Stand MAI (cu ft/ acre/yr)	Pine MAI (cu ft/ acre/yr)	Stand volume (cu ft/ acre)	Pine volume (cu ft/ acre)
CHK	11.2	6.9	482	219
COM	20.4	17.8	515	438
COMREP	21.4	19.1	511	473
6IN	21.0	17.4	563	474
6INREP	25.0	23.7	570	539
2IN	29.2	28.0	654	627
2INREP	39.4	37.9	804	775
2INDEF	20.4	18.3	432	428

Abstract: Ronald E. Stewart

FPM83-0210

Smith, Lloyd F. Early results of a liberation cutting in a pine-hardwood stand in northern Louisiana. Journal of Forestry. 45(2): 278-282; 1947.

In 1933, a liberation cutting on a tract of second-growth pine and hardwoods on former longleaf pine land in northern Louisiana felled 51 hardwoods and effectively girdled 22 more per average acre. An examination 7 years later showed that:

(1) The treated stand averaged 320 pines per acre not overtopped, in contrast to only 126 on the check area.

(2) The treated area had 520 living hardwood 1 inch d.b.h. and larger per acre, exclusive of sprouts from treated trees, compared with 538 per acre on the check, but there were more "free" hardwoods on the treated stand.

(3) Forty-six percent of the completely girdled trees had dead tops and no sprouts. Ninety-five percent of those felled had sprouted.

(4) Most of the treated hardwoods still living had from 2 to 5 sprouts per tree.

(5) The tallest sprouts had averaged about 2 feet in height growth annually. Healthy loblolly and shortleaf seedlings 2 feet high or more at the time of liberation in the same stand grew faster than this; hence liberation cutting will release such pines permanently.

(6) Most of the completely girdled hardwoods had broken off at the girdle.

(7) Of the pines released, only 5.1 percent were damaged by hardwoods following treatment.

(8) Estimated future yields of pine, pulpwood, and sawtimber give the liberated stand a definite financial advantage starting about 20 years after liberation, and increasing greatly beyond 25 years. With good markets and good management, a liberation cutting of this kind usually could be paid for out of a commercial cutting within 10 years.

Abstract: Larry Gross

FPM83-0211

Smith, L. F.; Schmidtling, R. C. Cultivation and fertilization speed early growth of planted southern pines. Tree Planters' Notes. 21(1): 1-3; 1970.

In 1958-59 a site was clearcut on an upland fine sandy loam in the Bowie and Shubuta series about 50 miles north of the Gulf Coast in southern Mississippi. Four site treatments, i.e., cultivation with and without three rates of fertilizer application, were compared with an untreated control. Cultivated areas were cleared of all stumps and slash, then plowed and disked. On the control area, stumps, soil, and competing vegetation were not disturbed.

In February and March 1960, 1-year-old seedlings were planted at 10- by 10-foot spacing on 60 plots. Plots were arranged in four random blocks for replication. In 1961 and 1962, all trees were sprayed with Bordeaux mixture and DDT to control needle disease and tip moths. On the cultivated plots, disking was done three times each year for 3 years after planting; the plots were mowed in the fourth and fifth growing seasons.

Fifth-year survival and average tree heights for cultivated and control plots are shown in Table 1.

Brown spot heavily infected control seedlings through the fifth year. In contrast the disease was light on all cultivated plots.

Table 1. Effect of cultivation on survival and growth of southern pine after 5 years

	Control		Cultivated	
Species	Survival (%)	Height (ft)	Survival (%)	Height (ft)
Longleaf pine	63.8	1.16	80.5	2.40
Slash pine	64.3	6.16	77.3	8.86
Loblolly pine	76.5	6.84	85.8	8.67

Abstract: Larry Gross

FPM83-0212

Spaeth, J. Nelson. Notes on release of white pine in Harvard Forest, Petershaumn, Massachusetts. Journal of Forestry. 20(2): 117-121; 1922.

Two contiguous 1/4-acre plots were established in the spring of 1915 on the Harvard Forest in Massachusetts, to determine the effect of improvement cutting on eastern white pine. The stand selected was representative of young pine and inferior hardwood (mostly grey birch and red maple) on an average site. Total height, d.b.h., health, and crown classes were recorded for each tree. The total number of living pines was 97 on one plot and 107 on the other plot, while the percentages of normal healthy trees were 51 percent and 39 percent, respectively. Trees were released on the plot with the lowest percentage of healthy trees, removing the equivalent of 9 cords per acre of wood. The other plot was left untreated.

The percentage of healthy pine trees before and 5 years after treatment is given in Table 1.

The number of trees left in a healthy condition on the release plot is sufficient to make a well-stocked stand at the end of a 60-year rotation. On the control plot, however, the number of trees in a healthy state shows a considerable decrease and the present number is far too few even to make a stand of normal density even though all the pines on the area could be released and recovered.

Based on another study, it was concluded that there is a practical height for the white pine at which, if the hardwoods are removed, the released pine will not need further attention. If the overstory of hardwood is removed before the pine has attained this height, a second removal cutting is necessary. This height for upland pasture pine on Quality II site, is 15 feet for pines if grey birch is the principal species in mixture or 12 feet if red maple predominates.

Table 1. Effect of release treatment on health of white pine five years after treatment

	Proportion of healthy pines (percent)	
	Before treatment	After treatment
Released	39	45
Unreleased	51	22

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C. : U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0213
Starr, John W. The importance of long term research in forestry. Down to Earth. 28(1): 30-32; 1972.

Two "forties" were established on the Mississippi State University School Forest to assess intensive management in natural upland flatwood pine stands. Growing stock in plots on one "forty" was cut back to 1,500, 3,000, and 4,500 cubic feet per acre and maintained at these levels by periodic cuts at 3-year intervals. All hardwoods were eliminated by injection with 2,4-D amine and basal spraying with 14 pounds acid equivalent per hundred gallons of 2,4,5-T ester in diesel oil. Reinvading hardwoods were controlled by basal spraying at 3-year intervals. The "natural forty" was not managed and was only protected from fires. Table 1 shows the results from permanent growth plots in each of the 40-acre compartments after 11 years.

Removal of all hardwoods not only favorably effects growth, but seed production of pines and several other variables in a forest stand as well. The "natural forty" will revert to the oak--hickory type while the "managed forty" will remain in pine as long as the hardwoods are held in check. About 30 percent of the annual growth (28 cubic feet per acre per year out of 93 cubic feet per acre per year) is in low-grade hardwoods on the "natural forty".

Table 1. Pine growth on managed and unmanaged plots over an 11-year period

	Basal area (sq ft/acre)		Present volume (cu ft/acre)		Total volume growth	MAI
	Pine	Hardwood	Pine	Total	(cu ft/acre)	(cu ft/acre/yr)
Natural forty	107	46	2954	3794	1029	93
Managed forty	93	0	2570	2570	1598 *	145

* Includes 800 cu ft/acre removed in thinnings

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0214

Steneker, G. A. Results of a 1936 release cutting to favor white spruce in a 50-year-old white spruce-aspen stand in Manitoba. Canada Department of Forestry Publication No. 1005. Winnipeg, Manitoba: Department of Forestry, Forest Research Branch, Manitoba, Saskatchewan, District Office; 1963. 17 p.

A study was established in 1936 on the Duck Mountain Forest Reserve, Manitoba, Canada, to assess the effects of two degrees of release on spruce volume production. The stand was established on a day-loam glacial till following a fire in the late 1880's. Principal tree species in 1936 were white spruce and aspen, with smaller amounts of jack pine, black spruce, balsam poplar, and white birch. Two 1/4-acre plots were subjected to a light and a heavy release cutting respectively. Trees competing with or overtopping white spruce were removed. Although most of the trees cut were aspen and jack pine, a small number of white and black spruce in the lower diameter classes were also removed. The light release cutting resulted in removal of 44 percent and the heavy release cutting of 60 percent of the total basal area. A third plot was retained as a control.

Results for white spruce and the total stand (all species) in 1957, 21 years after release, are shown in Table 1.

Light and heavy release almost doubled total volume of white spruce compared to untreated stands. Merchantable volume of white spruce was almost double that of control on the light release plot and almost triple on the heavy release plot. For all species, no cutting gave the largest total volume in cubic feet and heavy cutting gave the smallest. Heavy cutting resulted in only a slightly greater board foot volume than no cutting. Net total and board foot volume increments of white spruce were more than doubled and more than tripled respectively, as a result of the heavy release cutting. Diameter increment increased for all species as a result of the release cutting, with the heavy release producing the greatest increase. Of all species, white spruce grew the fastest. Height increment of white spruce was doubled as a result of release; that of other softwoods was increased only slightly.

Table 1. Effects of release on spruce volume production after 21 years

Degree of release	Species	Basal area (sq ft/acre)	Total volume (cu ft)	Merchantable volume (cu ft)
Control-	White spruce	44	844	1,510
no release	All	213	4,797	8,040
Light	White spruce	70	1,439	2,601
release	All	148	3,243	5,610
Heavy	White spruce	70	1,502	4,230
release	All	136	2,981	8,180

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C. : U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0215

Steneker, G. A. Growth of white spruce following release from trembling aspen. Forest Research Branch Publication No. 1183. Winnipeg, Manitoba: Canada Department Forestry and Rural Development; 1967. 16 p.

Between 1951 and 1954, a series of eight experimental release cuttings were made in 15- to 60-year-old stands in Manitoba and Saskatchewan to determine the effects of partial and complete removal of the aspen upon the development of the white spruce understory. The experimental areas were located within stands typical of the Mixedwood Forest Section at Riding Mountain, Manitoba and Reserve, Candle Lake, Montreal Lake, and Big River, Saskatchewan. All stands originated after fire. Site conditions were similar on the various areas. Topography is flat to gently rolling and the soils are well-drained glacial tills varying in texture from silty clayey loams to clayey loams. Growth data were obtained from 1/10-acre permanent sample plots. Two plots were chosen at each location as controls and two for release from which all aspen were removed. Two additional plots were chosen at both Bertwell and Reserve for partial release from which 50 percent of the aspen were removed by systematically cutting every other stem.

Ten-year diameter, basal area, height, and cordwood volume production are shown graphically.

Ten-year growth results of eight experimental release cuttings to favor white spruce in spruce-aspen stands, ranging in age from 15 to 60 years, have shown that:

1. Diameter increment of spruce can be doubled by removing the aspen canopy.

2. Height increment of spruce under immediate overhead suppression and in physical contact with the aspen crowns, can be doubled by release

3. The combined stimulus to height and diameter increment from release can increase merchantable volume production of spruce by about 60 percent.

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0216

Sterrett, J. P.; Adams, R. E. The effect of forest conversion with herbicides on pine (Pinus spp.) establishment, soil moisture and understory vegetation. Weed Science. 25(6): 521-523; 1977.

A study was installed in a mixed oak and black gum stand near Blacksburg, Virginia, to determine the effects of soil-applied fenuron at 5.6 and 11.2 kilograms per hectare and stem-injected 2,4,5-T on pine establishment, soil moisture, and understory vegetation. Treatments were replicated four times in a randomized block design. Plots were planted with 25 2-year-old eastern white pine seedlings 1 year after treatment. Table 1 shows survival 4 months and height 16 months after planting.

The poorest survival occurred in plots treated with 11.2 kilograms per hectare fenuron and needles of dying trees showed typical chlorotic symptoms. Since white pine is more shade tolerant than most pines, it is not surprising that unreleased trees survived as well as released trees. The average height difference of 16 to 18 centimeters between treated and untreated trees was significant.

Table 1. Survival rate and height growth of white pine by type of treatment

Treatment	Survival after four months (percent)	Height after 16 months (cm)
Untreated	88	25
Fenuron - 5.6 kg/ha	88	43
- 11.2 kg/ha	60	41
2,4,5-T	86	43

Abstract: Ronald E. Stewart

FPM83-0217

Stewart, R. E.; Beebe, T. Survival of ponderosa pine seedlings following control of competing grasses. In: Proceedings of 1974 Western Society of Weed Science, Vol. 27. Lanai, Oahu, Hawaii: Western Society of Weed Science; 1974: 55-58.

During April, 1972, a study was installed at several locations on the Entiat Ranger District, Wenatchee National Forest to determine effects of various grass control treatments on survival of newly planted ponderosa pine. Five study sites were selected: 2 sites with heavy-textured residual soils, and 3 sites with lighter-textured pumice soils. Average precipitation was 18 to 24 inches and elevations ranged from 2400 to 3400 feet.

At each study area six plots were installed. Each plot consisted of a line of five contiguous 1/100-acre (21 x 21 feet) subplots. One of six treatments was then randomly assigned to each plot in a randomized block design with the five study areas as blocks. Treatments were: (1) none-control (2) scalp, (3) 2 pounds acid equivalent pronamide per acre, (4) 2 pounds acid equivalent terbacil per acre, (5) 4 pounds acid equivalent atrazine per acre, and (6) 5 pounds acid equivalent dalapon per acre.

Herbicidal sprays were applied between April 19 and 21, using knapsack sprayers, formulated in 2 gallons of water to each 1/100-acre subplot. Sixteen 2-0 ponderosa pine seedlings were planted on each subplot within 4 days after spraying.

Pine survival and herbicidal effect on grasses were highly influenced by soil type. Both grass control and survival of ponderosa pine seedlings were greater on pumice soils than on residual soils, but the influence of grass control on survival was greater on residual soils.

Initial grass control and second year grass cover and seedling survival appear in Table 1.

Table 1. Effect of grass control on survival of ponderosa pine seedlings after 2 years

Treatment	Soil type	First year grass control (percent)	Second year cover (percent) Grass	Forb	Second year ponderosa pine survival (percent)
None	Residual	-	68	17	3
	Pumice	-	75	13	39
Scalp	Residual	-	74	12	13
	Pumice	-	71	7	40
Pronamide	Residual	0	70	19	16
	Pumice	0	69	9	23
Terbacil	Residual	28	46	20	21
	Pumice	90	13	16	31
Atrazine	Residual	2	52	13	20
	Pumice	64	27	4	62
Dalapon	Residual	78	24	34	21
	Pumice	73	26	17	58

Abstract: Larry Gross

FPM83-0218

Stoeckeler, J. H.; Limstrom, G. A. Reforestation research findings in northern Wisconsin and upper Michigan. U.S. Department of Agriculture Forest Service Station Paper No. 23. St. Paul, MN: U.S. Department Agriculture, Forest Service, Lake States Forest Experiment Station; 1950. 34 p.

Results are reported from a series of studies of response of northern conifers to various degrees of manual release on the Nicolet National Forest in Wisconsin. Response of individual species was related to shade tolerance: intolerant species such as jack pine, red pine, and Scotch pine develop poorly under a cover of aspen, paper birch, or other broadleaf trees. Even the more tolerant white pine and Norway spruce suffer reduced survival and growth. White spruce tolerates more cover and may even survive better but grow less under aspen or birch than in the open.

A number of hardwood and conifer species were planted under a medium cover of aspen (5500 stems per acre) in 1938 and released in 1940. Release treatments included reduction in herbaceous vegetation around each tree and cutting of the aspen-pin cherry overstory at three intensities: 100 percent removal; 80-90 percent removal; and 50 percent removal. Various classes of planting stock were tested with four replications of 200 trees each for each class and a total of 12,800 trees.

Results for conifer species after 9 years appear in Table 1.

In another study, one or two releases applied 2 and 4 years after planting were compared for jack pine and red pine. This test showed that jack pine requires heavier release and will tolerate less shade than red pine. The results after 10 years for two or more replications of 200 trees for each age class of stock are given in Table 2

Jack pine does best in full sunlight and should be freed from practically all overhead competition within a year after planting. A light uniform cover of aspen or brush, allowing about 80 percent of full sunlight, can be maintained for 1 or 2 years after planting and will reduce mortality in drought years.

An experiment on an upland sandy loam involving two types of scalps as compared with furrowing showed considerable advantage in both survival and growth for three pine species when planted in furrows; spruce, however, showed better survival in scalps. Comparisons were generally based on two or more replications usually of 1,500 or more trees for each ground preparation method and species. Standard scalps were about 24 inches square.

Special scalps were of the same size but all roots to a depth of 8 inches were removed. Results after 10 years are shown in Table 3.

Table 1. Survival rate and height growth after 9 years by degree of release

Species and class of stock	Survival rate (percent)				Height (feet)			
	Degree of release				Degree of release			
	100%	80-90%	50%	0%	100%	80-90%	50%	0%
2-0 Jack pine	88	87	87	36	11.3	9.9	9.1	1.1
2-1 Scotch pine	100	94	86	63	7.7	7.7	6.5	3.6
Red pine	86	78	92	65	6.7	6.1	6.6	4.9
White pine	70	64	57	44	5.1	4.4	5.2	3.8
3-1 Norway spruce	72	62	61	36	2.2	2.2	1.7	1.4
White spruce	91	80	91	86	3.7	3.6	4.5	4.1
1-0 Red oak	81	80	70	84	2.0	3.8	2.4	1.7

Table 2. Survival rate and height growth by age class and degree of release

Species and class of stock		1 low and 1 high release		1 low release only	
		Survival (percent)	Height (feet)	Survival (percent)	Height (feet)
Jack pine	1-0	58	9.7	27	8.7
	1-1	77	10.6	50	9.2
	2-0	62	10.4	51	7.3
	Average	66	10.2	43	8.4
Red pine	2-0	44	4.2	51	3.4
	2-1	57	5.5	49	4.6
	2-2	70	6.2	66	5.3
	Average	57	5.3	55	4.4

Table 3. Survival rate and height growth by age class species, and preparation method after 10 years

Species and class of stock		Standard scalp Survival (percent)	Standard scalp Height (feet)	Special scalp Survival (percent)	Special scalp Height (feet)	Furrows Survival (percent)	Furrows Height (feet)
Jack pine	2-0						
	1-0	53	10.4	63	11.7	72	12.5
Red pine	2-0	37	4.8	42	5.6	45	5.9
White pine	2-0	45	5.0	44	5.1	49	5.2
White spruce	3-0	39	4.1	30	4.3	27	4.7
Norway spruce	2-3-1	--	--	55	6.9	48	5.7
European larch	3-0	--	--	--	--	27	5.1
Red oak	seed	--	--	--	--	8	2.9

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0219

Stoeckeler, Joseph H. Ground preparation costs and first-year survival of planted red pine in southwestern Wisconsin. U.S. Forest Service Research Note LS-28. St Paul, MN: U.S. Department Agriculture, Forest Service, Lake States Forest Experiment Station; 1963. 4 p.

In 1962 a study involving 40 rows of 100 trees each was initiated on the Coulee Experimental Forest near La Crosse, Wisconsin to compare two age classes and five methods of ground preparation and planting. A prescribed burn was conducted in 1961, the year before planting, and all sumac and scattered brush were cut and piled. Site preparation treatments used in the study were: (1) contour bench terraces, (2) single furrow plow, (3) double furrow plow, (4) Lowther planting machine, and (5) 10-inch hand scalp. There was no control treatment. Site preparation methods were applied to eight rows each. Survival of planted 3-0 and 2-4 red pine after one growing season is recorded in Table 1.

The only significant differences in survival between ground preparation methods were in 3-0 red pine where both the Lowther method and single furrow were better than scalps. When trees were classified by vigor, there was an overall advantage in favor of transplants over seedlings; all comparisions of vigor also favor furrowing of some type over scalps.

Table 1. Effect of various ground preparation methods on first-year survival of red pine

Ground-preparation method	First year survival (percent) 3-0 pine	2-1 pine
Bench terrace	90.0	95.2
Single furrow	94.0	96.0
Double furrow	89.5	91.7
Lowther	93.0	95.5
Scalp	84.7	94.5

Abstract: Larry Gross

FPM83-0220

Stone, Douglas M. Growth of red pine planted on a northern hardwood site. USDA Forest Service Research Note NC-210. St. Paul, MN: U.S. Department Agriculture, Forest Service, North Central Forest Experiment Station; 1976. 4 p.

Competing hardwoods were removed from a red pine conversion planting by five hand cuttings during the first 10 years after planting 2-1-2 stock. Results after 46 growing seasons are shown in Table 1.

Results indicate that merchantable volume production on some well-drained northern hardwood sites could be doubled by intensive management of red pine.

Table 1. Effect of release on survival and growth of red pine after 46 years

	Survival (percent)	MAI (cu ft/acre/yr)	Merchantable volume (cu ft/acre)
Not released	25	73	3,360
Released	70	190	8,720

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0221
Stransky, J. J. Site preparation effects on soil bulk density and pine seedling growth. Southern Journal of Applied Forestry. 5(4): 176-179; 1981.

The objectives of this study were to measure and compare soil bulk density and pine growth on 3 sites that had been prepared by burning, chop and burn, KG blading, and slash piled and burned, and control. All 3 sites were located on the middle coastal plain of Texas. The study used a randomized block design consisting of three adjacent blocks and 4 site treatments on each of the 3 sites. Individual site treatment plots were 0.6 hectare squares. Loblolly pine 1-0 seedlings were planted at 2.4 x 3 meter spacing on all blocks.

Three years after site preparation, bulk density on both the chopped and KG-bladed plots was still significantly higher than on the control and burn treatments.

Table 1 shows results after 5 growing seasons.

Even though the soil bulk density was increased by KG-blading and chopping, the short-term effects, if any, on pine-seedling survival and growth were largely masked by the overall positive responses of the seedlings to reduced competition from other woody plants.

Table 1. Effect of site preparation on survival and growth of pines after 5 growing seasons

	Site treatment			
Survival and growth	Control	Burn	Chop	KG
Survival of pines (%)	57.0	63.0	79.0	87.0
Height of pines (cm)	297.0	282.0	349.0	351.0
Diameter of pines (cm)	3.0	3.1	4.4	4.7
Height of hardwoods (cm)	204.0	184.0	150.0	126.0
Number of hardwoods (m/ha)	11.54	9.57	8.73	4.96

Abstract: Larry Gross

FPM83-0222
Stransky, John J. Vegetation response to various methods of site preparation. Unpublished progress report on study FS-SO-1751-2.1. Nacogdoches, Texas: USDA Forest Service, Southern Forest Experiment Station, 1983.

See: Stransky, J. J.; Halls, L. K., 1981; and Stransky, J. J., 1981.

Data are presented on the survival and growth response of planted 1-0 loblolly pines to four site preparation methods following clearcutting of the residual pine-hardwood stand on the Stephen F. Austin Experimental Forest near Nacogdoches, Texas.

Four site treatments were: (1) control, (2) burning, (3) chopping with a Marden chopper, (4) KG blading. Seedlings were hand-planted in January 1975. Table 1 shows the counts and measurements in late January 1983, eight growing seasons after planting.

A second study was established to determine survival and growth of planted 1-0 loblolly pines to four site preparation methods following clearcutting of the residual pine-hardwood stand on International Paper Company's Cherokee Wildlife Management Area near Wells, Texas.

The four site treatments were: (1) control, (2) burning, (3) chopping with a Marden chopper, and (4) KG blading. Seedlings were hand-planted in February and March 1975. Counts and measurements in early February 1983, eight growing seasons after planting, are given in Table 2.

Table 1. Effect of site preparation on survival rate and growth of pine after an 8-year period

Study 1	Site treatments			
Survival and growth	Control	Burn	Chop	KG
Survival (%)	46.0	58.0	82.0	91.0
Height (cm)	605.0	615.0	732.0	834.0
Diameter (cm)	7.0	7.0	10.0	12.0
Pines overtopped (%)	24.6	21.1	5.0	0.0
Pines suppressed (%)	13.2	11.5	2.5	0.0
Snow damage (%)	0.0	2.1	0.9	0.7
Tip moth damage (%)	0.0	1.0	0.8	0.0
Fusiform rust (%)	1.5	8.0	6.0	6.5
Trees with cones (%)	0.0	1.0	0.0	1.5

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C. : U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

Table 2. Effect of site preparation on survival rate and growth of pine over an 8-year period

Study 2 Survival and growth	Site treatments Control	 Burn	 Chop	 KG
Survival (%)	52.0	39.0	64.0	73.0
Height (cm)	573.2	497.5	656.7	741.1
Diameter (cm)	8.8	7.3	10.5	12.4
Pines overtopped (%)	9.9	16.5	4.1	0.0
Pines suppressed (%)	4.1	11.1	2.2	0.0
Snow damage (%)	0.0	0.0	1.3	0.9
Tip moth damage (%)	5.5	15.8	12.5	9.8
Black turpentine beetle (%)	1.2	0.0	2.5	1.0
Southern pine beetle (%)	0.0	0.0	0.9	0.0
Fusiform rust (%)	1.4	3.6	8.6	11.9
Trees with cones (%)	7.7	13.9	5.4	7.4

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C. : U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0223
Strothmann, R. O. The influence of light and moisture on the growth of red pine seedlings in Minnesota. Forest Science. 13(2): 182-202; 1967.

A study was installed on the Cutfoot Experimental Forest in north-central Minnesota in a dense stand of residual hazel brush. Fifteen 1-0 red pine seedlings were assigned to each of six treatments combining two levels of light and three levels of soil moisture arranged in a completely randomized design. The treatments were: (1) control; (2) trenching only; (3) trenching plus supplemental watering; (4) no trenching, surrounding brush tied back; (5) trenching, surrounding brush removed by clipping; and (6) trenching plus supplemental watering, surrounding brush removed by clipping. To prevent subsequent root invasion, a sheet-metal cylinder was inserted in the trench. Competing vegetation within the trenched area was pulled out before planting, and any regrowth was clipped at weekly intervals.

Measurements were made on seedlings for two growing seasons after planting. The first growing season was wetter than normal while the second season was drier than normal. Height growth and patterns of terminal shoot and needle elongation are shown graphically. Data on needle, bud, stem, root characteristics, and dry matter production are displayed in tables.

Two-year data on stem diameter and dry matter production are shown in Table 1.

The elimination of either form of competition improved all aspects of seedling growth, but the removal of competition for light invariably produced a larger growth response than did the removal of competition for moisture. No unshaded seedlings died during the two-year study whereas 38 percent of the shaded seedlings died regardless of whether they were trenched or untrenched. Best growth resulted when both forms of competition were eliminated.

Table 1. Influence of light and moisture on growth of red pine after 2 years

	Not trenched	Trenched	Trenched and watered
Stem diameter (mm)			
Shaded	3.4	4.0	8.1
Unshaded	5.1	8.6	8.1
Dry weight per seedling (grams)			
Shaded	1.9	2.9	2.0
Unshaded	7.0	28.4	23.9

Abstract: Ronald E. Stewart

FPM83-0224

Stubblefield, George; Oliver, Chadwick D. Silvicultural implications of the reconstruction of mixed alder/conifer stands. In: Utilization and management of alder. Proceedings of a symposium. USDA Forest Service General Technical Report PNW-70. Portland, OR: U.S. Department Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1978: 307-320.

Mixed alder/hemlock/redcedar/Douglas-fir stands which began growth after a 1927 logging fire were studied on till soils of the Marckworth Forest of the central Washington Cascades. Trees were mapped and sectioned on six one-fiftieth-acre plots; stocking stem quality, and crown class were determined on 31 plots. The stand was always sparely stocked, and essentially all stems had begun within 20 years of the disturbance. Red alders were the same age or up to 17 years younger than the associated conifers on the same plot, although conifers were usually in a subordinate position. For analyses of site index, stocking, and growth rates, it cannot be assumed that the alders are the same age as the initiating disturbance.

Douglas-fir were found growing on or near only those plots in which they had started 10 years prior to the alder. It is probable that no Douglas-fir would be found on the site if the alders had all invaded when the first conifers did. A 10- to 12-year delay in alder invasion was needed for western redcedar to reach the upper canopy when grown with alder unless the cedar were allowed sufficient spacing to gain the necessary height advantage before the alders closed in. Western hemlock outgrew the alder at times if the alder was delayed 8 to 10 years.

If it is desirable to establish conifers, alder should be eliminated until crown closure of the conifers or until they have a 10-year head start. Another alternative may be dense planting of conifers with later precommercial thinning. Mixtures of alder, hemlock, and cedar may be grown by allowing all three species to enter at the same time. However, alder will outgrow the other two species on good sites.

Abstract: Ronald E. Stewart

FPM83-0225

Tackle, D.; Roy, D. F. Site preparation as related to ground cover density in natural regeneration of ponderosa pine. Technical Paper No. 4. Berkeley, CA: U.S. Department Agriculture, Forest Service, California Forest and Range Experiment Station; 1953. 13 p.

The study was designed to measure germination, survival, and height growth of seedlings in relation to ground cover density. The study was conducted on the Blacks Mountain Experimental Forest in northeastern California. Six areas of about 0.2 acres each were scarified with an offset disk-harrow. Seedling germination, survival, and height growth were sampled on milacre quadrats arranged in transects.

Germination, survival and height growth by ground cover density are in Table 1.

Results suggest that ponderosa pine seedbed preparation should be aimed at eliminating all competing ground cover and exposing loose mineral soil.

Table 1. Effect of ground cover density on natural regeneration of ponderosa pine

Ground cover density	Seeds germinating per acre	Seedling survival fourth year (percent)	Average height fourth year (inches)
Bare	33,329	33	5.6
Light	11,420	11	2.3
Medium	3,816	4	3.2
Heavy	2,914	4	2.5

Abstract: Larry Gross

FPM83-0226
Tarrant, Robert F. Stand development and soil fertility in a Douglas-fir--red alder plantation. Forest Science. 7(3): 238-246; 1961.

See: Miller, Richard E; Murray, Marshall D., 1978; also Berntsen, Carl M., 1961.

FPM83-0227
Tiarks, A. E.; Haywood, J. D. Response of newly established slash pine to cultivation and fertilization. Southern Forest Experiment Station Research Note SO-272. New Orleans, LA: U.S. Department Agriculture, Forest Service, Southern Forest Experiment Station; 1981. 4 p.

An experiment was established to examine the response of slash pine to varying degrees of cultivation by hoeing and to fertilization with nitrogen, phosphorus, and potassium. The study site, in central Louisiana, had been clearcut, chopped, and burned. Vegetation, mainly grasses and forbs, had completely occupied the site.

Slash pine seedlings, 1-0 bare root nursery stock, were graded for uniformity and hand planted in February 1974 at 1.5-foot intervals in eight rows 150 feet long and 10 feet apart. In April 1974, four of the rows were selected at random and fertilized with 200 pounds N, 200 pounds P_2O_5 and 70 pounds of K_2 per acre. The amount of cultivation was varied from none to complete by handhoeing a wedge shaped pattern along each row. The cultivated areas were kept free of competition for 3 years.

At the end of the first and second year every other tree was cut off at ground level leaving an effective spacing of 6 x 10 feet for the 3rd and 4th year. All trees were cut at the end of the fourth year for analysis.

Values for cultivation are estimated by regression and represent no weed control and complete control. Four year growth of slash pine as affected by cultivation and fertilization is shown in Table 1.

After 4 years, fertilization alone and complete competition control alone were about equally effective in improving biomass production. When both treatments were applied, biomass production increased 347 percent.

Table 1. Effect of cultivation and fertilization on growth of slash pine over a 4-year period

Cumulative growth after 4 years	Unfertilized		Fertilized	
	Uncultivated	Cultivated	Uncultivated	Cultivated
Root collar dia. (inches)	2.7	3.6	3.6	5.1
Height (feet)	8.5	9.2	10.5	14.4
Volume of main stem(cu in)	214.0	330.0	354.0	921.0
Total biomass (lbs/tree)	5.3	9.0	9.0	23.7
Weight of needles and branches (lbs/tree)	2.6	4.6	4.2	11.3

Abstract: Larry Gross

FPM83-0228
Tiarks, Allan E. Effect of site preparation and fertilization on slash pine growing on a good site. In: Jonew, Earle P., Jr., ed. Proceedings of the Second Biennial Southern Silvicultural Research Conference; November 4-5, 1982; Atlanta, GA. General Technical Report SE-24. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station 1983: 34-39

The study was located in Rapides Parish, Louisiana, on a site occupied by native grasses and scattered small hardwoods. The soil is moderately well-drained Beauregard silt loam. Site preparation and fertilizer treatments were applied in a split plot design. Site preparation treatments consisting of check, flat disking, and bedding, were applied to the main plots which were 116 x 148 feet. The check plots were burned several weeks before planting. Four fertilizer treatments were applied to subplots of each main plot. The treatments were: no fertilizer; 1,000 pounds per acre of lime; 88 pounds per acre of phosphorus; and the lime and phosphorus treatments combined. The fertilizers were broadcast by hand just before site preparation, and planting was delayed one season to allow the beds to settle. Slash pine 1-0 seedlings were planted and all dead trees were replaced with 1-1 stock at the end of the first growing season. Measurements were made on 24 pines in the middle of each subplot.

Effects of site preparation treatments on diameter and volume of slash pine at ages 4 through 13 (average of all lime and phosphorous treatments) are presented in Table 1.

The site preparation treatments and phosphorus fertilization increased tree height through age 13. Bedding increased height by 1.0 feet at age 3 and by 2.1 feet at age 10. However, by age 13 the trees on bedded plots were only 1.4 feet taller than trees on the check plots. The flat disking increased height growth about half as much as bedding up to age 10. By age 13, the advantage of bedding over disking was no longer significant. Bedding also increased tree diameter before age 13. Flat disking was marginally better than no mechanical site preparation up to age 10. Neither treatment was significantly better than the check by age 13.

The severe incidence of fusiform rust in the stand precludes growing susceptible slash pine on the site under any level of culture. While bedding caused a small increase in infection, the inherent level of infection is too high to make this a realistic difference. However, because rust often does not significantly affect tree growth until stem breakage occurs, the growth data should still be valid for comparison purposes. In the present study, the difficulty in measuring a small response in growth was confounded by a large mortality due to rust in later years, with the greatest losses occurring on plots with the largest trees.

Table 1. Effect of site preparation on diameter growth and volume of slash pine at ages 4 through 13

	Average d.b.h. (inches)			Total volume (cu ft/acre)		
Age	Check	Disk	Bed	Check	Disk	Bed
4	1.31	1.56	1.72	33	48	62
7	3.71	3.89	4.08	518	584	666
10	4.73	4.91	5.08	1040	1180	1170
13	5.64	5.76	5.98	1560	1750	1670

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0229
Todhunter, Michael N.; Beineke, Walter F. Effect of fescue on black walnut growth. Tree Planters' Notes. 30(3): 20-23; 1979.

The objective of this study was to determine the effect of tall fescue on the growth form, and survival of planted black walnut seedlings in contrast to seedlings growing in a natural, uncontrolled ground cover of forbs. Black walnut seedlings were planted in Parke County, Indiana, in the spring of 1971. Fescue grass was well established on part of the plantation at the time of planting. The remainder of the planting had a dense ground cover of approximately 70 percent forbs, 20 percent mixed grasses, and a few small clumps of bramble and woody vegetation. For the first 2 years after outplanting, simazine and atrazine were sprayed to control weeds in a 4-foot diameter circle around each tree. The study was analyzed as a two-way factorial with walnut family (progeny) and condition (fescue or no fescue) as the main factors.

At some later date (date not stated) trees growing in the fescue were compared to trees in the non-fescue area. Results after an unstated period of time are recorded in Table 1.

Fescue had a highly significant effect on height, sweep, diameter, and volume, but did not influence survival. Without fescue, the height almost doubled and diameter tripled. The volume was nearly five times greater without fescue. The data indicate that black walnut growth is greatly reduced by fescue when compared to a naturally occuring mixed ground cover.

Table 1. Effect of fescue on black walnut survival and growth

	Ground cover		
Survival and growth	Fescue present	Fescue absent	Improvement (percent)
Height (ft)	5.99	10.48	75.0
Sweep (ft)	0.15	0.09	46.7
D.b.h. (in)	0.53	1.57	196.2
Volume (cu ft)	0.0271	0.1323	388.2
Survival (%)	78.5	79.1	0.6

Abstract: Larry Gross

FPM83-0230

Tonn, Jonalea R.; Graham, Russell T. The effect of brush competition and plastic mulch on moisture stress of planted Douglas-fir. Research Note INT-320. Ogden, UT: U.S. Department Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 1982. 3 p.

The objective of the study was to determine how brush and black plastic mulch affect seedling survival, soil temperature, and plant moisture stress of newly planted Douglas-fir seedlings. The study was established in a 30-acre south-facing brushfield on the Priest River Experimental Forest in northern Idaho. The study was divided into 3 blocks with 3 treatments per block. The treatments were: brush, 3 x 3 feet plastic mulch, and 3 x 3 feet open areas free from brush. In the spring of 1980, 2-0 Douglas-fir seedlings were planted.

The area had above normal rainfall in May, July, August, and September. At the end of one growing season, there was no difference in seedling survival, plant moisture stress, or soil temperature among the three treatments. Survival also did not vary by slope position.

Abstract: Larry Gross

FPM83-0231
Trousdell, Kenneth B. Disking and prescribed burning: Sixth-year residual effects on loblolly pine and competing vegetation. USDA Forest Service Research Note SE-133. Asheville, NC: U.S. Department Agriculture, Forest Service, Southeastern Forest Experiment Station; 1970. 6 p.

In Sussex and Southampton Counties, Virginia, the effects of disking and of three series of prescribed burns on crown coverage and height of regenerating loblolly pine and competing hardwoods and shrubs were compared after 6 years. Each of eight 40-acre plots of 60-year-old loblolly pine was subjected to one of four site preparations before logging: (1) one winter burn followed by one summer burn; (2) one winter burn followed by two annual summer burns; (3) one winter burn followed by three annual summer burns; and (4) disking.

Results indicate that: (1) hardwood coverage was significantly less on sites subjected to three summer burns than on sites subjected to one summer burn; (2) pines were taller than hardwoods on all sites; and (3) hardwood and pine coverage were negatively correlated. Data after 6 years are presented graphically.

Abstract: Larry Gross

FPM83-0232
Vincent, A. B. Release of balsam fir and white spruce reproduction from shrub competition. Silvicultural Leaflet No. 100. Ottawa, Canada: Canada, Department Northern Affairs and National Resources, Forestry Branch, Division Forest Research; 1954. 4 p.

See: Baskerville, G. L., 1961; also Baskerville, G. L., 1959.

FPM83-0233

Von Althen, F. W. Effects of weed control on the survival and growth of planted black walnut, white ash, and sugar maple. The Forestry Chronicle. 47(4): 223-226; 1971.

This paper reports the results of three studies carried out to determine the effects of various weed control treatments upon the early survival and growth of planted black walnut, white ash, and sugar maple.

All seedlings were planted in a former agricultural field located on a flood plain of the Ausable River near Parkhill in southern Ontario. All planting was done in the spring after the field had been plowed and tilled the previous autumn. No controls were included in any of the studies.

Study 1. Sixteen black walnut (1+0), white ash (2+0), and sugar maple (2+0) seedlings were planted per treatment in the spring of 1966 in a randomized block arrangement with four replications. Treatments consisted of: a) mulching with a 4-foot-wide cover of black polyethylene film, .004 inches thick; b) rototilling in June and July of the first year; c) rototilling in June and July of the first 2 years after planting; and d) a single application of 3 pounds per acre active Simazine sprayed in 3-foot-wide band shortly after planting.

Study 2. Twenty black walnut (1+0), white ash (2+0), and sugar maple (2+0) seedlings were planted in each treatment in the spring of 1967 in randomized block arrangement with three replications. Treatments consisted of: a) mulching with a 4-foot-wide cover of black polyethylene film, .004 inches thick; and b to e) a single application of active Simazine (wettable powder) at a per acre dosage of 3, 6, 9, or 12 pounds.

Study 3. Nine black walnut (1+0) seedlings were planted in each treatment in the spring of 1966 in a randomized block arrangement with six replications. Treatments consisted of: a) mulching with a 4-foot-wide cover of black polyethylene film, .004 inches thick; b) mulching with a 4-foot-wide cover of clear polyethylene film, .004 inches thick; c) mulching with a 3-foot-wide cover of black polyethylene film, .0015 inches thick; d) mulching with a 3-foot-wide cover of clear polyethylene film, .002 inches thick; and e) manual weeding in June and July of the first year after planting.

All treatments controlled weed growth effectively during the first year, but only 4-foot-wide covers of black polyethylene, 9 and 12 pounds per acre dosages of active Simazine or rototilling for 2 years provided an effective relief from competition during the third year. Three-year survival and height growth by study and treatment is present in Table 1.

Black walnut and white ash obtained their highest cost benefits when 3 pounds of active Simazine were used.

Table 1. Effect of weed control on the survival and growth of planted black walnut, white ash, and sugar maple after 3 years

	Survival (percent)			Height growth (inches)		
Treatments	Walnut	Ash	Maple	Walnut	Ash	Maple
Study 1						
Black polyethylene 4 ft wide	89	89	20	21	32	0
Rototilled for 1 year	94	86	19	15	21	0
Rototilled for 2 years	93	86	33	31	38	10
Active Simazine 3 lb/acre	92	66	17	13	14	0
Study 2						
Black polyethylene 4 ft wide	95	98	23	28	45	4
Active Simazine 3 lb/acre	100	100	3	25	30	4
Active Simazine 6 lb/acre	98	65	8	30	18	10
Active Simazine 9 lb/acre	95	40	25	39	11	12
Active Simazine 12 lb/acre	100	27	5	34	9	3
Study 3						
Black polyethylene 4 ft wide	91	-	-	25	-	-
Clear polyethylene 4 ft wide	87	-	-	23	-	-
Black polyethylene 3 ft wide	93	-	-	19	-	-
Clear polyethylene 3 ft wide	78	-	-	19	-	-
Manual weeding	68	-	-	18	-	-

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0234

Von Althen, F. W. Eight-year results of an afforestation study. Forestry Chronicle. 48(2): 325-326; 1972.

This report represents the 8-year survival and growth data for an afforestation study established in 1964 near Richmond Hill, Ontario.

One half of a hayfield with a clay soil was plowed and disked in autumn before spring planting. In the other half of the field, a scalp 18 inches in diameter was removed at each prospective planting spot at time of planting. Twelve seedlings of 1+0 sugar maple, 2+0 red oak, 1+0 black locust, 2+0 basswood, 2+0 white ash, 2+0 silver maple, and 12 transplants of 2+2 white pine and 2+2 white spruce were planted by spade at a spacing of 3 x 3 feet, in each of 28 plots. Each plot covered an area of 0.037 acres. Shortly after planting, ammonium nitrate, triple superphosphate and potassium sulphate were broadcast on the surface in the following amounts (pounds of active ingredient per acre): level A: N-75, P-40, K-40; level B: N-150, P-80, K-80; level C: N-300, P-160, K-160. Granular simazine was applied alone and together with the fertilizer in dosages of 3, 6, and 12 pounds of active ingredient per acre.

The following 14 treatments were therefore applied in each of the two site preparation areas: plots 1 and 2 (control), no fertilizer or herbicide applied; plots 3-5, Simazine applied at 3, 6 and 12 pounds per acre, respectively; plots 6-8, fertilization at level A plus Simazine applied at 3, 6 and 12 pounds per acre, respectively; plots 9-11, fertilization at level B plus Simazine applied at 3, 6 and 12 pounds per acre, respectively; plots 12-14 fertilization at level C plus Simazine applied at 3, 6 and 12 pounds per acre, respectively.

All sugar maple, basswood, and red oak seedlings were browsed by rabbits each winter, causing multiple shoots. Therefore they were not evaluated.

Satisfactory survival (with the exception of white spruce) and growth occured only on plowed and disked plots that were also treated with herbicide or herbicide plus fertilizer.

Table 1 presents the average survival and height growth under two intensities of site preparation. Table 2 shows the effect of herbicide after plowing and disking.

Table 1. Effect of site preparation on survival and height growth of afforestation after 8 years

Species	Plowed and disked Survival (percent)	Plowed and disked Height growth (feet)	Scalped Survival (percent)	Scalped Height growth (feet)
Black locust	74	14.9	39	5.2
Silver maple	80	9.8	66	3.7
White ash	69	9.7	45	2.1
White pine	75	4.1	76	3.2
White spruce	58	4.5	54	2.3

Table 2. Effect of herbicide and fertilizer on 8-year growth

Height growth by type of treatment (feet)

Species	Control	Herbicide only	Herbicide plus fertilizer Level A	Level B	Level C
Black locust	10.0	15.5	15.5	13.5	18.5
Silver maple	1.5	9.0	10.5	12.0	12.0
White ash	3.5	6.5	12.5	10.0	13.0
White pine	3.0	4.8	4.0	4.1	4.5
White spruce	3.3	4.4	4.4	5.2	4.9

Diameter growth by type of treatment (inches)

Species	Control	Herbicide only	Herbicide plus fertilizer Level A	Level B	Level C
Black locust	0.91	1.92	2.28	1.70	2.22
Silver maple	0.0	0.76	1.01	1.08	1.21
White ash	0.0	0.38	1.00	0.90	1.07
White pine	--	--	--	--	--
White spruce	--	--	--	--	--

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0235

Von Althen, F. W. Site preparation and post-planting weed control in hardwood afforestation: white ash, black walnut, basswood, silver maple, hybrid poplar. Canadian Forest Service Report O-X-325. Sault Ste. Marie, Ontario: Canadian Forestry Service, Department of the Environment, Great Lakes Forest Research Centre; 1981. 22 p.

This report presents the five-year results of studies on the effects of site preparation and post-planting weed control on the survival and growth of planted 1+0 black walnut, 2+0 basswood, 2+0 white ash, 2+0 silver maple and cuttings of the hybrid poplar clone I 45/51 (P x euromaericana). The study was carried out in a former field near Hornby, Halton County, Ontario.

All hardwood seedlings were planted by machine and the cuttings were planted with a dibble in the spring of 1976. Site preparation treatments consisted of plowing and disking one part of the area in its entirety and broadcast application of pronahide, plowing and disking strips of different widths to one side or from either side to the middle, rototilling or spraying a strip with paraquat, and a control. Post-planting weed control consisted of applications of simazine shortly after planting and in April of the next two years over the total area plowed and disked in its entirety, or applied in strips of different widths over the plowed and disked, rototilled and paraquat strips and the control.

The experiment was laid out in a randomized block design with 12 seedlings or cuttings per species in each of eight treatments replicated three times for a total of 288 seedlings or cuttings per species. Effects of site preparation and post-planting weed control on the survival and height growth of planted basswood, black walnut, white ash, and silver maple seedlings and hybrid poplar cuttings 5 years after planting are shown in Table 1.

Table 1. Effects of site preparation and weed control on hardwood survival and growth after a five-year period

Site Preparation	Annual simazine application	Basswood Survival (%)	Basswood Height growth (cm)	Black Walnut Survival (%)	Black Walnut Height growth (cm)
Control, no treatment	Continuous band 1.2 m (4 ft) wide	86	61	92	52
Continuous band of paraquat 1.2 m (4 ft) wide shortly before planting	Continuous band 1.2 m (4 ft) wide	89	50	92	52
Three furrows plowed from either side to the middle and disked	Continuous band 1.2 m (4 ft) wide	94	63	97	103
Six furrows plowed to one side and disked	Continuous band 1.2 m (4 ft) wide	94	92	94	99
Rototilled strip 1.8 m (6 ft) wide	Continuous band 1.8 m (6 ft) wide	89	94	100	69
Six furrows plowed from either side to the middle and disked	Continuous band 2.7 m (9 ft) wide	94	94	94	130
Nine furrows plowed to one side and disked	Continuous band 2.7 m (9 ft) wide	92	118	100	124
Total area plowed and disked several times; Pronomide broadcast in autumn before planting	Broadcast over total area	100	184	97	160

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

Table 1. (continued)

Site preparation	Annual simazine application	White ash Sur-vival (%)	White ash Height growth (cm)	Silver maple Sur-vival (%)	Silver maple Height growth (cm)	Hybrid poplar Sur-vival (%)	Hybrid poplar Height growth (cm)
Control, no treatment	Continuous band 1.2 m (4 ft) wide	67	105	50	24	0	0
Continuous band of paraquat 1.2 m (4 ft) wide shortly before planting	Continuous band 1.2 m (4 ft) wide	94	71	97	56	8	79
Three furrows plowed from either side to the middle and disked	Continuous band 1.2 m (4 ft) wide	94	164	97	96	53	210
Six furrows plowed to one side and disked	Continuous band 1.2 m (4 ft) wide	94	170	100	93	92	234
Rototilled strip 1.8 m (6 ft) wide	Continuous band 1.8 m (6 ft) wide	89	163	100	99	92	240
Six furrows plowed from either side to the middle and disked	Continuous band 2.7 m (9 ft) wide	100	193	75	100	66	239
Nine furrows plowed to one side and disked	Continuous band 2.7 m (9 ft) wide	78	182	100	163	87	279
Total area plowed and disked several times; Pronomide broadcast in autumn before planting	Broadcast over total area	97	250	100	384	94	670

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0236
Wahlenberg, W. G. Planting pine among brush. The Timberman. 1927 March.

See: Wahlenberg, W. G., 1930.

FPM83-0237
Wahlenberg, W. G. Effect of ceanothus brush on western yellow pine plantations in the northern Rocky Mountains. Journal of Agricultural Research. 41(8): 601-612; 1930.

See: Wahlenberg, W. G., 1927.

Eighteen hundred 1-2 ponderosa pine were planted in April 1926 on an east slope having a typical evenly scattered cover of snowbrush ceanothus near Haugan, Montana. The area had been burned in 1910 and most shrub stems were within 2- to 4-feet high. Six hundred well distributed shrubs were selected and three trees were planted on the slope just below each shrub. One tree was planted well under the crown, one was placed at the outer edge of the crown, and one was planted in the open. Soil moisture, evaporation, humidity, and soil temperature at these three locations were also measured. Survival and condition of planted pines in August 1926, after one growing season show in Table 1.

Trees planted closely under the brush survived best during the dry season following spring planting. The evaporating power of the air in the shade of the shrubs was less than half that in the adjacent open areas. On, calm, clear days relative humidity in the shade was greater, soil moisture was greater, maximum and minimum soil temperatures were less, and the range in both air and soil temperatures was less under ceanothus than in the open. Experience indicates that ceanothus is a desirable nurse plant for ponderosa pine, but the long-term effect on growth once trees are established is not known.

Table 1. Effect of ceanothus brush on survival of ponderosa pine during one growing season

	Condition (percent)		Survival
	Thrifty	Unthrifty	(percent)
Under ceanothus	80	9	89
Edge of crown	57	11	68
Open	40	13	53

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0238

Wahlenberg, W. G.; Doolittle, W. T. Reclaiming Appalachian brush lands for economic forest production. Journal of Forestry. 48(3): 170-174; 1950.

Quarter- and half-acre test plots in Georgia and North Carolina were established in stands of laurel and rhododendron and planted with eastern white pine. Site treatments included complete grubbing; cutting, piling, and burning of brush; clearing lanes; and clearing spots. Lane and spot clearings were tried both with and without supplemental grubbing of roots. On untreated check plots, white pine failed to produce a stand. Results after 14 years appear in Table 1.

Hand grubbing was exorbitant in relation to its benefits. Partial clearing followed by planting can be nearly as effective as complete clearing if properly done. Pines should be planted in the center of lanes cleared to a width equal to three-quarters of the height of the shrubs.

Table 1. Survivial rate and height growth of white pine after 14 years by type of treatment

Treatment	Survival (percent)	Average height (ft)
Complete clearing		
cut, pile, burn	64	13.0
cut and grub	54	14.5
Lanes		
clear	58	9.3
cut and grub	60	8.9
Spots		
clear	61	6.7
cut and grub	63	7.8

Abstract: Ronald E. Stewart

FPM83-0239
Waldron, R. M. Hazel foliage treatments to reduce suppression of white spruce reproduction. Forest Research Division Technical Note No. 75. Ottawa, Canada: Canada Department Northern Affairs and National Resources, Forestry Branch; 1959. 17 p.

In May 1954, six 1/40-acre plots were established on the Riding Mountain Forest Experimental Area on upland till soils in Manitoba, Canada. The area contained dense beaked hazel, scattered mature white spruce and over-mature aspen. Each plot was planted with 49 3-2 white spruce transplants. In August, three plots were sprayed with 2,4-D in water applied with a garden pressurized sprayer at a concentration of 1,875 parts per million. The remaining three plots were left as controls. The survival and height of the spruce on all six plots were recorded in the spring of 1958. Results after 4 years are in Table 1.

Differences in both survival and height between treated and untreated were highly significant despite herbicide injury to 55 percent of the surviving spruce.

In August 1950, eight 1/10-acre plots and one 1/100-acre plot were treated with one of six herbicide treatments: 2,4-D at 30 ounces per acre (2 plots) and 60 ounces per acre; 2,4,5-T at 30 ounces per acre (2 plots) and 60 ounces per acre; 2,4-D plus 2,4,5-T at 30 ounces per acre each; and ammate at 800 and 1,600 ounces per acre. Herbicides were applied in water using a garden pressurized sprayer. Heights and annual height growth of natural white spruce present on the plots and on the surrounding untreated area were measured in 1958, 7 years after treatment. Results are presented in Table 2.

Height growth on the treated plots was greater than on the untreated area, but the increased growth did not occur until 4 years after treatment. Differences in height growth between treated and untreated trees were increasing with time in this study of natural reproduction and in the study of planted white spruce. Slightly over 50 percent of the spruce present on the treated plots in 1950 were taller than the surrounding hazel sprouts in 1956; all were under the hazel in 1950. On the untreated area, the hazel was still taller than most of the spruce reproduction. There was no visible herbicide damage on any of the natural white spruce in any of the treated plots.

Table 1. Effect of foliage treatment on survival and height growth of spruce over a 4-year period

	Survival (percent)	Height (inches)
Untreated	28.6	11.1
Sprayed with 2,4-D	57.1	16.6

Table 2. Effect of herbicide on white spruce growth compared to hazel growth

	Tree height comparison (number of trees)		Height of trees (feet)	
	Treated	Untreated	Treated	Untreated
Taller than hazel	19	-	4.6	-
Even with hazel	8	9	3.8	4.9
Shorter than hazel	7	26	2.7	2.9

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0240

Waldron, R. M. The effect of preplanting ground treatment on early survival and growth of planted white spruce. Tree Planters' Notes. 65: 6-8; 1964.

In 1952, an experiment was established at the Riding Mountain Experimental Area in Manitoba to test the effectiveness of two preplanting ground treatments on the early survival and growth of white spruce transplants planted on a moderately well-drained, grey-wooded soil with a clay-loam texture. The planting site supported a few scattered mature white birch and a continuous well-developed cover of beaked hazel. Two treatments, scalping to mineral soil and disking with an Athens plow, and an untreated control, were randomly assigned to one of three 50 foot square plots. Treatments were replicated three times. A total of 1,944 white spruce of two age classes, 2-2 stock averaging 6 inches in height and 3-2 stock averaging 9 inches in height, were planted in rows with a 4-foot spacing. Survival after 10 years is shown in Table 1.

Transplant survival was highest on the scalped plots and about equal on the undisturbed and disked plots, and reflected the intensity of vegetative competition on the areas. The overall height in 1961 was not related to age of planting stock or type of preplanting ground treatment. These results suggest that in dry years and on exposed, well-drained clay-loam sites on the Riding Mountain Forest Experimental Area, planting small stock on machine-made scalped plots will enhance the possibilities of obtaining well-stocked plantations.

Table 1. Effect of preplanting ground treatment on survival of white spruce over a 10-year period

	Survival rate (percent)		
	2-2 stock	2-3 stock	Average
Untreated	40	35	37
Scalped	67	39	54
Disked	46	23	35

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0241
Walker, Laurence C. Early scrub-oak control helps longleaf pine seedlings. Journal of Forestry. 52(12): 939-940; 1954.

A study was installed during the winter of 1948-49 in the Escambia Experimental Forest and the Conecuh National Forest in southern Alabama. Two general site-classes were sampled: (1) a relatively productive deep loamy sand or shallow sandy loams with heavy subsoil and (2) deep sandy soils recognized as poor longleaf sites. A randomized block design was used at three locations. Paired blocks were installed on a poor site on the Escambia, on a good site on the Escambia, and on a good site on the Conecuh. Each block was divided into square 1/10-acre plots to which the various treatments were randomly assigned. Treatments included no release and release of natural longleaf pine seedlings from a heavy 1947 seed crop from a dense overstory of scrub oaks using ammate when seedlings were from 1 to 4 years of age. Seedling data were taken from 100 quarter-milacre subplots in each 1/10-acre plot. All plots were prescribe burned for brown spot control when the seedlings were 2 and 4 years old. When the seedlings were 3 years old, the quarter-milacre subplots were thinned to a maximum of three seedlings each.

Table 1 shows average root collar diameters of 4-year-old seedlings.

Release one year after germination produced faster root-collar diameter growth than did more delayed treatment. Four-year-old seedlings that had been released at 1 year of age averaged about 56 percent larger in diameter than those never released. Early oak control is more effective on poor sites than on good sites. Survival of pines released after 1 year of growth was 98 percent while only 76 percent of the subplots in the unreleased area had living seedlings.

In a supplemental study on a good and a poor site, overstory scrub oak control 1 year before germination and the year of germination were compared with no release. Table 2 shows root-collar diameters of 1-year-old seedlings.

Release at germination produced larger 1-year-old seedlings than did either release 1 year prior to germination or no release. Control of oaks ahead of seedfall permits herbs and grass to become established and replace the hardwoods as competitors.

Table 1. Effect of site condition and early release on longleaf pine root collar diameter after 4 years

	Average root collar diameter (inches)			
	Escambia		Conecuh	
Time of release	Poor site	Good site	Good site	All sites
No release	0.25	0.34	0.41	0.34
At age 1	0.48	0.46	0.62	0.53
At age 2	0.39	0.39	0.58	0.46
At age 3	0.32	0.32	0.46	0.37

Table 2. Effect of site condition and timing of release on pine root collar diameter growth after 1 year

	Average root collar diameter (inches)		
Time of release	Poor site	Good site	Both sites
No release	0.11	0.16	0.14
1 year before germination	0.15	0.16	0.15
At germination	0.18	0.24	0.21

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0242
Walters, Russell S. Conversion planting on poor hardwood sites shows promise in Ohio. U.S. Forest Service Technical Paper 168. Columbus, Ohio: U.S. Department Agriculture, Forest Service, Central States Forest Experiment Station; 1959. 5 p.

In 1954, a study was begun on the Vinton Furnace Experimental Forest in southeastern Ohio to test the possibility of clearcutting low quality ridgetop oak-hickory stands for conversion to pine. The ridges have shallow surface soil and a fine-textured, plastic subsoil. The hardwoods were completely clearcut during the fall and winter of 1953 on three blocks, each consisting of two 1/2-acre plots. The plots were then planted to a mixture of shortleaf, pitch, and eastern white pine the following spring. The planted pines were released in half the plots in the summer of 1954 by cutting the sprouts from around the pines and spraying the stumps with a mixture of 34-D and 2,4,5-T in diesel oil. A second release was made in the summer of 1956.

Results for the first 5 growing seasons after planting are presented graphically.

Although white pine survived best, survival on all plots was adequate: 80 percent in released plots and 71 percent on unreleased plots after 5 years. Pine survived best on the poorest site and poorest on the best site. Apparently, the better the site the more competition the hardwood sprouts offer to the pines. After 5 years, 43 percent of the living white pine and 71 percent of the living shortleaf and pitch pines are "free to grow" without having had the benefit of a release treatment. Apparently the planted pines are able to outgrow the brush and sprout competition. The average height of trees on released plots is significantly greater than on unreleased plots, but the actual difference is small (somewhat more than 1 foot for shortleaf and pitch pine and about 6 inches for white pine after 5 years). The trends in the graph of height growth suggest that the differences may be increasing with time, however.

Early release is not justified on these poor sites although it may be necessary to release portions of a plantation to insure a more even distribution of the pines. On better sites, where hardwood competition is more severe, release probably would be required.

Abstract: Ronald E. Stewart

FPM83-0243

Walters, Russell S. Coniferous understory influences sugar maple (Acer saccharum Marsh.) sap production. Forest Service Research Paper NE-398. Broomall, PA: U.S. Department Agriculture, Forest Service, Northeastern Forest Experiment Station 1978. 5 p.

This study was installed on two adjacent portions of a sugarbush in the town of Essex in Chittendon County, Vermont to evaluate the effects of a conifer understory on syrup production. Each area covered about 0.5 hectare. One area was an open parklike stand with no conifers (open sugarbush). The other area was heavily populated with conifers that were cut and removed (cut sugarbush).

Before the conifers were removed, the maple trees in each portion of the sugarbush were tapped and the sap was collected over a 3-year calibration period. All conifers larger than 2.5 centimeters in diameter were removed from the cut area. The 28 highest-yielding trees in each area were selected for comparison of sap yield. Sap was collected for 9 years after the removal of the conifers.

During the 3 sap seasons of the calibration period and the 3 years following treatment, an average of 14 percent less sap was collected from the trees in the cut sugarbush. In the sixth sap season after treatment and each year thereafter, the annual average sap volume from the cut sugarbush was slightly greater than that from the open sugarbush.

The understory removal did stimulate radial growth. In the cut sugarbush the radial growth averaged 16 millimeters per year after treatment compared to 11 millimeters per year before conifer removal.

Abstract: Ronald E. Stewart

FPM83-0244

Wendel, G. W. Converting hardwoods on poor sites to white pine by planting and direct seeding. USDA Forest Service Research Paper NE-188. Upper Darby, PA [Station now at Broomall, PA]: U.S. Department Agriculture, Forest Service, Northeastern Forest Experiment Station; 1971. 19 p.

Two site-paired plots each of 50-year-old oak near Parsons, West Virginia, were underplanted in 1954 with 3-0 white pine seedlings in three site strata; oak site index 59 (lower slope), site index 53 (middle slope), and site index 45 (upper slope). One paired plot was untreated and on the other the overstory was girdled immediately after planting. After four growing seasons, a second release was applied to half of each treated plot. Table 1 presents the results in 1968, after 15 growing seasons.

On similar sites, excellent survival of underplanted pine can be maintained for at least 15 years. After 15 years on areas with an oak site index of about 45, 40 percent of the pines will be free to grow if the overstory is killed at planting time; on areas of oak site index 60, only half as many pines will be in this position. Two releases on the highest quality site equalled the effect of one on the poorest site.

Table 1. White pine survival rate, height and diameter growth after 15 years by degree of release

Site index, growth and survival	Degree of release		
	No release	One release	Two releases
Site index 59			
Survival (%)	88.2	80.5	--
Height (ft)	4.4	13.3	18.1
D.b.h. (in)	0.17	1.43	2.47
Site index 52			
Survival (%)	91.1	96.1	--
Height (ft)	6.1	11.7	18.2
D.b.h. (in)	0.43	1.17	2.25
Site index 45			
Survival (%)	90.5	93.6	--
Height (ft)	6.4	18.8	19.1
D.b.h. (in)	0.45	2.30	2.49

Abstract: Ronald E. Stewart

FPM83-0245

Wenger, Karl F. Growth and prospective development of hardwoods and loblolly pine seedlings on clearcut areas. Station Paper No. 55. Asheville, NC: U.S. Department Agriculture, Forest Service, Southeastern Forest Experiment Station; 1955. 19 p.

A study of the development of hardwoods after clearcutting was made on the Bigwoods Experimental Forest, Hertford County, North Carolina. Two methods for studying hardwood development were used. The first concerned the area occupied by new hardwood growth in relation to time since cutting, soil characteristics, and seedbed preparation. The second dealt with height growth and lateral expansion, in relation to the same factors of age, soil, and seedbed, of five species of hardwood sprout clumps deemed the most serious competitors of pine seedlings.

The area occupied by the new hardwood growth was estimated on square 1/10-acre plots by the line-intercept method. Sixty-seven plots were distributed over three soil groups, two soil surface conditions and several ages of hardwood sprout growth based on time since clear cutting the pine stand.

Findings of the study:

1. Fire increased growth of hardwood cover on well-drained soil.
2. Hardwood sprouts from winter cuttings grew as fast or faster than sprouts from summer cuttings.
3. Hardwood crown width and height increased in direct proportion to total height.
4. Loblolly pine seedlings respond to release and grow well.
5. Release significantly increased the percentage of seedlings that became dominant.
6. Liberation and cleaning are of doubtful benefit without poisoning to kill the roots so that resprouting does not occur.
7. Annual height growth of pine seedlings tends to accelerate in succeeding years while height growth rates of hardwood sprout clumps tend to decrease.

FPM83-0246

Westveld, Marinus. Increasing growth and yield of young spruce pulpwood stands by girdling hardwoods. Circular No. 431. Washington, D.C.: U.S. Department Agriculture; 1937. 20 p.

Girdling of overtopping hardwoods has substantially increased red spruce production on plots established by the Forest Service in 1905 at Corbin Park, New Hampshire. At the beginning of the experiment the stand was composed of an almost pure hardwood overstory, the basal area of which averaged a little more than 100 square feet per acre, and a spruce understory containing few trees more than 2 inches in diameter. Three half-acre plots were established, the stands varying but slightly as to composition, age, total basal area, density, thrift, and reproduction. A relatively light girdling operation was carried out in 1905 and a more severe one in 1915, removing 71.4 percent of the hardwood trees in plot 1 and 90.3 percent of those on plot 2. Plot 3 was left undisturbed as a control. Measurements at 5-year intervals following the first girdling showed that the pulpwood species grew much more rapidly on the girdled plots than on the control plot in height, diameter, basal area, and volume.

In 1935, the stand of spruce on the plot heavily girdled amounted to 1,607 cubic feet per acre (in trees 1 inch or more in d.b.h. in 1905) and that on the plot moderately girdled amounted to 974 cubic feet per acre, in contrast with 172 cubic feet per acre on the untreated plot.

Table 1. Effects of girdling on growth of spruce over a thirty-year period

Measurements	Untreated Before 1905	Untreated After 1935	71% removed Before 1905	71% removed After 1935	90% removed Before 1905	90% removed After 1935
Basal area (sq ft)						
Red spruce	1.40	9.12	3.25	59.73	2.13	98.30
Total	98.16	103.95	112.96	117.74	114.53	117.56
Height (ft)						
Red spruce	-	25.0	-	26.2	-	29.6
D.b.h. (in)						
Red spruce	3.0	4.6	2.5	5.5	2.7	6.5
Volume (cu ft/ acre, 1 in d.b.h. and over)						
Red spruce	62.8	171.7	95.7	974.2	89.2	1,607.2
Sound merchantable volume (cu ft/acre)						
Red spruce	-	43.0	-	466.0	-	1,085.0
Total	-	566.0	-	1,210.0	-	1,197.0

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C. : U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0247
Whipple, Sherman D.; White, Edwin H. Response of planted loblolly pine following various conversion methods. Bulletin 362. Auburn, AL: Auburn University Agriculture Experiment Station; 1965. 26 p.

See: Glover, Glenn A.; Knowe, Steven A.; Gjerstad, Dean H., 1981

FPM83-0248

Wilde, S. A.; Shaw, B. H.; Fedkenheuer, A. W. Weeds as a factor depressing forest growth. Weed Research. 8(3): 196-204; 1968.

A study was installed in two adjacent, 31-year-old plantations of red pine located at the McNaughton State Camp in Oneida County, Wisconsin. The primary purpose in establishing the McNaughton plantation was to investigate the effect of cultivation on the growth of trees.

Reforestation of 20 acres was accomplished by planting 2-0 red pine seedlings on the bottom of 8- to 10-inch deep furrows. On the adjacent 4-acre plot, the planting of the trees was preceded by criss-cross ploughing and disking of the land. The soil on this area was subsequently cultivated by hand between the rows during the following two springs.

Table 1 shows results after 31 years.

The plantation on cultivated soil produced about three times as much volume as the plantation grown on uncultivated soil. An equation is developed for estimating the loss of timber (in cords per acre) from the weight of competing ground vegetation. Experience with the equation suggests an accuracy of ± 10 percent in 80 percent of randomly selected stands.

Table 1. Effect of cultivation on growth of red pine after 31 years

	Ave. height (ft)	Ave. d.b.h. (in)	Basal area (sq ft)	Volume (cu ft)	Volume (cords/acre)
Cultivated	45.0	5.4	154	2750	27.5
Uncultivated	29.5	4.1	118	1080	10.8

Abstract: Larry Gross

FPM83-0249
Willcocks, A. J. Growth studies on a twenty-eight-year-old plantation at Moonbeam, Ontario. Unpublished report, on file. Kapuskasing, Ontario. Ontario Ministry of Natural Resources; 1979.

Two small adjacent 28-year-old stands of white spruce planted in 1951 with dominant stock (selected taller stock from the nursery bed) at the Bonner Tree Improvement Center, Moonbeam, Ontario, were compared. Both plantations were established on a sandy loam to clay loam soil. One plantation had been continually cleaned of competing vegetation throughout its growing period. The other was uncleaned and had become engulfed by *Rubus* spp. and aspen. Measurements were obtained from 100 randomly selected trees in the weeded plantation (50 each from trees to be thinned and trees to be left) and 50 trees from the unweeded plantation.

Results 28 years after planting appear in Table 1.

High volume yields and phenomenal growth rates characterized the study of the Moonbeam white spruce plantation. This conclusion was the result of intensive management that placed dominant nursery stock on a productive, upland site in a spacing grid that provided the potential for full site utilization. Full utilization was accomplished by controlling the undesirable competitors. The unmanaged plantation had the same potential as the managed stand after planting but lacked the subsequent cleaning and tending that released the managed plantation.

Table 1. Results of growth study of 28-year-old plantation

	Net merchantable volume (cu ft/acre)	D.b.h (in)	Height (ft)	Trees/acre
Unweeded	582	3.84	25.5	952
Weeded	2384	6.10	35.4	742

Abstract: Ronald E. Stewart

FPM83-0250
Williams, Robert D. Releasé accelerates height growth of yellow-poplar seedlings. Journal of Forestry. 62(2): 95-97; 1964.

See: Williams, Robert D., 1976.

FPM83-0251

Williams, Robert D. Release accelerates growth of yellow-poplar: An 18-year look. USDA Forest Service Research Note NC-202. St. Paul, MN: U.S. Department Agriculture, Forest Service, North Central Experiment Station; 1976. 4 p.

Results from a study on the Hoosier National Forest near Oriole, Indiana, show that young yellow-poplar will survive under a high overstory, but grow faster if released. A harvest cut in fall 1956 reduced basal area from about 100 to 40 square feet per acre. In July 1967, twelve 0.1-acre plots were established to find out how overhead release would affect survival and development of new seedlings. Three intensities of release were tried: (1) complete release (residual basal area of 0 square feet), (2) high release (residual basal area of 17 square feet) and (3) no release (residual basal area of 40 square feet). The three treatments were replicated four times. Mean height of the tallest yellow-poplar on each quadrant 18 years after the 1956 harvest cut appears in Table 1.

Mean diameter of the largest trees in the complete release plots is about five times greater than that of the largest trees in the check plots. Mean d.b.h. of the largest yellow-poplar per quadrat is 0.5 inches in the check plots, 1.1 inch in the high release, and 2.7 inches in the complete release. Yellow-poplar will survive under a partial overstory, but growth is very slow. Trees completely released are four times taller and five times larger in diameter than unreleased trees. Completely released trees are almost twice as tall and their diameter is more than twice that of the high release trees.

Table 1. Effect of release on growth of yellow-poplar after 18 years

		Mean height of tallest trees in quadrant (feet)		
Year seed germinated	Tree age (years)	Check	High release	Complete release
1957	17	6.1	14.8	25.0
1958	16	2.7	4.6	10.4
1959-1961	13-15	1.4	---	0.4
1962-1973	1-12	3.5	---	---

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0252

Williston, Hamlin L.; Huckenpahler, Bernard J. Hardwood underplanting in north Mississippi. Journal of Forestry. 55(4): 287-290; 1957.

For three successive years, four replications each of 25 trees were underplanted with white ash, white oak, yellow-poplar, black locust, black walnut, and loblolly pine in upper, middle, and lower slopes, and on minor bottoms near Oxford, Mississippi. The overstory on half of these plots was killed by girdling and poisoning immediately before planting. Where necessary, sprouts and other competing vegetation were cut back annually. Loblolly pine, black locust and yellow-poplar plantings usually kept ahead of competition after two releases.

Results after 5 years are shown in Table 1.

Survival and height growth were significantly increased by release. Of the six species tested, loblolly pine was the most suitable for underplanting in rehabilitating the upland hardwood type in north Mississippi. Immediate release of all underplantings is needed to obtain satisfactory survival and height growth.

Table 1. Effect of release on survival and growth of hardwood underplanting after 5 years

	Average height (feet)		Survival (percent)	
	Released	Unreleased	Released	Unreleased
Loblolly pine				
Upper slope	72	46	8.4	2.3
Middle slope	76	34	7.5	1.4
Lower slope	72	41	8.2	1.8
Minor bottom	35	7	8.4	1.2
White ash				
Upper slope	78	90	2.7	1.2
Middle slope	91	81	2.7	0.9
Lower slope	95	86	3.3	1.2
Minor bottom	95	79	3.7	1.2
Black walnut				
Upper slope	19	46	1.8	1.9
Middle slope	15	27	1.8	2.0
Lower slope	16	32	2.8	2.5
Minor bottom	55	46	5.2	2.8
White oak				
Upper slope	55	53	1.8	0.9
Middle slope	47	64	1.7	1.0
Lower slope	51	57	1.7	1.1
Minor bottom	38	36	1.9	1.1
Yellow-poplar				
Upper slope	54	17	5.2	0.6
Middle slope	56	23	4.6	0.6
Lower slope	80	20	7.8	0.8
Minor bottom	64	37	8.4	1.8
Black locust				
Upper slope	76	32	6.8	2.3
Middle slope	61	44	7.2	1.8
Lower slope	68	41	10.8	1.2
Minor bottom	73	7	10.4	1.8

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0253

Williston, Hamlin L.; Huckenpahler, Bernard J. Response of six conifers in north Mississippi underplantings. Journal of Forestry. 56(2): 135-137; 1958.

Sixteen plots, each containing six 0.1-acre species subplots, were established on ridge and upper slope stands of blackjack oak, post oak, and hickory (basal area of 64 square feet per acre) near Oxford, Mississippi. Each year, for four consecutive years, four randomly selected plots were planted with shortleaf, loblolly, longleaf, slash, and Virginia pine and eastern redcedar. Sixty-four seedlings were planted in each subplot. The overstory hardwoods on half the plots were girdled and poisoned before planting and sprouts cut annually where necessary. Differences in survival and height growth due to year of planting were not significant. Results averaged over planting years after 5 years are shown in Table 1.

Release slightly improved survival of loblolly, shortleaf, and longleaf pine but differences were not significant. Immediate release from hardwood competition, however, resulted in a significant increase in height growth. Seedlings on released plots are almost three times as tall as those on unreleased plots after 5 years.

Table 1. Survival and height growth of released and unreleased pine after 5 years

Species	Survival (percent)		Height (ft)	
	Released	Unreleased	Released	Unreleased
Loblolly pine	56	46	8.0	3.1
Shortleaf pine	54	51	4.9	1.8
Virginia pine	53	60	6.2	2.9
Slash pine	18	20	6.2	2.0
Longleaf pine	10	7	1.1	0.1
Eastern redcedar	66	70	2.6	0.9

Abstract: Ronald E. Stewart

FPM83-0254
Williston, H. L.; McClurkin, D. C. Soil moisture-seedling growth relations in conversion planting of oak ridges to pine. Journal of Forestry. 59(1): 20-23; 1961.

Early in 1956, a study was established near Oxford, Mississipi to determine how three intensities of hardwood removal would affect soil moisture relations and growth and survival of loblolly pine. Nine 0.4-acre plots were staked out to form 3 blocks on a ridge of shallow loessial soils. Loblolly seedlings with stem length of 6 to 8 inches were planted under an existing hardwood stand on March 1 at a 6- by 7-foot spacing. Three replications of three hardwood treatments were randomly assigned to plots and applied during the second week of April. Treatments were: (1) overstory removed-hardwoods over 3.5 inches d.b.h. were frill-girdled, and treated with 2,4,5-T, (2) understory removed-hardwoods from 6 inches tall to 3.5 inches d.b.h. were cut and stumps treated with 2,4,5-T, and (3) all hardwoods 6 inches tall and larger were treated as in 1 and 2. There were no check plots.

Survival and height of loblolly pines at the end of three growing seasons are recorded in Table 1.

Plots on which all hardwoods were controlled had better seedling survival and growth and more soil moisture than did plots on which only the overstory or understory hardwoods were treated. Immediately after treatment, residual hardwood basal area was 14, 39, and 0 square feet per acre on treatments 1, 2, and 3. After three growing seasons, the basal area of hardwoods was 24, 47, and 4 square feet per acre.

Table 1. Effect of hardwood removal on survival and growth of loblolly pine after 3 growing seasons

Treatment	Survival (percent)	Height (feet)
Overstory removed	88	5.3
Understory removed	83	4.1
All hardwoods removed	94	8.8

Abstract: Larry Gross

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0255
Wittenkamp, R.; Wilde, S. A. Effect of cultivation on the growth of red pine plantations. Journal of Forestry. 62: 35-37; 1964.

A study was installed in the spring of 1935 on a 9-acre tract surrounding the McNaughton State Forestry Camp in Oneida County, Wisconsin. This nearly level area of podzolized Hiawatha outwash sandy loam soil supported a heavy cover of blueberries, sweet fern, bracken fern, bunchberry, and grasses. Two-year-old red pine seedlings were planted on areas prepared in the following manner: (1) 2 acres plowed and disked before planting with subsequent one cultivation by hand between the rows in each of the following two springs; (2) 2 acres spot planted with hoeing around the trees to a 2-foot radius with hoeing repeated once in each of the following two springs and; 3) 5 acres furrowed to a depth of 7 inches with the trees planted on the bottom of the furrows. The growth of trees was determined during the summer of 1962 by measuring diameters of the stand and heights of dominant and codominant trees on six 1/5-acre plots. Results after 27 years are shown in Table 1.

Cultivation increased yield by about 300 percent. The outcome of this study, covering a period of more than a quarter century, strongly suggests that suppression of weed vegetation through cultivation of other methods is one of the most promising means of increasing the yield of forest crops.

Table 1. Effects of cultivation on growth of red pine over 27 years

Method of cultivation	Average height (ft)	Average d.b.h. (in)	Basal area (sq ft)	Volume (cu ft/acre)
Furrow planting, hand cultivation	39.6	4.8	149	2,277
Spot planting, hoe cultivation	38.0	5.6	162	2,187
Furrow planting, no cultivation	26.3	3.7	94	765

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C. : U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0256

Worst, Raymond H. A study of effects of site preparation and spacing on planted slash pine in the Coastal Plain of southeast Georgia. Journal of Forestry. 62: 556-560; 1964.

See: May, Jack T.; Rahman, Shamsur; Worst, Raymond E., 1973.

FPM83-0257

Yawney, Harry W. Introducing white pine into poor-site hardwood stands in West Virginia. Station Paper No. 154. Upper Darby, PA: [station now at Broomall]: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1961. 10 p.

In 1954, an exploratory study was established on the Monongahela National Forest in Tucker County, West Virginia, to determine on what sites eastern white pine could be interplanted or underplanted into low quality oak-hickory stands with reasonable success and at minimum expense. Six paired 0.3-acre plots were established at three slope positions--lower, middle, and upper--on a steep southwest-facing slope. The soil was a Gilpin silt loam derived from acid shale with interbedded sandstone. The natural forest was composed of pole size low grade hardwoods 40 to 50 years old. Site indexes for oak were 59, 52, and 45, respectively for lower, middle, and upper pairs of plots. About 160 3-0 white pine seedlings were planted on each plot in the spring of 1954. Seedlings were planted in the most advantageous spots to reduce the effect of competition from existing cover. On one plot at each slope position, overstory trees 4 inches d.b.h. and larger were girdled. The overstory was left undisturbed on the companion plot. Late in 1957, four growing seasons after planting, a second release was made on half of each previously treated plot. Only that vegetation growing in immediate proximity of each pine was cut.

White pine survival and height after six growing seasons is shown in Table 1.

Survival on all plots has been exceptionally good with no significant differences among treatments or slope positions. However, most of the seedlings on plots that were not released are sparsely needled, lightcolored, and spindly, have crooked leaders, and generally lack vigor. Seedlings on released plots are heavily needled, of good color, and straight-stemmed. By the end of the second growing season, differences in height growth due to treatment were apparent. After the third season, seedlings on released plots averaged a foot taller, and after the sixth season they averaged more than twice as tall as those on unreleased plots. After 2 years, there has not been much additional response by the pines to the second release. Height growth was inversely related to site, probably as a result of the intense hardwood sprout and shrub competition on the best site.

Table 1. Effect of site quality on white pine survival rate and height growth after six growing seasons

		Released		Not released	
Slope position	Site index	Survival (%)	Height (ft)	Survival (%)	Height (ft)
Lower	59	89.0	5.25	94.4	2.48
Middle	52	98.4	5.79	93.5	2.75
Upper	45	98.7	6.53	91.2	2.60

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0258

Yocum, H. A. More than one treatment may be needed to release underplanted pines. Southern Forestry Notes No. 140. New Orleans, LA: U.S. Department Agriculture, Forest Service, Southern Forest Experiment Station. 1962. 4 p.

Loblolly pines were underplanted in two studies in northern Alabama on sites fully occupied by young upland hardwoods. Best results were obtained by cutting or girdling all hardwoods over 5 feet tall or more than 1.6 inches d.b.h. Hardwoods were treated at the time of planting, no silvicides were used, and there were no follow-up treatments.

Pine survival after 12 years in one test averaged less than 50 percent and more than half were overtopped. For the other test, survival was 67 percent after 6 years and about 1/6 of the pines were overtopped. Both studies strongly suggest that, where young hardwoods dominate a proposed planting site, control prescriptions should provide for repeat treatments or for initial treatment with silvicides.

Abstract: Ronald E. Stewart

FPM83-0259

Youngberg, C. T.; Wollum, A. G.; Scott, W. Ceanothus in Douglas-fir clearcuts: Nitrogen accretion and impact on regeneration. In: Gordon, J. C.; Wheeler, C. T.; Perry, D. A., eds. Symbiotic nitrogen fixation in the management of temperate forests. Proceedings of a workshop. Corvallis, OR: Oregon State University, Forestry Research Laboratory; 1979: 224-233.

The impact of natural levels of snowbrush ceanothus on Douglas-fir regeneration was studied over a 2-year period on six clearcuts in the central Cascade Mountains of Oregon. A total of 1,112 milacre plots were sampled on units that had at least a 50 percent cover of ceanothus. The units were classified as good or poor sites based on soil depth and stoniness. Number of seedlings by species, height and age of each seedling and its position in relation to ceanothus, browse damage, and general health and vigor of seedlings were recorded on each plot. Seedlings ranged in age from 5 to 9 years and included both planted and natural regeneration.

Table 1 shows the percent milacre stocking of Douglas-fir in relation to ceanothus cover.

Table 2 shows the incidence of browse damage, total height of 9-year-old seedlings, and average height growth in 1968 of 10-year-old seedlings in relation to ceanothus cover.

In addition to the ameliorating influence of ceanothus cover on soil temperature and moisture, the higher milacre stocking under cover is probably related to the protection from browsing animals provided by the brush cover.

Total height and annual height growth of Douglas-fir seedlings were also higher under cover than in the open. Seedlings growing under ceanothus cover did not experience any nitrogen stress during the active growing season while those in the open dropped below the 1.2 percent foliar N level, considered to be the minimum for adequate growth. The greater annual growth in the 10th year in the edge position and the small growth differences between the open and under positions suggests that competition for moisture is becoming greater. This possible increase in competition for moisture between year 7 and 10 coincides with the time that increase in biomass N levels off. This suggests that a release operation should occur during this period.

Table 1. Regeneration of Douglas-fir under natural influence of ceanothus cover over a 2-year period

	Stocking Open (%)	Stocking Under (%)
Good site	45.2	67.1
Poor site	33.5	42.0
Total	36.5	52.9

Table 2. Health and condition of Douglas-fir stocking after 2 years

	Stocking Open	Stocking Edge	Stocking Under
Browsed and mechanically damaged (%)	69.0	73.0	28.0
Total height (m)	0.82	1.19	1.59
Height growth (cm)	31.0	50.0	36.0

Abstract: Ronald E. Stewart

Stewart, R. E.; Gross, L. L.; Honkala, B. H. Effects of competing vegetation on forest trees: a bibliography with abstracts. Washington, D.C.: U.S Department of Agriculture, Forest Service; 1984. 1 v. (loose-leaf).

FPM83-0260

Zavitkowski, J.; Newton, Michael; El-Hassan, Babiker. Effects of snowbrush on growth of some conifers. Journal of Forestry. 67(4): 242-246; 1969.

Douglas-fir seedlings planted in snowbrush ceanothus stands 0 to 15 years old survived and developed significantly better than ponderosa pine, western hemlock, and noble fir under the same site conditions. Capacity of all four species to dominate the site was greatest in snowbrush at age 0, decreasing with increasing age of the snowbrush. Snowbrush attains full occupancy of the site in about 10 years, causing severe suppression after that time. Height growth of six naturally developing conifer species was reduced by one-half under suppression by snowbrush. Findings indicate that snowbrush is more detrimental than beneficial to forest regeneration on west slopes of the Oregon Cascades.

Abstract: Ronald E. Stewart

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