Division of Agricultural Sciences
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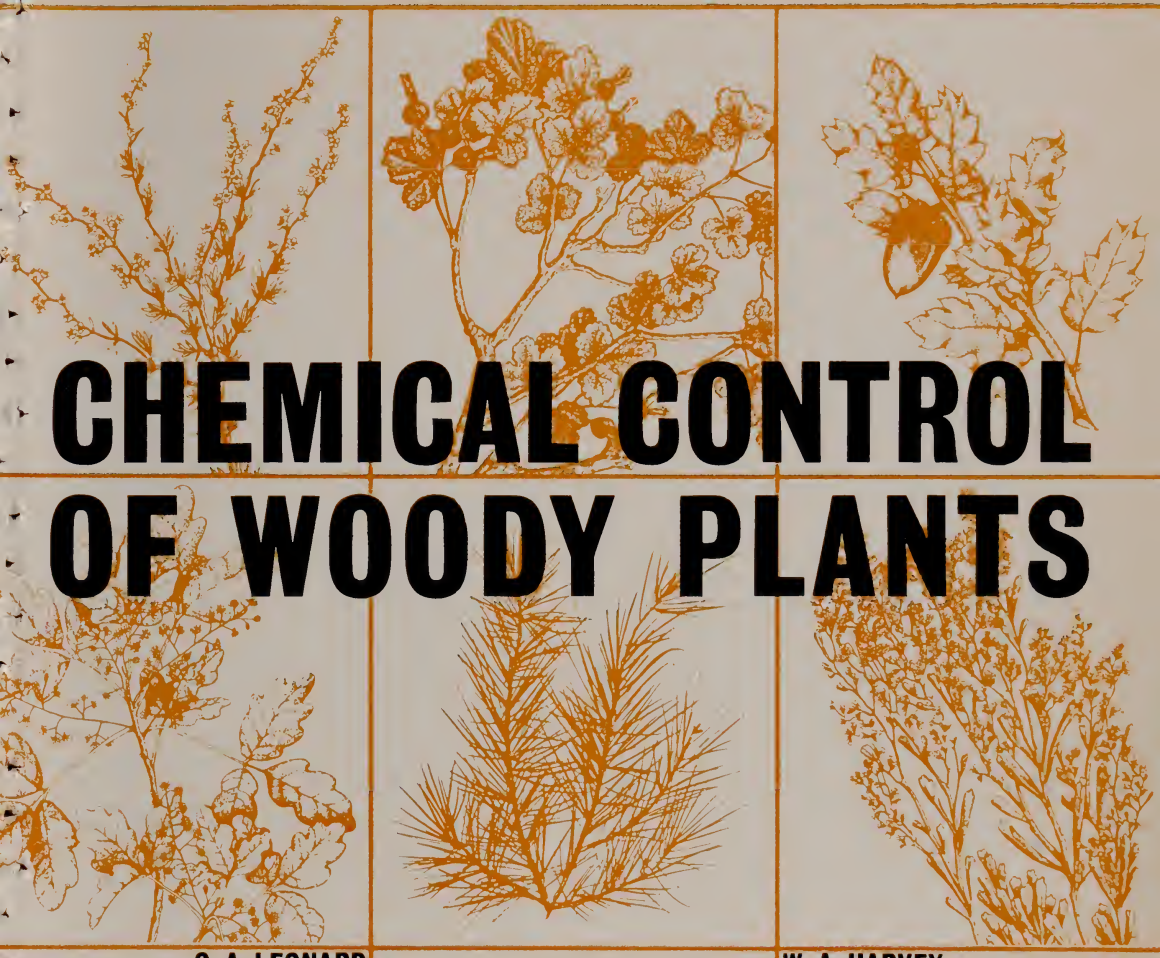

CHEMICAL CONTROL OF WOODY PLANTS

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This bulletin lists chemicals used for controlling woody plants, and describes application equipment and methods of application. Problems involved in control are discussed and solutions are given. Tables showing reactions of woody plants to chemical treatment are also included.

CALIFORNIA AGRICULTURAL EXPERIMENT STATION

BULLETIN 812

WARNING ON THE USE OF CHEMICALS AND RULES FOR SAFE USE

Herbicides vary in toxicity to man and other animals but all should be used with care. The following suggestions for the use and handling of herbicides will help minimize the likelihood of injury, from exposure to such chemicals, to man, animals and crops, other than the pest species to be controlled.

Always read all precautionary labeling directions before using herbicides and follow them exactly. Notice warnings and cautions before opening the container. Repeat the process every time, no matter how often you use a herbicide, or how familiar you are with the directions. Apply material only in amounts and at times specified.

Keep herbicides out of reach of children, pets, irresponsible persons, and livestock. They should be stored outside the house, away from food, feed and seed, and under lock and key.

SPECIAL MATERIAL

Always store sprays and dusts in their original containers and keep them tightly closed. Never keep them in anything but the original container.

Never smoke, eat or chew while spraying or dusting.

Avoid inhaling sprays or dusts. When directed on the label, wear protective clothing and a proper mask.

Do not spill herbicides on the skin or clothing. If the liquid concentrates are accidentally spilled, remove contaminated clothing immediately and wash the contaminated skin thoroughly.

Wash hands and face and change to clean clothing after applying herbicides. Also wash clothing each day before re-use.

If symptoms of illness occur during or shortly after dusting or spraying, call a physician or get the patient to a hospital immediately.

Cover food and water containers when treating around livestock or pet areas. Do not contaminate fish ponds, streams, or lakes.

Always dispose of empty containers so that they pose no hazard to humans, animals, valuable plants or wildlife.

Observe label directions and follow recommendations to keep residue on edible portions of plants within the limits permitted by law.

Do not use the mouth to siphon liquids from containers or to blow out clogged lines, nozzles, etc.

Do not spray with leaking hoses or connections.

Do not work in the drift of a spray or dust.

Confine chemicals to the property and crop being treated. Avoid drift to adjoining property and crops by stopping treatment if the weather conditions are not favorable.

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Chemical Control of Woody Plants[1]

THE following control recommendations are based upon research investigations carried out by the University of California personnel in the Agricultural Experiment Station and Agricultural Extension Service in cooperation with the State Departments of Agriculture and Public Health, the United States Department of Agriculture, and the agricultural and chemical industries.

These recommendations have been developed on a statewide basis, but special problems of control in local situations have been noted and in these instances recommendations apply only to the area designated. Controls for the major problems are given, but these problems may not be present in every area. Use the recommendations applicable to your area.

NEARLY one-half of California's land is covered with woody plants, and about one-third of this cover is brush and noncommercial forests now of little economic value. Some of this land is suitable for conversion for range and crop purposes, other areas may be cleared for watersheds, and still others will eventually be partially cleared for rural living and recreation. Fairly large areas not appreciably altered by man will likely remain, especially within national and state park and wilderness area boundaries.

Slightly over one-sixth of California is covered with commercial coniferous forests whose productivity cannot be maintained without effective measures for reforesting burned-over areas and increasing the productivity of the rest. Herbicides can perform a valuable function in timber production, as losses from forest fires can be reduced by construction of effective fuelbreaks made by chemical removal of underbrush and unwanted trees along ridgetops.

Herbicides properly used can perform an important function in controlling unwanted woody plants, such as poison oak, while leaving those that are desirable. California can be made a better place to live by landscape improvement and by minimizing the destructiveness of chaparral and forest fires.

Tables detailing preparation and use of herbicides discussed in text will be found at the back of this publication.

NOTE: See pages 5 and 16 for further precautions on use of chemicals.

EFFECTIVE CHEMICALS

The chemicals most effective for controlling woody plants are:

2,4-D, 2,4,5-T, silvex, AMS, amitrole, fenuron, fumigants, picloram, dicamba, and cacodylic acid.

2,4-D and 2,4,5-T (2,4-dichlorophenoxyacetic acid, and 2,4,5-trichlorophenoxyacetic acid) are commonly used for controlling woody plants of many different species. 2,4,5-T controls a greater number of species of woody plants than 2,4-D but each of the chemicals listed is more effective on certain plants. Since most brush areas are composed of several species, mixtures of 2,4-D and 2,4,5-T called "brush killers," are commonly used; both of these compounds appear to affect woody plants in the same basic manner. Radioactive tracer tests indicate that 2,4-D is absorbed by leaves in greater amount than 2,4,5-T, but also indicate that 2,4,5-T is more stable in plants. Relative effectiveness of the compounds varies with plant species, and with time and method of application.

[1] Submitted for publication November 20, 1963.

These herbicides are available in several different formulations. The most commonly used and satisfactory formulations for brush spraying are the "low volatile" esters: butoxyethanol, propylene glycol butyl ether, and isooctyl. Although termed low volatile, their volatility makes them unsafe for use near susceptible crops, such as vineyards, especially when high temperatures prevail. (A much more volatile formulation of the butyl ester is often used on big sagebrush where there is no danger to adjacent crops.)

Special formulations of esters of 2,4-D and 2,4,5-T are used to reduce drift, particularly from air application. These make a so-called invert emulsion, which is a thick mayonnaise-like (water in oil) emulsion forming large drops or particles when sprayed. Thickness of the emulsion can be varied by changing the ratio of oil and water.

Water-soluble amines are the most effective of the various formulations for killing trees by the cut-surface method, and are sometimes used for controlling brush, especially where volatility is a hazard. Amines are essentially nonvolatile, but are not as effective as esters when used as foliage sprays on established brush species.

Oil-soluble amine formulations are generally more effective than water-soluble amines when applied as foliage sprays, but are less effective than esters. Essentially nonvolatile, they may be used in place of esters when nonvolatility is desired.

Acid formulations have low volatility but are more volatile than the amines. Acid formulations, generally less effective than esters, are used where low volatility is important.

Silvex (2(2,4,5-trichlorophenoxy)propionic acid), a compound similar to 2,4,5-T, is sold as water-soluble amine and low-volatile ester formulations. Silvex is more effective than 2,4-D or 2,4,5-T in controlling certain woody plants such as live oak, salt-cedar, poison oak and blackberries.

AMS (amonium sulfamate), an inorganic herbicide used for controlling a wide variety of woody plants, is more effective where high humidity and fog are present. AMS can be used with relative safety near growing crops and ornamentals. It is soluble in water and is applied as an aqueous spray containing a wetting agent or emulsifiable oil.

Amitrole (3-amino-1,2,4-triazole) is a water-soluble herbicide that induces chlorosis (yellowing or blanching of normally green parts) in plants. Results are more consistent when a small quantity of sticker-spreader or household detergent is added to the spray mix. Amitrole is used widely on poison oak, and also may be used on black locust, many species of *Rubus*, and elm. Cut-surface treatments have shown no promise except on big-leaf maple in the spring.

Fenuron (3-phenyl-1,1-dimethylurea) is applied to the soil in the form of pellets and absorbed by the roots.

Fumigants are especially useful for quick control of woody plants. Effective fumigants include DD® (1,3-dichloropropene and 1,2-dichloropropane mixture), Telone® (principally 1-3-dichloropropene), EDB (ethylene dibromide), and SMDC (sodium N-methyl dithiocarbamate).

Picloram (4-amino-3,5,6-trichloropicolinic acid) is a new herbicide. Spray mixtures of picloram and other herbicides will probably be used, as picloram is not effective against all brush species and appears to be slightly more damaging to grasses than 2,4-D. Forty pounds per acre of 10 per cent picloram pellets were effective in controlling chamise and mountain misery in a test conducted in 1963. The results on toyon, canyon live oak and California black oak were much less favorable.

Good control of chamise, mountain misery, whiteleaf manzanita, Ceanothus, creeping sage, and periwinkle was obtained with 4 pounds of picloram (potassium salt) per acre applied as a foliage spray; 1 pound per acre was adequate on some of these species. Good control of poison oak has been obtained by high volume leaf-stem spraying, but control with a similar quantity of picloram applied at 20 gallons per acre or with the mist blower was less complete. Foliage sprays gave only poor control of interior

live oak and toyon. High volume sprays appear more promising at this time than does low volume application.

Picloram applied to cuts in trees shows considerable promise; present evidence indicates that good results may be obtained using a wider spacing of the cuts than is possible with 2,4-D amine. Picloram appears to be very mobile in some woody plants, especially in madrone, California buckeye, and California laurel.

Picloram can injure desired species of woody plants by being picked up by the roots following application to the soil.

Recommendations for use of picloram cannot be made now as adequate data are lacking, but the above mentioned results should serve as a guide in testing programs.

Dicamba (2-methoxy-3,6-dichlorobenzoic acid) appears to produce plant reactions similar to picloram but is less effective. Preliminary data indicate that it is effective against chamise, Ceanothus, and madrone.

Dicamba, as well as picloram, is more stable in soil and probably is more stable in plants than are phenoxy herbicides. (Mixtures of dicamba and phenoxy herbicides will probably be used for woody-plant control.)

Cacodylic acid (dimethyl arsinic acid) shows promise for early thinning in stands of conifers when applied to cuts in the trunks. It can also be used as a contact spray for killing back shoots of unwanted woody plants.

PRECAUTIONS IN THE USE OF CHEMICALS FOR WOODY-PLANT CONTROL

2,4-D, 2,4,5-T, and **silvex** are growth-regulatory-type weed killers and can cause injury to nearby plants by volatility and spray drift. In California, a use permit from the County Agricultural Commissioner is required in order to purchase more than ½-pound of chemical per day. Do not use the same equipment for applying fungicides and insecticides, since it is difficult to remove all traces of the herbicides from sprayers.

AMS is corrosive to spray equipment, which should be washed immediately after use.

Fenuron will cause chlorosis on shrubs or trees having roots beneath the point of treatment. Washing (as from heavy rainfall) may cause injury to grass some distance from the point of application.

Fumigants are poisonous and cause severe blistering if allowed to remain on the skin. If these materials are splashed on the skin, they should be washed off immediately with soap and water. If spilled on clothing or shoes, these garments should not be worn again until the articles are cleaned or washed.

Amitrole should be used with caution on rangeland. Remove all livestock before treatment and do not graze or plant to forage crops for 8 months after treatment.

APPLICATION METHODS

The degree of control of most species of woody plants growing in California is determined by the amount of herbicides applied; this appears to be true for all methods of application: foliar and basal sprays, cut-surface applications on stems, and stump and soil treatments. Where chemical cost, selectivity, and residues are not important considerations, increasing the dosage usually increases the control. Regardless of dosage, however, many species of plants will require re-treatment for complete control (especially with foliage spray treatments).

FOLIAR SPRAYING

In foliar spraying, leaves and stems are covered with the spray solution, and spraying must be done at the proper time. Deciduous woody plants, such as poison oak, should be sprayed during the growing season after most leaves have fully

enlarged, and spraying can be continued as long as plants are growing. Woody plants are much less sensitive to sprays when growth stops due to exhaustion of soil moisture, and many of them require as much as three annual applications for satisfactory control.

Woody plants sprouting from crown or root are most effectively controlled by treating sprouts after a fire or after cutting. Brush and forest fires are an annual occurrence in California; therefore, spray programs should be planned ahead so as to be immediately available following fires. The best time to spray burned areas is the first or second spring following the fire. Another important advantage of spraying after a fire is that much of the fuel has already been consumed and dead brush resulting from spraying does not appreciably increase fire hazard.

Individual plant treatment with ground equipment is necessary when broadcast methods are not effective, when bushes are scattered, or when selective control of individual plants is desired.

It is important to spray all parts of the plants, including the lower leaves and stems, because most herbicides are not translocated (moved within the plant) effectively over long distances. Movement of the herbicide into the crown and roots is increased by thorough coverage of the lower leaves and stems.

Brush killer. Use 4 pounds of acid equivalent of an equal mixture of 2,4-D and 2,4,5-T (low-volatile esters), 1 gallon of diesel oil, and water to make 100 gallons of spray mixture. Apply with conventional spray equipment with agitation; for a back-pack mist blower, use the same amount of chemical and oil and water to make 4 to 8 gallons of spray mix. Use the same quantity of chemical, diesel oil, and water for making spray mixtures with silvex. Diesel oil usually increases the effectiveness of the sprays and helps to make the sprayed woody plants visible, especially when a back-pack mist blower is used.

AMS. Use 75 pounds of chemical, make to 100 gallons with water, and add 8 ounces of sticker-spreader (an effective spray is made by replacing 10 gallons of the water with 10 gallons of an emulsifiable oil). AMS solutions can be applied with conventional sprayers.

Amitrole. Use 5 pounds of amitrole to 100 gallons of water plus 8 ounces of sticker-spreader.

Over-all spraying with ground equipment, using brush killer or AMS, is often used if there are too many plants to spray individually.

Brush killer. Use 4 pounds of an equal mixture of 2,4-D and 2,4,5-T (low-volatile esters), ½-gallon of diesel oil, and water to make 40 gallons. Apply this volume per acre with a conventional sprayer equipped with a spray boom. The same quantity of chemical can be applied in a much lower volume (5 to 10 gallons) with a mist blower. Excellent results have been obtained with 5 to 10 gallons per acre applied with the back-pack mist blower.

AMS. Use 75 pounds of AMS, 10 gallons of emulsifiable oil and sufficient water to make 50 gallons per acre. This spray can be applied with a mounted mist blower or conventional spray equipment with spray boom.

Aircraft application is useful for treating large areas, especially those difficult to spray with ground equipment. Use brush killer and oil mixture as above, but add only enough water to make 5 to 10 gallons of spray—using the lesser amount for burned-over areas.

Invert emulsions are applied to rights-of-way by centrifugal sprayers mounted on helicopters; this keeps sprays largely confined to the desired strip. Drift is not eliminated but it is far less than when a normal emulsion is applied by spray booms. Use 6 to 12 pounds acid equivalent of a mixture of 2,4-D and 2,4,5-T in diesel oil and water to make 12 to 20 gallons per acre. The ratio of diesel oil to water affects the viscosity of the invert spray mixture; viscosity is increased as the percentage of water in the mixture is increased. Where minimum drift is desired, minimum diesel oil to make a flowable emulsion should be used; however,

1. Back-pack mist blower. (Photo courtesy Alva G. Neuns.)

such spray mixtures lose some of their effectiveness. Width of spray swaths from the helicopter can be varied from 20 to 50 feet.

BASAL SPRAYING

In this method, chemicals are applied in diesel oil to lower parts of the stems of woody plants. Best results are obtained when soils are neither excessively wet or dry; winter and spring applications are generally satisfactory, although good results have been obtained in forested areas with late spring and summer applications. 2,4,5-T is more effective than 2,4-D for controlling woody plants by this method, but an equal mixture of these two compounds approaches 2,4,5-T in effectiveness and for economy brush killer is recommended.

Brush killer. Use 16 pounds of an equal mixture of 2,4-D and 2,4,5-T (low-volatile esters) in sufficient diesel oil to make 100 gallons of spray mixture. Cover all sides of the stems near the ground line, using a solid-cone spray, and apply 2 to 3 fluid ounces of mixture for each inch of stem diameter—enough to have runoff at the base of plant. The method is most useful on stems up to 2 inches in diameter; larger stems should be frilled or cut into near the base and the spray also applied to cuts.

CUT-SURFACE TREATMENT ON TREES

This treatment is effective for controlling unwanted trees. It is more selective than spraying and treatments can be made

throughout the year, but it is usually most effective from late fall through early summer. There is no spray-drift problem.

Deep cuts are made near ground-level with a heavy hatchet or axe. Each cut should be horizontal, to retain applied chemicals, and cuts should be close together (on vigorous sprouting species such as live oak it is best to make a complete girdle). Undiluted 2,4-D amine (water soluble) should be put into the cuts, using a pump oil-can or polyethylene squeeze bottle. Use about 1 milliliter of amine for each inch of stem diameter; a 14-inch tree should receive about ½ fluid ounce. 2,4,5-T amine is also effective but is more expensive than 2,4-D amine; it should be used on maples, however.

Several mechanical injectors for making cut-surface applications are available. Some models automatically release a squirt of chemical at each cut; others have a trigger arrangement which must be tripped. (A disadvantage of the automatic-release type is that insufficient chemical may get into the cuts.) Cuts, or jabs, must be close together and deep enough to penetrate into the wood. Amines are easier to inject when diluted with an equal quantity of water, but further dilution with water is undesirable as the quantity of solution must be increased to compensate for increased dilution.

Injections of esters in diesel oil give good results if cuts are filled with the mixture; diesel oil makes esters flow more readily and helps lateral movement. Volume per cut should be increased as the concentration of the chemical is reduced. A recommended mixture consists of 4 pounds acid equivalent of an equal mixture of 2,4-D and 2,4,5-T esters made to 4 gallons with diesel oil. Esters are not as effective as water-soluble amines in preventing sprouting.

STUMP TREATMENTS

Stumps may be sprayed with the basal spray mixtures described. Stumps and bases of all sprouts, and all small sprouts, should be thoroughly sprayed. Effectiveness of treatment is increased by cutting into stumps near the base, and control is best when stumps are treated immediately after felling the trees. Such stumps may be treated with 2,4-D amine (water soluble) applied liberally to the tops of the stumps and in cuts close to the ground; winter is the best season for treatment. Water-soluble 2,4,5-T amine should be used on stumps of maple. AMS crystals placed on stump-tops are also used to control sprouting, but are less effective.

SOIL TREATMENT

Fenuron is the only herbicide of importance now being used in soil application for controlling woody plants (see results with picloram pellets, page 4). It is marketed in the form of pellets containing 25 per cent actual fenuron. Applications should be made at base of the stems, from November through January under California conditions. It is most effective on granitic and sandy soils. It has proved effective on live oak, blue oak, toyon, coffeeberry and other chaparral species but has given poor kills of poison oak. Three ounces should be placed at the base of each cluster of live oak stems; a large clump may have several stem clusters and thus may require as much as a pound of pellets. Bushes die over a period of 3 years or more. Although the chemical is expensive, application is easy and in many cases no re-treatment is necessary.

Soil fumigants are useful for killing individual woody plants and have been effective against poison oak, blue oak, live oak, walnut and grape rootstocks: Killing is most rapid during periods of greatest growth. Use 1½ fluid ounces of a soil fumigant (such as DD®) per hole 6 to 8 inches deep, spaced about 6 inches apart around base of the plant. Roots are normally killed about 10 inches from the point of application but have occasionally been killed as far away as 30 inches. Care should be taken when treating close to desirable plants, as their roots might be damaged.

2. Live oak regrowth controlled with fenuron pellets.

APPLICATION EQUIPMENT

The major considerations when selecting equipment are availability, efficiency, selectivity, and amount of spray drift. Mechanical agitation in the spray tank is essential when emulsions of 2,4-D, 2,4,5-T, and silvex are used.

Back-pack knapsack and compressed air sprayers. Commonly used for treating individual woody plants.

Back-pack mist blowers. Useful when a small volume of spray mixture, or speedy application in a small area, is needed. Sprayers should be equipped with a quick shut-off valve near the opening where spray mixture enters the air-stream, and the orifice-opening should be adjustable at this same point. Allowance must be made for spray drift when using this equipment.

Power sprayers. Used for spraying individual woody plants and for broadcast spraying. For hard-to-reach areas, side hoses may be attached to the main hose-line (pneumatic-type couplings facilitate operations). Spray booms or offset nozzles on mobile sprayers are sometimes used for spraying roadsides or fields of brush.

Mounted mist blowers. Useful in areas where tractors can operate.

Helicopters and airplanes. Helicopters have largely replaced the airplane for broadcast spraying, except on more easily accessible areas. Difficult areas can be flown over successfully and relatively safely with a helicopter, and small clearings can serve as heliports. Spray drift is a problem in aircraft spray-application, but attempts are being made to minimize it through development of proper spraying devices.

RANGELAND PROBLEMS

Coyotebrush, California sagebrush, and sages are controllable by aircraft spraying with 2,4-D. Soil moisture should be sufficiently high for good plant growth. Poor control will result if the plants are not growing vigorously. To control these plants, 4 pounds of 2,4-D (water-soluble amine) per acre is recommended; the spray mixture should contain ½-gallon of emulsifiable oil and water to make 10 gallons. Where sages are present, an ester formulation in place of amine, and diesel oil in place of emulsifiable oil, should be used.

For coastal brush containing blackberries, poison oak, and other sprouting species, use the brush-killer mix suggested for over-all spraying (page 6). Sprayed areas should be burned in the fall following spraying, and brush regrowth should be ground-sprayed the following summer. Grazing helps control brush regrowth.

Chamise control should be initiated after a fire by seeding burned areas with the grass desired. Regrowth can be controlled by using ground equipment the first or second year after a fire. A brush-killer mixture of 2,4-D and 2,4,5-T is suggested, but 4 pounds of 2,4-D ester per acre usually gives a comparable kill. Under unfavorable conditions more than 4 pounds of herbicide per acre increase the kill. The best period for spraying in the first year after the burn is from late April through May, and from March through May in the second year. Chamise is controllable by individual plant treatment from December through June, but soil moisture must be adequate for shoot and/or root growth. Plants surviving the first chemical application can be controlled by re-treatment.

Chamise regrowth can also be controlled by aircraft spraying during the first spring after a fire, using the same herbicides as above and a spray volume of 5 gallons per acre. Timing is critical: plants should have sprouted but regrowth over 10 inches tall is often hard to kill with a single spraying; excessive growth following rainy periods, or insufficient growth due to drought, reduces effectiveness of sprays.

Good to excellent control of chamise with one application is obtained 50 to 60 per cent of the time. When good control is not obtained with one application satisfactory control is normally achieved with one or two annual re-treatments. An additional advantage of re-treatment is that many of the other sprouting species present require repeat applications for control (sprouting manzanita, toyon, poison oak). Nearly all brush seedlings are killed by aircraft treatment, but new seedlings may develop where grass is sparse or nonexistent. When good control of chamise and brush seedlings has been obtained, the remaining plants are best controlled by individual plant treatment.

Grazing is important in converting chamise-covered areas to grass and in maintaining the conversion. Perennial grass and clovers are highly desirable as they help control brush and weeds. On areas where grass grows poorly a certain amount of spraying is necessary to prevent return of brush.

Shrubby vegetation (often spoken of as "chaparral") is widespread in California, and is comprised of manzanitas, Ceanothus, shrub oaks, chamise, and other predominately evergreen shrubs. Areas needing control should be crushed (if possible), burned, and seeded to grass. Spraying should begin the following spring (as with chamise), although the date of spray application should be slightly later to allow time for sprouts to develop. At least 4 pounds of brush killer per acre should be used, and more than one re-treatment must be made for good control. Unwanted plants remaining after three annual aircraft applications should be given individual treatment (shrub oaks are the most difficult to control). Grazing helps greatly in achieving and in maintaining control.

3. Dense chaparral converted to grass by burning, seeding, and spraying. Note small, untreated plots on left

Woodland and woodland-grass areas may be converted to grasslands by using individual plant treatments. It is advisable that trees be felled in winter and the stumps treated with 2,4-D amine (see **Stump Treatments,** page 8). Treated areas should be burned after about 1½ years and then seeded to grass. Grazing does much to control brush regrowth, but a back-pack mist blower can be used where needed.

Trees can also be treated by the cut-surface method, preferably during winter or spring, using 2,4-D amine. Such plants as understory poison oak, and coffeeberry, are "released" and grow better because of treatments—they can be sprayed with a back-pack mist blower. Grass growth beneath treated trees is usually markedly increased. Burns should not be made for several years in order to allow dead trees to fall and furnish fuel for a good burn.

Two or three annual individual plant treatments are usually needed to control sprouts which develop abundantly on oak woodlands that have been burned, or bulldozed and burned. Oaks are controlled with difficulty, so all parts of them should be carefully covered with spray. Sprouts of interior live oak, blue oak, and poison oak are more sensitive to silvex sprays than to either 2,4-D or 2,4,5-T. Where interior live oak and blue oak are present in limited numbers, fenuron pellets may be more economical than sprays because of reduced labor costs. Two ounces of pellets per clump may be used on blue oak, and three ounces on live oak.

Big sagebrush and green rabbitbrush are controllable with esters of 2,4-D. Big sagebrush is the dominant shrub on large areas of California range; green rabbitbrush is dominant or important only on limited areas. Range grasses respond quite favorably when released from competition with these shrubs.

Big sagebrush can be controlled by aircraft spraying of 2 pounds of 2,4-D per acre, with ½-gallon of diesel oil and water to make 5 or 6 gallons of spray. Spray should be applied when plants are growing vigorously and the first new leaves are as large as the old leaves.

Green rabbitbrush is deciduous and is sprayed at a later date than big sagebrush. Spraying should begin after the new twig growth has attained an average length of 3 inches; spraying can continue as long as there is enough soil moisture for vigorous growth. A single application of 3 pounds of 2,4-D ester per acre, with ½-gallon of diesel oil and water to make 5 or 6 gallons of spray, controls about 80 per cent of the plants. A good kill of big sagebrush and green rabbitbrush can be obtained by spraying with 3 pounds of 2,4-D per acre at this time.

FOREST AND REFORESTATION PROBLEMS

Chemical control of undesirable woody plants, either trees or brush, can be of value on forest lands as well as on range lands, and commercial use of herbicides in reforestation programs in California has been increasing since 1954. The growth of desirable forest trees can be speeded either on seeded areas or in natural stands by removal of competitive growth and by careful manipulation of the vegetation. Although undesirable woody species may be similar on range and on forest land, the objectives of control are different. Maximum tree growth requires a reduction in competition for both light and moisture. Grass is not desirable because of competition and because it is attractive to wildlife (particularly deer) and livestock which damage small trees.

Fortunately, conifers are moderately resistant to 2,4-D and 2,4,5-T except when the shoots are growing. In general, 2,4-D is more damaging to conifers than is 2,4,5-T.

Spraying after burning or mechanical clearing should be done as soon as possible to achieve quicker planting, to allow less time for grass to become established, and to best control brush seedlings and sprouts. A burned-over area provides favorable conditions for sprout development and establishment of grass—and these attract deer and other wildlife detrimental to young Douglas fir. Areas covered with chemically killed brush, however, are neither as accessible nor as attractive to deer as are burned areas. Broadcast spray applications should be made between June 15 and August 15. Mountain misery, brush seedlings, and broad-leafed weeds are most readily controlled following this plan. Trees can be planted in the winter or spring following spraying. Better plant kills are likely to be obtained—and this is an important consideration for areas where an appreciable investment will be made in planting.

Newly established plantations or young natural seedlings of Ponderosa pine can tolerate 1 pound of 2,4,5-T per acre soon after shoot growth stops in the summer; tolerance increases rapidly so that the small pines can usually withstand 2 pounds of 2,4,5-T per acre after mid-August. Pines 5 or more years old appear slightly more tolerant to sprays than do younger trees. Mist-blower sprays are more damaging than sprays applied with a boom. Pines may become slightly more sensitive to autumn sprays if early autumn rains occur.

Established stands of conifers may often be released by controlling competing vegetation. Conifers in the immediate vicinity of trees treated by the cut-surface method show a growth increase; this may develop within 2 years after treatment.

Dormant sprays applied by helicopter on madrone and tan oak are most effective when applied between mid-March and bud-break of the Douglas fir. It is suggested that 3 pounds acid equivalent of an equal mixture of 2,4-D and 2,4,5-T esters be applied, either in sufficient diesel to make 10 gallons of mix per acre, or as an emulsion using 1 gallon of diesel and water to make 10 gallons of spray per acre. A second application will be required in a few years. Some of the madrone is killed by these treatments, and tan oak is severely damaged. Re-

covery of these trees is slow, which gives the conifers an opportunity to grow. Understory grand fir, hemlock, and western cedar benefit from the spraying, even though sprays may cause injury. Recovery normally requires 1 to 3 years.

Dormant sprays should be applied on the deciduous species of red alder and vine maple when buds of these species are breaking. The spray mixture consists of 2 pounds of 2,4,5-T (ester) in 9½ gallons of diesel oil per acre. In such treatments, alders 8 inches or less in diameter are often killed, but vine maple is top-killed only. Other associated species (bay, madrone, chinkapin, snowbrush ceanothus, cascara) are top-killed; sprouting is vigorous on snowbrush ceanothus and cascara following treatment. It is not yet known whether a single spraying will sufficiently release conifers when the latter two plants are the dominant species present.

Proper helicopter spraying on Douglas fir in summer causes little damage to this tree after shoot elongation has ceased. A treatment consisting of 1½ pounds of 2,4,5-T ester in ½-gallon of diesel oil, with water to make 8 gallons per acre, gives moderate control of blueblossom ceanothus, snowbrush ceanothus, and cascara. Some commerical spraying is done during the period of shoot growth of the Douglas fir in order to achieve better brush control—but tree injury suggests that this period should be avoided if possible.

Tall trees and snags make helicopter application unsafe and good application by any means impossible, so they should be felled prior to spraying. Stumps of sprouting species should be treated to reduce or prevent sprouting. Areas to be treated should have an adequate stand of understory conifers.

SPECIAL PROBLEMS

Wild currants and gooseberries (Ribes spp.) are alternate hosts to the white pine blister rust which has been so destructive to white and sugar pine in northern California. Individual plant treatments are required for control (table 1).

4. Fuel breaks can be attractive as well as useful. Woody growth was cut and burned, sprouts and seedlings were sprayed, and the area seeded to grass. (Photo courtesy California State Division of Forestry.)

Fuel breaks—cleared paths located on woody or brushy ridges and elsewhere—are important in controlling fires. They are of two types. One type is produced by removing all woody growth on the breaks, and is common in chaparral areas. The other type of break is used in wooded areas, and is produced by removing dense stands of understory brush and some trees.

The best time to develop a fuel break in chaparral is after a fire, since most of the fuel is consumed at this time and the new sprouts and seedlings are more easily controlled than the old brush. In southern California helicopters are used to spray wide strips in order to prevent re-establishment of a brush cover. Dosages for such sprays are normally twice that used on range areas, and two or more applications are made at yearly intervals. Back-pack mist blowers and fenuron pellets may be used in the final cleanup of breaks. Grass establishes naturally on breaks and retards the re-establishment of brush. Grazing of breaks helps prevent return of brush cover.

The use of brush-free breaks in wooded or forested areas should be greatly expanded. Shrubs and dense stands of small trees should be removed to create a park-like effect. Trees and grass help prevent return of brush understory, and limited spraying will help maintain the breaks.

Fire hazard reduction around homes and buildings in brushy areas is often of vital concern. Widely scattered native shrubs and trees should be left for landscape purposes, and their natural adaptation to a site is an important consideration in landscaping. Unwanted woody plants can be controlled by methods already described. Keeping dry grass at a minimum helps control fire, and this can be aided by grazing. Where this is undesirable, grass should be reduced by mowing or chemical treatment. Most native woody plants can tolerate a low dosage of a combination of simazine, amitrole, and 2,4-D applied to the soil in winter.

Water supplies often can be increased by controlling woody plants around

5. Fire hazard around dwellings can be reduced by removing most of the brush. Attractive shrubs can be left for landscaping.

6. Poison oak control in coastal live oak woodland. Photos show an area (left) before control was started, and an area (right) after control was achieved.

springs and streams, and there is evidence that water yields may be increased on watersheds by substituting grass for woody growth (it is often desirable to leave a few shrubs and trees for scenic effect). Watersheds should be grazed to reduce fire hazard and to help prevent reinvasion by woody plants.

Stream beds are often clogged with woody growth which restricts water flow and may use quantities of water. Such woody growth can be controlled with amine forms of 2,4-D and 2,4,5-T applied in spring and summer. If it is necessary to delay spray applications until mid-fall, ester sprays containing 10 per cent diesel oil should be used.

Good control of willows and cottonwood has been obtained with AMS in the Salinas Valley, where the use of 2,4-D and 2,4,5-T is hazardous. The control achieved in this area was probably aided by foggy conditions which enhance absorption. Maintenance spraying is necessary to prevent return of the brush.

Woody plants on right-of-ways restrict accessibility, constitute a fire hazard and may entangle transmission lines. Ground spray equipment has been used for most herbicide applications on right-of-ways in California.

Invert emulsions applied by helicopter with equipment already described have been used to a limited extent in California. Since the swath width can be carefully regulated, practically all the spray falls on the right-of-way and plants immediately adjacent show little effect. However, a few fine droplets which may drift onto sensitive crops are produced, so caution is necessary.

Poison oak may be controlled by brush killer, amitrole, silvex, AMS, and picloram. Applications are most effective after all of the major stems have some mature leaves. Spraying should cease when the leaves start to turn red or yellow. The most effective period for spraying will vary according to rainfall, elevation, slope, etc., but seldom lasts over a month or two at any one location.

Complete control of poison oak requires one or more annual re-treatments. Occasional maintenance spraying should be planned after reasonable control has been achieved. Poison oak regrowth is slow in developing the year following the initial spray, and treatment should be delayed until a few mature leaves have developed. Most efficient control is obtained by spraying every other year.

Brush killer is usually recommended for poison oak on rangeland because it is economical, and because it will at the same time control most other woody plants. Silvex is better than brush killer when applied at a very low volume with a mist blower.

Picloram is also a good killer of poison oak but some re-treatment should be anticipated.

Amitrole is preferred for poison oak control around the home and in parks because it is less likely to damage wanted plants, and because it is effective over a longer period of the growing season than is brush killer. Amitrole will injure grass, however, and should be used with caution around conifers (see caution on use of amitrole on rangeland).

AMS may be used for controlling poison oak but is less effective than amitrole.

Regulations on Injurious Herbicides

Certain herbicides including 2,4-D, 2,4,-5-T, MCPA, 2,4-DP, and silvex are classified as injurious materials because drift from treated areas may affect surrounding desirable plants. Before they can be purchased or used, a permit must be obtained from the County Agricultural Commissioner.

These phenoxy herbicides, particularly 2,4-D, 2,4,5-T, and silvex, are widely used for woody-plant control and are relatively nontoxic in amounts normally used. The precautions listed herein are for continued safe use of herbicides rather than an indication of undue hazard.

Herbicide Residues

New herbicides and formulations are registered and continually appear on the market. These herbicides will be included in the recommendations after the University of California verifies their effectiveness and determines that the registered use will not result in a residue exceeding the legal tolerance when used under California conditions.

These suggestions for woody-plant control are based on the best information currently available for each herbicide listed. If followed carefully, they should result in satisfactory control and should not leave residues that will exceed the tolerance established for any particular chemical. To avoid excessive residues, follow directions carefully with respect to dosage levels, number of applications, and minimum interval between application and harvest or grazing.

Drift of Herbicides

Drift of herbicides is by far the most important cause of illegal residues on forage crops and damage to susceptible crops. No herbicide can be applied by either aerial or ground equipment without some drift occurring; however, less drift occurs from a ground application than from an aerial application, and sprays cause less drift than do dusts.

Drift can be kept to a minimum and the contamination or damage to other crops reduced if certain precautions are observed in the selection of the herbicide, method of application, type of formulation (dust, spray, or granular), timing of treatment, wind direction and velocity and the distance between the point of application and the nearest susceptible crop downwind.

It is the responsibility of the farmer and the applicator to consider the above points before applying a herbicide. Where possible, these recommendations offer several alternatives for control. The herbicide which will best meet the requirements for a safe application in respect to surrounding crops, animal farming operations, beneficial insects and wildlife should be selected.

University of California Policy for Making Pest Control Recommendations

Pest control recommendations made by University of California personnel are based upon those materials for which there is specific information regarding effectiveness under California conditions, residues that will remain on the crop at harvest, phytotoxicity, and wherever possible their effect upon beneficial predators, parasites, honey bees, fish and other wildlife. Recommended chemicals must also be registered and labeled for use both by the United States Department of Agriculture and the California State Department of Agriculture.

Wildlife

To protect fish and other wildlife, do not apply known harmful herbicides over canals or streams and do not allow drainage from treated fields to enter waterways immediately after application. Special

precautions regarding protection of wildlife species will be given, when necessary, in the recommendation.

THE GROWER IS RESPONSIBLE for residues on his own crop as well as for problems caused by drift from his property to other properties or crops.

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In order that the information in our publications may be more intelligible it is sometimes necessary to use trade names of products or equipment rather than complicated descriptive or chemical identifications. In so doing it is unavoidable in some cases that similar products which are on the market under other trade names may not be cited. No endorsement of named products is intended nor is criticism implied of similar products which are not mentioned.

Table 1. Foliage Spray Concentrations for Individual Plant Treatment

Plant	Chemical	Pounds of chemical per 100 gallons of diluent*	Diluents	Comments
Alder, red	Brush killer	2	Water	High degree of kill is common with one application; 2,4–D is also effective.
Arrowweed	2,4–D amine	2	Water	April through October.
Blackberry	2,4,5–T ester or silvex ester	2–3	Water plus ½-gallon diesel oil	Spray as long as soil moisture is adequate for growth. Burn canes in the fall. Plan on one or two re-sprays fo complete kill.
	Amitrole	3–4	Water plus wetting agent	Spray as long as soil moisture is adequate for growth. Burn the canes in the fall. Plan on one or two re-sprays for complete kill.
Buckeye	Brush killer	2–3	Water plus ½-gallon diesel oil	Re-treatment necessary following year.
Broom, Scotch	2,4–D ester	2	Water plus ½-gallon diesel oil	Spray while in flower.
	2,4,5–T ester	2	Water plus ½-gallon diesel oil	For older plants.
Ceanothus (all species)	2,4,5–T ester	2	Water plus 1-gallon diesel oil	Spray while soil moisture is adequate for growth.
Chamise	Brush killer	4	Water plus 1-gallon diesel oil	Winter and spring best, when soil moisture conditions are good.
Chaparral whitethorn	Brush killer	2	Water plus 1-gallon diesel oil	Most effective on sprouts and seedlings.
Cherry	2,4,5–T ester	4	Water plus 1-gallon diesel oil	Best on regrowth after fire. One or two re-treatments necessary.
Chinkapin, Sierra evergreen	2,4,5–T ester	4	Water plus 1-gallon diesel oil	Two or three applications necessary.
Coffeeberry	2,4–D ester	4	Water plus 1-gallon diesel oil	One or two re-treatments necessary.
Cottonwood	Brush killer	4	Water plus ½-gallon diesel oil	Re-treatment necessary. Use 10 per cent diesel oil in the fall.
Coyotebrush	2,4–D ester or amine	2	Water plus ½-gallon summer oil (with amine only)	Best April through July.
Currants and gooseberries (Sierra gooseberry, stink currant, Sierra currant, western black currant, fuschia gooseberry)	2,4–D ester	½–1	Water plus ½-gallon summer oil	Thoroughly spray leaves, stems, and bases. Best in period of active growth. See USDA Circ. 906 (1952).
Sticky currant, California gooseberry, wax currant, red-flowered currant, Lobbs gooseberry	Brush killer or 2,4,5–T	1–1½	Water plus ½-gallon summer oil	Thoroughly spray leaves, stems, and bases. Best in period of active growth.

Siskiyou gooseberry, nutmeg currant, white stemmed gooseberry, swamp black currant, hupa gooseberry, Menzies gooseberry, mountain gooseberry, Tulare gooseberry, trailing black currant	2,4,5–T ester	2	Water plus ½-gallon summer oil	Spray as for other species of *Ribes*. Use 10 per cent diesel oil during late season and spray whole plant, soaking basal plants well.
Deerbrush ceanothus	2,4–D or 2,4,5–T ester	1–2	Water plus ½-gallon diesel oil	June through July. Seedlings and young plants most sensitive.
Elderberry	Brush killer	2	Water	Re-treatment necessary.
Eucalyptus	2,4,5–T ester	4	Water plus 1-gallon diesel oil	Spray sprouts in spring. Re-treatment necessary.
Gorse	2,4,5–T ester	4	Water plus 1-gallon diesel oil	Burn. Spray regrowth when 2 ft. tall. Several re-treatments necessary.
Grape	2,4–D amine	4	Water	Midsummer and later if soil moisture high.
Hazel	2,4–D ester	2	Water	Spray after leaves fully expanded. Two applications may be necessary.
Hollyleaf buckthorn	Brush killer	4	Water plus 1-gallon diesel oil	One or two re-treatments necessary.
Madrone	2,4–D ester	4	Water plus 1-gallon diesel oil	Effective when dormant and growing. Re-treatment necessary.
Manzanita, non-sprouting forms	2,4–D ester	4	Water plus 1-gallon diesel oil	Period of active growth. Moderately effective when dormant.
Manzanita, sprouting forms	2,4–D ester	4	Water plus 1-gallon diesel oil	Period of active growth.
Maple, big leaf and vine	2,4,5–T ester or silvex	3	Water	Several repeat applications necessary. Difficult to control by foliage sprays.
Oak, black	Brush killer or 2,4,5–T ester	4	Water plus 1-gallon diesel oil	Re-treatment necessary.
Oak, blue, Oregon and valley	Brush killer or silvex	4	Water or water plus 1-gallon diesel oil	Spray sprouts from May through June. Re-treatment necessary.
Oak, interior live, California live, and canyon live	Brush killer or silvex	4	Water plus 1-gallon diesel oil	Spray when leaves are plentiful and soil moisture moderate or high. Re-treatment necessary.
Oak, California scrub and leather	Brush killer	4	Water plus 1-gallon diesel oil	Same as for live oak.
Oak, tan	Brush killer	4	Water plus 1-gallon diesel oil	Spring dormant period best. Re-treatments required. About equally senstitive to 2,4–D and 2,4,5–T.
Poison oak	Brush killer or silvex	2–3	Water plus ½-gallon diesel oil	Spray after leaves fully expanded and before they turn yellow or reddish. Two or more re-applications at yearly intervals needed.
	Picloram	2	Water plus wetting agent	As above.
	Amitrole	5	Water plus wetting agent	As above.
	AMS	75	Water plus wetting agent	As above.

Table 1.—continued

Plant	Chemical	Pounds of chemical per 100 gallons of diluent*	Diluents	Comments
Redbud	2,4,5-T	4	Water plus 1-gallon diesel oil	Spray after leaves fully expanded in spring. Re-treatment necessary.
Redwood	2,4-D ester	12	Water plus ½-gallon diesel oil	Spray sprouts in September or later. Re-treatment necessary.
Rose, California	2,4,5-T ester	4	Water plus 1-gallon diesel oil	Spray when flowering; re-treatment required.
Salmonberry	Amitrole	3	Water plus wetting agent	Associated Douglas fir will be injured.
Saltcedar	Silvex	4	Water plus ½-gallon diesel oil	Most effective on regrowth; spring treatment is better than fall.
Thimbleberry	2,4,5-T ester	3	Water plus 1-gallon diesel oil	Spray during periods of active growth. Thorough coverage of whole plant necessary for high degree of kill. Re-treatment necessary.
Toyon	2,4-D ester	4	Water plus 1-gallon diesel oil	Most effective on regrowth after a burn. Dormant sprays are effective. Re-treatment necessary.
Tree of heaven	2,4-D ester	4	Water plus 1-gallon diesel oil	Several sprayings necessary to eliminate this plant completely.
Willow	2,4-D ester	3	Water or water plus 1-gallon diesel oil	Spray as long as soil moisture is satisfactory and leaves are green and healthy. Re-treatment is necessary and varies with species.
	AMS	75	Water plus wetting agent	Best in foggy areas. Other comments same as above.

* Use actual lbs. of chemical. For mist-blower application use 4 to 8 gallons of diluent.

Table 2. Woody Plant Control Using Broadcast Spray Applications with Ground Rigs, Mist Blowers, and Aircraft*

Plant	Chemical	Pounds of chemical per acre*	Diluents	Comments
Alder, red	2,4–D or brush killer	2	Water plus ½-gallon diesel oil	Most effective on trees less than 8″ in diameter when growing.
	2,4,5–T ester	2	Diesel oil	March to early April at bud-break.
Blackberry	Silvex ester	4	Water plus ½-gallon diesel oil	Spray when most canes are flowering. Re-treatment necessary.
Blueblossom ceanothus	2,4,5–T ester	3	Diesel oil	Spray June or July.
Cascara	Amitrole	2	Water	
Ceanothus, mature plants	2,4,5–T ester	2–3	Diesel oil	2,4,5–T effective on all species, but some require re-treatment. Some species can be treated when dormant.
Ceanothus, 1- and 2-year-old seedlings	2,4–D or 2,4,5–T ester	2	Water plus ½-gallon diesel oil	Spray before moisture limits growth.
Ceanothus, big pod and spiny	2,4–D or 2,4,5–T ester	3	Diesel oil	
Ceanothus, wedgeleaf	2,4,5–T	2	Diesel oil	
Chamise, old mature	Brush killer	6	Water plus 1-gallon diesel oil	Re-treatment may be necessary.
	Picloram	2	Water plus wetting agent	
Chamise sprouts and seedlings	Brush killer or 2,4–D ester	4	Water plus ½-gallon diesel oil	First year regrowth best, especially when sprayed by aircraft. Treat late April through May. Re-treatment often necessary.
				Two-year and older sprouts and seedlings controllable with ground equipment or repeated aircraft treatments, March through May. Kill enhanced by increasing dosage.
Chaparral whitethorn	2,4,5–T ester	3	Diesel oil	Most effective on sprouts.
Conifers	2,4–D ester	12	Diesel oil	When very actively growing. California nutmeg is resistant. Re-treatment may be necessary.
Cottonwood	AMS	75	Water plus 10-gallon diesel oil (and emulsifier)	Best in foggy areas.
Coyotebrush	2,4–D amine or ester	4	Water plus ½-gallon summer oil	Best from May through July.
Deerbrush ceanothus	2,4–D or 2,4,5–T ester	2–3	Water plus ½-gallon diesel oil	Best during growing season. Spray at a later date in pine plantations.
Deerweed	2,4–D ester	2	Water plus ½-gallon diesel oil	Young plants most sensitive.

Table 2.—continued

Plant	Chemical	Pounds of chemical per acre	Diluents	Comments
Goldenfleece	2,4–D ester	2	Water plus ½-gallon diesel oil	Young plants most sensitive.
Lupine	Brush killer	2	Water	When flowering.
Madrone	Brush killer	3	Water plus 1-gallon diesel oil or diesel oil only	Best in March–April. Re-treatments necessary for complete control; however, one spray may be enough to release conifers.
Manzanita, sprouting	2,4–D ester	4	Water plus ½-gallon diesel oil	On sprouts following a fire. Requires at least one application per year for 3 years.
Manzanita, non-sprouting mature plants	2,4–D ester	4	Water plus ½-gallon diesel oil	Best when growing. Some species controlled with one spray; others require more.
Manzanita, 1- and 2-year-old seedlings	2,4–D ester	3	Water plus ½-gallon diesel oil	After growth starts in spring but while soil moisture is high.
Maple, vine	2,4,5–T ester	2	Diesel oil	March to early April at bud-break. For conifer release.
Mountain mahogany	Brush killer	4	Diesel oil	Spray sprouts following burn the previous year. Re-treat the following year.
Mountain misery (or bear-mat)	2,4–D or 2,4,5–T ester	2–4	Water plus ½-gallon diesel oil	Growing season best. Old growth requires one or two re-treatments while regrowth after a fire requires at most only one re-treatment. 2,4–D is most effective, but 2,4,5–T is most selective if conifers are present.
Oak, blue	Silvex	2	Water plus 1-gallon diesel oil	Only when growth is most active. Three sprays give moderate control.
Oak, California scrub	Brush killer	4	Diesel or summer oil	Spray sprouts second year after burn. Re-treatments necessary.
Oak, tan	Brush killer	3	Water plus 1-gallon diesel oil or diesel oil only	Same comments as for madrone. Used for release of Douglas fir.
Poison oak	Brush killer or silvex	3	Water plus ½-gallon diesel oil	Spray after leaves fully expanded. Re-applications necessary.
Rabbitbrush, green	2,4–D ester	3	Water plus ½-gallon diesel oil	Spray after new growth has attained an average length of 3 inches and while soil moisture is high.
Sage, purple, white and creeping	2,4–D ester	4	Water plus ½-gallon diesel oil	After active growth starts in spring, while soil moisture is high.
Sagebrush, big, silver, and low	2,4–D ester	2	Water plus ½-gallon diesel or summer oil	After active growth has started (3–4 inches of new twig growth), while soil moisture is high.
Sagebrush, California	2,4–D amine or ester	4	Water plus 1-gallon summer oil	April through June, or after active growth has started, while soil moisture is still high.

Silktassel	Brush killer	4	Water plus 1-gallon diesel oil	Treat regrowth in spring following a burn.
Snowbrush ceanothus	2,4,5–T ester	2	Diesel or water plus ½-gallon diesel oil	May use diesel oil during spring dormant period, and water—diesel during growing season. Snowbrush control is enhanced if dosage increased, but conifer damage is increased. Sprouting is variable.
Sumac, laurel	2,4–D ester	4	Water plus ½-gallon diesel oil	Spray sprouts following burn the previous year. Re-treat following year.
Toyon	2,4–D ester	4	Water plus ½-gallon diesel oil	Spray sprouts following burn the previous year. Re-treat following year.
Whitethorn, mountain	2,4–D or 2,4,5–T ester	2	Water plus ½-gallon diesel oil	Increase dosage to 4 lbs. if no conifers present.
Willow	2,4–D ester	4	Water plus ½-gallon diesel oil	Spray as long as soil moisture is high enough for growth. Species of willow vary greatly in their sensitivity to 2,4–D and re-treatments are necessary.
	AMS	75	Water plus 10-gallon diesel oil and emulsifier	Best in foggy locations.
Yerba santa, California and woolly	2,4–D ester or brush killer	4	Water plus ½-gallon diesel oil	Spray after active growth has begun but while soil moisture is high. Most sensitive within 2 years of burn (sprouts less than 2 years old).

* Use actual lbs. of chemical. The total volume of spray per acre should be 20–40 gallons by ground rig, and 5–10 gallons by mist blower and aircraft.

Table 3. Control of Woody Plants Using the Cut-Surface Method (2,4–D Amine Unless Otherwise Indicated)*

Common name of tree	Spacing of cuts	Comments
Buckeye	Frill†	Late fall to late spring best
Cottonwood	Cuts 6 inches apart	Effective at all seasons.
Fir, Douglas	Cuts 6 inches apart	Some trees survive unless very carefully done
Laurel, California	Frill	Late fall through midsummer best
Madrone	Cuts 6 inches apart	Late fall through midsummer best
Maple, bigleaf	Frill—use 2,4,5–T, amine or silvex	Same chemical should be used on maple stumps
Oak, black	Frill	Late fall through midsummer best
Oak, blue, valley and Oregon	Cuts 6 inches apart	Late fall through spring best
Oak, interior live, California live, canyon live, tan and California scrub	Frill	Late fall through spring best; these are vigorous sprouting species so careful application is necessary
Pine, digger and ponderosa	Cuts every 8 inches	Cuts must penetrate into the wood to be effective
Willow	Frill	Effective at all times

* See discussion of picloram, page 5.
† Frill = continuous line of cuts.

Table 4. Control of Woody Plants with Basal Sprays*

Common name of plant	Chemical	Comments
Alder, red	Brush killer	Spring is better than winter; make cuts in larger stems
Chamise, ceanothus, Scotch broom, common broom, tree tobacco	Brush killer	Sensitive and readily killed
Cottonwood and willow	Brush killer	Make cuts in larger stems
Currants and gooseberries	Brush killer	Thoroughly soak bases (crowns) for high degree of control
Maple, bigleaf	2,4,5–T or silvex	March through early summer
Maple, vine	2,4,5–T	
Oak, blue	Brush killer	Two fluid ounces per inch stem diameter; effective at all times
Oak, interior live, coast live, canyon live, tan and black	2,4,5–T best, but brush killer will do	Three fluid ounces per inch stem diameter; best in spring; make cuts in larger stems
Poison oak	Brush killer	Spring and early summer; re-applications necessary
Rose, California	2,4,5–T ester	Thoroughly wet all sides of the stems and crowns; best when soil has medium moisture content

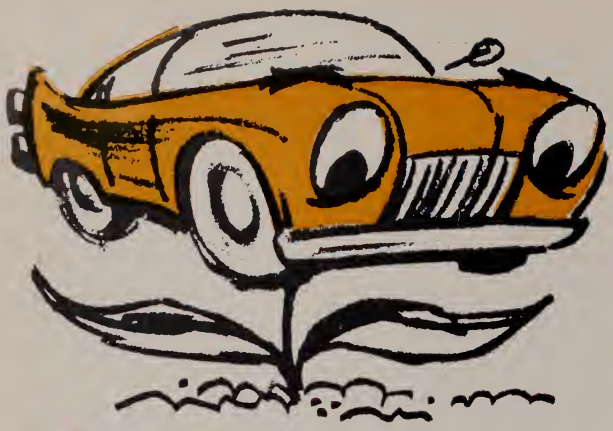
* Use 16 lbs. actual chemical (ester formulations) per 100 gallons of diesel oil.

APPENDIX

Common and scientific names of woody plants mentioned in tables 1, 2, 3, and 4.

Common name	Scientific name	Table under which control is outlined
Alder, red	*Alnus rubra*	1, 2, 3
Arrowweed	*Pluchea sericea*	1
Blackberry	*Rubus* spp.	1
Blueblossom ceanothus	*Ceanothus thyrsiflorus*	2
Buckeye, California	*Aesculus californica*	1, 3
Broom, Scotch	*Cytisus scoparius*	1, 4
Broom, common	*Spartium junceum*	4
Cascara, buckthorn	*Rhamnus purshiana*	2
Ceanothus	*Ceanothus* spp.	1, 2, 4
Ceanothus, bigpod	*C. megacarpus*	2
Ceanothus, spiny	*C. spinosus*	2
Ceanothus, wedgeleaf (buckbrush)	*C. cuneatus*	2
Chamise (greasewood chamise)	*Adenostoma fasciculatum*	1, 2, 4
Chaparral whitethorn	*Ceanothus leucodermis*	1, 2, 4
Cherry	*Prunus* spp.	1
Chinkapin, Sierra evergreen	*Castanopsis sempervirens*	1
Coffeeberry, California	*Rhamnus california*	1
Cottonwood	*Populus* spp.	1, 2, 3, 4
Coyotebrush (kidneywort baccharis)	*Baccharis pilularis*	1, 2
Currants and Gooseberries		1, 4
Sierra gooseberry	*Ribes roezlii*	1
Stink currant	*R. bracteosum*	1
Sierra currant	*R. nevadense*	1
Western black currant	*R. petiolare*	1
Fuchsia gooseberry	*R speciosum*	1
California gooseberry	*R. californicum*	1
Wax currant	*R. cereum*	1
Lobbs gooseberry	*R. lobbii*	1
Redflowered currant	*R. sanguineum*	1
Sticky currant	*R. viscosissimum*	1
Siskiyou gooseberry	*R. binominatum*	1
Nutmeg currant	*R. glutinosum*	1
Whitestem gooseberry	*R. inerme*	1
Swamp black currant	*R. lacustre*	1
Trailing black currant	*R. laxiflorum*	1
Hupa gooseberry	*R. marshalii*	1
Menzies gooseberry	*R. menziesii*	1
Mountain gooseberry	*R. montigenum*	1
Tulare gooseberry	*R. tularense*	1
Deerbrush ceanothus	*Ceanothus integerrimus*	1, 2
Deerweed (broom deervetch)	*Lotus scoparius*	2
Elderberry	*Sambucus* spp.	1
Eucalyptus	*Eucalyptus* spp.	1
Fir, Douglas	*Pseudotsuga menziesii*	3
Golden fleece (Fleece Goldenweed)	*Haplopappus arborescens*	2
Gorse	*Ulex europaeus*	1
Grape	*Vitis* spp.	1

Common name	Scientific name	Table under which control is outlined
Hazel, California	*Corylus cornuta* var. *californica*	1
Hollyleaf buckthorn	*Rhamnus crocea* var. *ilicifolia*	1
Laurel, California	*Umbellularia californica*	3
Lupine, stream	*Lupinus rivularis*	2
Madrone, Pacific	*Arbutus menziesii*	1, 2, 3
Manzanita, nonsprouting	*Arctostaphylos viscida*	1, 2
	A. manzanita	1, 2
	A. glauca	1, 2
Manzanita, sprouting	*A. patula*	1
	A. glandulosa	1
Maple bigleaf	*Acer macrophyllum*	1, 3, 4
Maple, vine	*A. circinatum*	1, 4
Mountain misery (or bear-mat)	*Chamaebatia foliolosa*	2
Mountain mahogany	*Cercocarpus* spp.	2
Nutmeg, California	*Torreya californica*	2
Oak, blue	*Quercus douglasii*	1, 2, 3, 4
Oak, California black	*Q. kelloggii*	1, 3, 4
Oak, California scrub	*Q. dumosa*	1, 2, 3
Oak, canyon live	*Q. chrysolepis*	1, 3, 4
Oak, leather	*Q. durata*	1
Oak, California live	*Q. agrifolia*	1, 3, 4
Oak, interior live	*Q. wislizenii*	1, 3, 4
Oak, Oregon white	*Q. garryana*	1, 3
Oak, valley	*Q. lobata*	1, 3
Oak, tan	*Lithocarpus densiflora*	1, 2, 3, 4
Pine, digger	*Pinus sabiniana*	3
Pine, ponderosa	*P. ponderosa*	3
Poison oak (California poison oak)	*Rhus diversiloba*	1, 2, 4
Rabbitbrush, green	*Chrysothamnus viscidiflorus*	2
Redbud, California	*Cercis occidentalis*	1
Redwood	*Sequoia sempervirens*	1
Rose, California	*Rosa californica*	1, 4
Sage, creeping (Sonoma)	*Salvia sonomensis*	2
Sage, purple (whiteleaf)	*S. leucophylla*	2
Sage, white	*S. apiana*	2
Sagebrush, big	*Artemisia tridentata*	2
Sagebrush, low	*A. arbuscula*	2
Sagebrush, silver	*A. cana*	2
Salmonberry	*Rubus spectabilis*	1
Saltcedar	*Tamarix* spp.	1
Silktassel, Fremont	*Garrya fremontii*	2
Snowbrush ceanothus	*Ceanothus velutinus*	2
Sumac laurel	*Rhus laurina*	2
Thimbleberry, western	*Rubus parviflorus*	1
Toyon (Christmasberry)	*Photinia arbutifolia*	1, 2
Tree of heaven (ailanthus)	*Ailanthus glandulosa*	1
Tree tobacco	*Nicotiana glauca*	4
Whitethorn, Mountain	*Ceanothus cordulatus*	2
Willow	*Salix* spp.	1, 2, 3, 4
Yerba santa, California	*Eriodictyon californicum*	2
Yerba santa, woolly	*E. tomentosum*	2



ME! A FARM PRODUCT?

Well, not exactly—you can't grow automobiles on farms, but farm products are essential in manufacturing them. Consider the annual agricultural needs of just one major automobile company.

. . . . . 900,000 bushels of corn
736,000 bushels of flaxseed
74,000 bales of cotton

or, *in terms of approximate acreage:*

. . . . . 15,000 acres of corn
80,000 acres of flax
78,000 acres of cotton

During the same period this company used products derived from 364,000 sheep and 36,000 cattle—plus many other items such as hog bristles and beeswax. In all, produce equivalent to the output of 1,000 good-sized farms is needed yearly. No wonder a top executive in the automotive industry has said: "Our plants, here and throughout the world, would have to close their doors in a few days if their flow of agricultural materials were to stop."

Supplying America's countless industries—and feeding the nation bountifully—makes agriculture America's biggest and perhaps most important business. That is one reason why anything which affects agriculture affects everybody.