THIRTY-NINTH ANNUAL REPORT OF FORAGE RESEARCH IN THE NORTHEASTERN UNITED STATES

1975

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1975

Thirty-Ninth Annual Report of Forage Research in the Northeastern United States

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A Joint Contribution of the

U.S. Regional Pasture Research Laboratory

and the

Agricultural Experiment Stations

of the

Twelve Northeastern States

Participating Agencies

Beltsville Agricultural Research Center
Chesapeake-Potomac Area, and
North Atlantic Area
of the Northeastern Region
Agricultural Research Service, U.S. Department of Agriculture

and the

Agricultural Experiment Stations of

Connecticut (Storrs)
Delaware
Maine
Maryland
Massachusetts
New Hampshire
New Jersey
New York (Cornell)
New York (Geneva)
Pennsylvania
Rhode Island
Vermont
West Virginia

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This report is prepared for the official use of forage crop research workers in the region. Copies are sent to all organizations involved in the forage research program of the 12 Northeastern States, to all investigators in the Northeastern Region and to some interested institutions outside the region. Since it is reproduced in limited numbers it is not available for general distribution to individuals outside the region. Requests by institutions desiring to be placed on the mailing list or by individuals requesting a particular copy should be addressed to the Director, U.S. Regional Pasture Research Laboratory, University Park, PA 16802.

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PREFACE

This Annual Report is intended primarily for use by forage research and extension workers in the Northeastern United States. It contains brief reports of research projects conducted on forages at most of the State Agricultural Experiment Stations in the region as well as research on forages conducted by the Northeastern Region, Agricultural Research Service, U.S. Department of Agriculture. Our appreciation is extended to all contributors and to the contact person at each station who coordinated the collection of reports.

We attempted to have this report coincide with the writing of CRIS reports, but discovered that the State Experiment Stations and ARS have different due dates. Thus, a few projects are not represented in the present report. After the changes in fiscal year dates are completed, we will set a new due date for the report that more closely coincides with the writing of other research reports.

A special note of appreciation is due Mrs. Vicki Meyer and Mrs. Amina Birkenmayer, members of the Pasture Laboratory staff. They carried almost all of the responsibilities in getting this report assembled.

Your comments and suggestions on how this report might be improved would be greatly appreciated.

Richard R. Hill, Jr.
Acting Laboratory Director

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Roster of Research and Extension Workers in the Northeastern United States with Some Forage Crops and Grasslands Orientation

Name	Field of Interest	Department
University of Connecticut Storrs 06268		
Allinson, D. W.	Forage Management	Plant Science
Cowan, W. A.	Animal Nutrition	Animal Industries
Dest, W. M.	Weed & Turf Invest.	Plant Science
Griffin, G. F.	Soil Fertility	Plant Science
Peters, R. A.	Weed Investigations	Plant Science
Washko, W. W.	Forage Management	Plant Science
Wengel, R. W.	Soil Physics	Plant Science
University of Delaware Newark 19711		
Crittenden, H. W.	Legume Diseases	Plant Science
Fowler, R. E.	Beef Cattle Nutrition	Animal Sci. & Agr. Biochemistry
Haelein, G. F. W.	Nutritive Evaluation	do.
Jones, E. R.	Forage Management	Dept of Agriculture Delaware State College Dover, DE 19901
Mitchell, W. H.	Forage Management	Plant Science
Morehart, A. L.	Physiology	Plant Science
Reitnour, C. M.	Horse Physiology	Animal Sci. & Agr. Biochemistry
Svec, L. V.	Physiology	Plant Science
University of Maine Orono 04473		
Apgar, W. P.	Forage Utilization	Ani. & Vet. Sci.
Brown, C. S.	Forage Management	Plant & Soil Sci.
Forsythe, H. Y., Jr.	Forage Insects	Entomology
Holyoke, V. H.	Silage Corn Mgt	Plant & Soil Sci.
Rowe, R. J.	Engineering Harvesting	Agr. Eng.

Name	Field of Interest	Department
University of Maryland College Park 20742		
Clark, N. A.	Forage Mgt	Agronomy
Decker, A. M. Jr.	Forage Mgt	Agronomy
Leffel, E. C.	Animal Science	Animal Science
Vandersall, J. H.	Dairy Science	Dairy Science
University of Massachusetts Amherst 01002		
Fenner, Heinrich	Animal Nutrition	Vet. & Ani. Sci.
Mudgett, R.	Food & Agr. Eng.	Eng (Food & Agr)
Vietor, Donald	Plant & Soil Sci.	Plant & Soil Sci.
Whitney, L. F.	Agr. Eng.	Eng (Food & Agr)
University of New Hampshire Durham 03824		
Byers, G. L.	Agr. Eng.	Water Resources Res. Center
Dunn, G. M.	Genetics	Plant Science
Estes, G. O.	Forage Nutrition	Plant Science
Fairchild, T. P.	Animal Nutrition	Animal Sciences
Frick, G. E.	Agr. Economics	E.R.S.
Holter, J. B.	Animal Nutrition	Animal Sciences
Koch, D. W.	Forage Plant Phys.	Plant Science
Mitchell, J. R.	Forage Mgt	Plant Science
Peirce, L. C.	Genet. Hort. Crops	Plant Science
Rutgers University, The State University of New Jersey New Brunswick 08903		
Duell, R. W.	Highway Vegetation	Soils & Crops
Evans, J. L.	Nutritional Value	Animal Science
Halisky, P. M.	Plant Pathology	Plant Biology
Ilnicki, R. D.	Weed Control	Soils & Crops
Mears, D. R.	Agr. Eng.	Engineering
Race, S. R., Jr.	Forage Insects	Entomology & Economic Zoo.

Name	Field of Interest	Department
Rutgers University (Continued)		
New Brunswick 08903		
Ramage, C. H.	Production Util.	Animal Science
Singley, M. E.	Engineering Util.	Engineering
Sprague, M. A.	Mgt Preservation	Soils & Crops
Vander Noot, G. W.	Forage Util.	Animal Science
Cornell University (New York)		
Ithaca 14853		
Campbell, J. K.	Agr. Eng.	Agr. Eng.
Duke, W. B.	Weed Control	Agronomy
Fick, G. W.	Forage Phys. & Mgt.	Agronomy
Grunes, D. L.	Soils & Plant Nutr.	U.S. Plant, Soil & Nutr. Lab.*
Helgesen, R. G.	Entomology	Entomology
Linscott, D. L.	Weed Control	Agronomy
Lowe, C. C.	Genetics & Breeding	Plant Breed. & Biometry
Millar, R. L.	Plant Pathology	Plant Pathology
Murphy, R. P.	Genetics & Breeding	Plant Breed. & Biometry
Reid, J. T.	Animal Nutrition	Animal Science
Schaaf, H. M.	Genetics & Breeding	Plant Breed. & Biometry
Seaney, R. R.	Forage Mgt	Agronomy
Van Soest, P. J.	Animal Nutrition	Animal Science
New York State Agricultural Experiment Station		
Geneva 14456		
Braverman, S. W.	Plant Pathology	Seed Investigation & USDA-ARS
Dolan, D. D.	Plant Introduction	do.
Fiori, B. J.	Entomology	USDA-ARS, Ent.
Sherring, W. R.	Seed Technologist	Seed Investigations

*USDA-ARS Cooperative Appointment

Name	Field of Interest	Department
The Pennsylvania State University University Park 16802		
Ace, D. L.	Dairy Extension	Dairy Science
Adams, R. S.	Dairy Extension	Dairy Science
Bartlett, H. H.	Agr. Eng	Agr. Eng
Baumgardt, B. R.	Animal Nutrition	Animal Science
Baylor, J. E.	Pasture & Forage Crops (Extension)	Agronomy Extension
Bloom, J. R.	Nematode Control	Plant Pathology
Burdette, L. A.	Animal Nutrition Ext.	Animal Science
Cash, E. H.	Animal Nutrition	Animal Science
Cleveland, R. W.	Genetics & Breeding	Agronomy
Cowan, R. L.	Animal Nutrition	Animal Science
Downs, W. G.	Forage Mgt	Agronomy (P.O. Rector)
Dum, S. A.	Farm Mgt Ext	Economics
Fox, R. H.	Soil Fertility	Agronomy
Guss, S. B.	Vet. Sci. Ext.	Vet. Sci.
Hartwig, N. L.	Weed Control	Agronomy
Hershberger, T. V.	Animal Nutrition	Animal Science
Hower, A. A., Jr.	Forage Insects	Entomology
Johnson, M. W.	Corn Breeding	Agronomy
Kardos, L. T.	Soil Physics	Agronomy
Kesler, E. M.	Dairy Science	Dairy Science
Kjelgaard, W. L.	Agr. Eng.	Agr. Eng.
Knievel, D. P.	Forage Phys.	Agronomy
Kradel, D. C.	Vet. Medicine	Vet. Sci.
Long, T. A.	Animal Nutrition	Animal Science
Lukezic, F. L.	Forage Pathology	Plant Pathology
Marriott, L. F.	Soil Fertility	Agronomy
McKee, G. W.	Ecology, Phys.	Agronomy
Merritt, T.L.	Animal Science	Animal Science
Partenheimer, E. J.	Agr. Econ.	Agr. Econ. & Rural Sociology
Risius, M. L.	Genetics & Breeding	Agronomy
Shenk, J. S.	Forage Grass Breed.	Agronomy
Starling, J. L.	Genetics & Breeding	Agronomy
Thomas, W. I.	Representative NE	Agr. Exp. Sta.
Wangsness, P. J.	Animal Nutrition	Animal Science
Washko, J. B.	Forage Management	Agronomy
Wilson, L. L.	Animal Science	Animal Science
Yendol, W. G.	Non-Pesticide Insect Control	Entomology

Name	Field of Interest	Department
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Wakefield, R. C.	Management	Plant & Soil
University of Vermont Burlington 05401		
Gotlieb, A. R.	Plant Pathology	Botany
MacCollom, G. B.	Entomology	Entomology
Smith, A. M.	Animal Nutrition	Animal Sciences
Welch, J. G.	Nutritional Value	Animal Sciences
Wood, G. M.	Forage & Turf Mgt.	Plant & Soil Sci.
West Virginia University Morgantown 26506		
Anderson, G. C.	Animal Nutrition	Ani. & Vet. Sci.
Baker, B. S.	Forage Mgt	Allegheny Highlands Proj., Elkins, WV
Balasko, J. A.	Forage Phys.	Plant Sciences
Bennett, O. L.	Forage Mgt	Plant Sciences & USDA-ARS
Butler, Linda	Entomology	Plant Sciences
Diener, R. G.	Agr. Eng.	Resource Mgt.
Elliott, E. S.	Root Diseases	Plant Sciences
Horvath, D. J.	Animal Nutrition	Ani. & Vet. Sci
Keefer, R. F.	Soil Fertility	Plant Sciences
Pohlman, G. G.	Soil Fertility	Plant Sciences (Emeritus)
Reid, R. L.	Animal Nutrition	Ani. & Vet. Sci.
Thomas, R. O.	Dairy Nutrition	Ani. & Vet. Sci.
Toben, G. E.	Agr. Econ.	Resource Mgt
Ulrich, V.	Plant Breeding	Plant Sciences
Veatch, Collins	Weed Control	Plant Sciences (Emeritus)

Name	Field of Interest	Department
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Adams, J. R.	Entomologist	Insect Path. Lab.
Arminger, W. H.	Agronomist	Biol. Waste Mgt. Lab.
Barnes, R. F.	Forage and Range	Nat. Prog. Staff.
Bond, J.	Animal Science	Ruminant Nutr. Lab.
Cantwell, G. E.	Entomologist	Insect Path. Lab.
Carlson, G. E.	Agronomist	Light & Plant Growth Lab.
Chatterton, N. J.	Plant Physiol.	do.
Coulson, J. R.	Entomologist	Beneficial Insect Intro. Lab.
Dinius, D. A.	Animal Science	Ruminant Nutr. Lab.
Dubley, R. F.	Agric. Eng.	Physical Contr. Lab.
Elgin, J. H., Jr.	Agronomist	Field Crops Lab.
Faust, R. M.	Entomologist	Insect Path. Lab.
Feldmesser, J.	Zoologist	Nematology Lab.
Foote, R. H.	Agric. Admin.	Sys. Entomol. Lab.
Foy, C. D.	Soil Scientist	Plant Stress Lab.
Garrison, C. S.	Agronomist	Seed Quality Lab.
Goering, H. K.	Animal Science	Ruminant Nutr. Lab.
Goodwin, J. S.	Entomologist	Insect Path. Lab.
Graham, J. H.	Plant Path.	Plant Stress Lab.
Heimpel, A. M.	Entomologist	Insect Path. Lab.
Hill, K. R.	Chemist	Ana. Chem. Lab.
Hooven, N. W., Jr.	Animal Scientist	Ani. Oper. Unit
Howell, R. K.	Plant Path.	Air Pollution Lab.
Hyland, H. L.	Botanist	Germplasm Res. Lab.
Keyes, J. E., Jr.	Animal Scientist	Gene. & Mgt. Lab.
Klingman, D. L.	Weed Control	Turfgrass Lab.
Kulik, M. M.	Plant Path.	Seed Quality Lab.
Lentz, P. L.	Botanist	Mycology Lab.
Lindahl, I. L.	Chemist	Ruminant Nutr. Lab.
Louloudes, S. J.	Entonomogist	Insect Path. Lab.
Lynch, G. P.	Animal Scientist	Ruminant Nutr. Lab.
Marsh, P. B.	Plant Physiologist	Nutr. Microbio. Lab.
Moe, P. W.	Animal Scientist	Ruminant Nutr. Lab.
Murray, J. J.	Agronomist	Field Crops Lab.
Neal, J. W., Jr.	Entomologist	Field Crops Lab.
Oakes, A. J.	Agronomist	Germplasm Res. Lab.
Oltjen, R. R.	Animal Scientist	Runinant Nutr. Lab.
Ostazeski, S. A.	Plant Pathologist	Field Crops Lab.
Owens, L. D.	Plant Physiologist	Plant Nutr. Lab.
Pearson, R. E.	Genet. Animal	Genet. & Mgt. Lab.
Powell, J. B.	Geneticist	Field Crops Lab.

Name	Field of Interest	Department
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Reynolds, P. J.	Animal Scientist	Ruminant Nutr. Lab.
Rumsey, T. S.	Animal Scientist	Ruminant Nutr. Lab.
Schechter, M. S.	Chemist	Chem. & Biophys. Control Lab.
Schroder, R. F.	Entomologist	Beneficial Insect Intro. Lab.
Simpson, M. E.	Plant Pathologist	Nutr. Microbio. Lab.
Slyter, L. L.	Chemist	Nutr. Microbio. Lab.
Smith, L. W.	Animal Scientist	Bio. Waste Mgt. Lab.
Terrell, E. E.	Botanist	Plant Taxonomy Lab.
Toole, V. K.	Plant Physiologist	Seed Quality Lab.
Tyrrell, H. F.	Animal Scientist	Ruminant Nutr. Lab.
Vaughn, J. L.	Microbiologist	Insect Path. Lab.
Waldo, D. R.	Animal Scientist	Ruminant Nutr. Lab.
Walker, J. M.	Soil Scientist	Biol. Waste Mgt. Lab.
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Berg, C. C.	Genetics (Grasses)
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Gross, C. F.	Soil Fertility
Gustine, D. L.	Biochemistry
Hill, R. R., Jr.	Genetics (Alfalfa)
Hite, R. E.	Plant Pathology
Jung, G. A.	Forage Management
Kendall, W. A.	Plant Physiology
Leath, K. T.	Pathology (Legumes)
Sherwood, R. T.	Pathology (Grasses)
Zeiders, K. E.	Plant Pathology

SECTION I

BREEDING, GENETICS, AND PLANT INTRODUCTION RESEARCH

Title: Report of Northeast Regional Plant Introduction Station, Geneva, NY; and Regional Project NE-9--The Introduction, Testing, Multiplication and Preservation of Potentially Valuable Plants for Crop Improvement and Industrial Use

Leaders: D. D. Dolan, S. W. Braverman, and W. R. Sherring, New York (Geneva)

Promising Forage Legume Introductions - 1975

1. Alfalfa (*Medicago sativa*)

The 1975 alfalfa planting consisted of 60 introductions and the 1974 planting carried over consisted of 50 introductions. During 1975, evaluation notes were taken on both plantings as follows: uniformity, habit, vigor, plant size, crown width, size of stems, leafiness, leaf size, leaf color, time of blooming, time of ripe pods, flower color, pod shape, degree of damage from leafspot, leafhopper and alfalfa weevil, recovery after summer cutting, percentage winter survival and spring recovery.

The following notes were taken on individual alfalfa introductions.

Notes on the '74 Planting

P.I. 162459 *M. sativa* Uruguay. Vigorous, nonspreading, crown 7", height 14", large, long leaf, good recovery after cutting. Noted on Sept. 4.

P.I. 173737 *M. sativa* Turkey. Vigorous, crown width 13 1/2", medium size leaves, going dormant, susceptible to leafspot.

P.I. 196229 S *M. sativa* India (Dolan selection). This is an individual plant selection from the original introduction. Very large leaf, 4.5 cm x 2.0 cm, 12" tall, variable in fall recovery, lacks winter hardiness.

P.I. 206575 *M. sativa* Greece. Excellent vigor, height 14 1/2", crown 12", large broad leaf 3.5 cm x 1.5 cm, good fall growth.

P.I. 238147 *M. sativa* Turkey. Prostrate type, excellent vigor, height 7", very small leaf, very susceptible to leafspot, very susceptible to leafhopper, poor fall recovery.

P.I. 268065 S M. sativa Sweden. Individual plant selection, excellent vigor, uniform, excellent fall recovery. Much branched at base, many stems, spreads by rhizone, height 12". A filled out row, crown 13", leaf large 4.0 cm x 1.9 cm. Possible leafspot tolerance and possible leafhopper tolerance.

G-22868 M. sativa Geneva. Individual plant selection from Vernal. Good fall recovery, height 10", small leaf, crown 9" wide, susceptible to leafspot.

P.I. 255962 M. sativa Canada. Relatively short, height 7", crown width 7", fine stems, leaf small to medium size, almost a clover type leaf, 2.0 cm x 1.4 cm. Susceptible to leafhopper, some leafspot but very tiny spots, possible tolerance. Looks like it has germplasm from M. falcata.

P.I. 268065 S M. sativa Sweden. An individual plant selection labeled 72-21-1. The original selection was for good seed set. It is a vigorous, strong spreader with dark, green, small leaves. Height 8", crown width 10", spreads by rhizomes underground and fills in row. Susceptible to both leafhopper and leafspot.

Notes on '75 Planting

These accessions at the time of note taking were in their first season of growth. Consequently, the notes are rather incomplete.

P.I. 201864 M. sativa Iran. Dark green leaves with purple flowers.

P.I. 199276 Port. Dense, leafy, small, dark green leaves. Pale purple flowers.

P.I. 179702 India and 211054 Afgh. Very susceptible to leafhopper.

P.I. 179947 India, 183328 India, 180303 India and 183060 India. All four excellent seed set.

P.I. 172985 Tur. Dense growth, dark, green, small leaves, pale purple flowers. Possible tolerance to leafhopper.

P.I. 182241 Tur. Variable from plant to plant, very susceptible to leafhopper.

G-23168 Canada. Short plant, height 14 1/2", dense growth, small dark green leaves, excellent forage, good seed set. Possible resistance to leafhopper.

G-23169 Canada. Short, dense plant, small, dark green leaves. Excellent seed set.

G-22867 S Nova Scotia. Individual plant selection from the original G number. Long stems, small, dark green leaves, a white leaf mutation on leaves. Excellent seed set.

G-23170 Canada. Excellent forage crop, dense, dark, small green leaves, excellent seed set, both yellow and blue flowers. Very definitely has M. falcata germplasm in it.

P.I. 346908 USSR. Very tall, 40" tall, very vigorous, late blooming, pale purple flowers. Poor seed set, possible leafhopper tolerance.

P.I. 345647 USSR. Medium height, 22", much branched at base, dense, late blooming, very many flowers, pale purple to violet flower color, small, dark green leaves. Possible tolerance to leafhopper.

G-22269 S New York. An individual plant selection from the original G number. 74-136-10. A falcata type with yellow flowers. Unusually tall, 24" tall, vigorous, medium leafy with small leaves, excellent seed set. Continues to bloom after there is already a heavy set of seed. Possible tolerance to leafhopper.

2. Red Clover (Trifolium pratense)

The 1975 red clover planting consisted of 55 introductions. During the interval mid-July to mid-August, each introduction was rated for uniformity, habit, vigor, size of plant, number of stems, size of stems, leafiness, earliness of bloom, number of heads in seed production, susceptibility to both powdery mildew and virus disease. In this, the first year of growth, the introductions most promising with regard to vigor, plant habit and leafiness are the following: P.I. 204502 Tur., 221523 Swe., 235852 Swe., 235856 Swe., 237731 Ger., 239700 Switz., 257274 Swe.

Red clover introductions carried over from 1974 that looked promising in their second season of growth are the following: P.I. 229799 Fin., 235849 Swe., 236458 Fin., 304294 Fin., 304537 Tur., 304779 Swe., and 384056 Pol.

3. White Clover (Trifolium repens)

Beginning from mid-June and continuing to July 10, evaluation notes were taken on two plantings of white clover. Each introduction was rated for type, uniformity, vigor, plant size, degree of spread, leafiness, time of bloom, seed set, susceptibility to leafspot, powdery mildew, rust and virus infection. Also, degree of damage due to leafhopper and leafminer.

The following introductions of white clover in the 1975 planting were the most promising with regard to these characteristics: P.I. 184936 Neth., 234938 Swit., 245128 N. Hamp., 251189 Yugo., 255185 Pol., and 256733 Iran.

The following white clover introductions carried from the 1974 planting appeared promising in their second season of growth: P.I. 201214 Austral., 204788 Italy, 206302 Tur., 232109 Ger., 237291 Den., 237292 Den., 237735 Ger., 381049 Iran, and 384020 Pol.

A white clover from Morocco P.I. 384699 was noted to be relatively free of insect damage on August 29.

Promising Forage Grass Introductions - 1974

P.I. 234467 Spain. Arrhenatherum elatius. Vigorous, very leafy, filled in row. Leaf height 22", no wax on leaves, variable in susceptibility to rust.

P.I. 287764 Spain. Arrhenatherum elatius. Variable in both vigor and leafiness, leaf height 16", leaves dark green and waxy. Filled in row, some plants tolerant to rust and some plants tolerant to Helminthosporium leafspot.

P.I. 381926 France. Phleum pratense. Tall and erect, soft, drooping leaves, leaf height 12", broad tussock. Rust on both stems and leaves.

P.I. 383363 Wales. Phleum pratense. Low pasture type, soft, drooping type, leaf height 14", crown 15" wide, light green leaves. Excellent recovery after cutting. Does not go dormant in fall. Free of both disease and rust.

P.I. 383364 Wales. Phleum pratense. Hay type, erect and leafy, both basal leaves and leaves on culms. Leaves large and dark green, height of leaves 16", crown 11". Free of both disease and rust. Seed harvested July 31, 1975.

Promising Forage Grass Introductions - 1975

P.I. 231758 NH. Bromus inermis. Vigorous, leaf height 16", large, dark green leaves, spreading by rhizomes, waxy leaf surface. Crown 10', plant width 27", free of disease.

P.I. 386325 Neth. Phleum pratense. Pasture type with soft droopy leaves, height 12", crown 6", late blooming. Leaves brown during a dry period in August.

P.I. 388039 Belgium. Phleum pratense. Hay type, leaf height 18", dark, green leaves. Relatively short-broad, tapering leaf. Seed harvested Aug. 28, 1975.

G-23199 USSR. Good vigor, dark, green leaves, height of leaves 18", leaves waxy, possibly drought tolerant. Very many basal leaves at center, however not as attractive as 'Masshardy' nearby. Showing both stem rust and leaf rust.

G-23200 Czech. Dactylis glomerata. Vigorous and leafy, leaf height 19", crown width 7", leaves waxy and dark green. Individual leaf measures 37 cm x 1.1 cm. Very susceptible to drought, otherwise excellent. Showing some leaf rust.

P.I. 235455 Swit. Arrhenatherum elatius. Vigorous and leafy, leaf height 15", leaves dark green and waxy. Individual leaf 31 cm x 1.0 cm. Drought tolerant but susceptible to leaf rust.

Title: Breeding for Yield, Quality and Disease Resistance in Alfalfa

Leader: R. R. Hill, Jr., U.S. Pasture Research Laboratory

Alfalfa synthetics derived from single clones exhibited widely varying responses to inbreeding in the S_1, S_1-SYN-1, S_2-SYN-1, S_3, and S_3-SYN-1 generations. Inbreeding depression for spring growth and plant height at harvest time was practically zero for two of six clones, and very severe in three of the six. Statistical analysis under a newly developed, two-allele genetic model for autotetraploids revealed that most of the differences could be explained by additive and digenic genetic effects. Parameter values varied from clone to clone in the same population, however.

Comparison of different methods of selection for disease resistance (page 16 of the 1974 Report) continues. The most recent evaluations reveal that resistance to Leptosphaerulina leafspot may be good enough to warrant a germplasm release. A satisfactory level of resistance to Phoma leafspot has not been obtained.

Survival of experimental synthetics with 1, 2, 4, 8 and 16 parental clones was very poor, and the experiment was abandoned. Syn-2 plants of these synthetics were established in the greenhouse for production of another sample of Syn-3 seeds.

Title: Breeding and Genetics of *Bromus inermis*

Leaders: G. M. Dunn and H. Z. Lea, New Hampshire

Stomatal index, the proportion of stomata to epidermal cells, was calculated for three ploidy levels of bromegrass. Mean stomatal indexes 14.8, 15.6 and 15.0 for 4x, 6x and 8x, respectively, did not differ significantly.

An inheritance study was initiated on a rolled leaf mutant by crossing it to normal self-fertile parents. All F_1 plants were normal. Backcross, F_2 and F_3 progenies will be obtained.

In two bromegrass yield trials, significant differences were generally not obtained except for the relatively poor performance of Polar and Carlton.

Title: Breeding for Improved Forage Quality

Leaders: J.S. Shenk, M. L. Risius, R. W. Cleveland, and R. L. Cowan, Pennsylvania

An infrared light reflectance spectro/computer is being designed and built to analyze forage and associated feedstuffs for their major chemical constituents. These include moisture, protein, cell walls, hemicellulose, cellulose, and lignin. After calibration of the instrument with forage samples containing these chemical data, the instrument will have the potential to simultaneously analyze for these six constituents in less than 2 minutes with less than 5 g of forage. This new technology will be applied to our forage breeding programs.

This first year's data of an investigation of genotype x environment interactions involving crownvetch clones have been completed. The objective was to determine whether crownvetch clones selected for high or low in vitro dry matter disappearance (IVDMD) would retain their relative ranking over other environments. Six clones were vegetatively propagated and established in replicated field trials in Pennsylvania, Virginia, West Virginia, Wisconsin, and Georgia. Forage samples were harvested three times and environmental data collected at each location. Analysis of the IVDMD data indicated that clones, harvests, locations, and all interaction sources of variation were significant; however, the clone mean square significantly exceeded all interaction mean squares involving clones. Thus the genotype x environment interaction among clones was minimal and real clonal differences existed among these clones for IVDMD regardless of location or harvest.

Title: Breeding of Improved Varieties of Forage Species Adapted to the Northeast

Leaders: J. S. Shenk, R. W. Cleveland, and M. L. Risius, Pennsylvania

The inheritance and potential for genetic improvement of forage quality in orchardgrass (Dactylis glomerata L.) were evaluated in a spaced plant study involving seven synthetics. The offspring of the 27 parent clones of these synthetics were harvested over 2 years in first and second growth and grazed by sheep in third growth. Year by genotype interactions were significant for all traits except second harvest IVDMD. These interactions were found to be predominantly independent of maturity effects. The relative magnitude of variance estimates indicated genetic control of first harvest IVDMD and protein was both additive and nonadditive before and only nonadditive after adjustment for maturity. Control of second harvest IVDMD and protein and third growth sheep preference was found to be additive.

Heritability estimates for IVDMD and protein were 8 and 22% respectively, in the first harvest. These estimates dropped to zero upon adjustment for maturity and were 46% for both traits in the second harvest. The estimate for third growth sheep preference was 34%. The results indicated that breeding for improved IVDMD protein and sheep preference would be feasible. Replication would be required to reduce variance contributed by environmental sources. Maturity effects were major contributors of first harvest variance and that any breeding program would require precise measurement of maturity to distinguish real genetic difference from stage of growth differences.

Title: Breeding of Perennial Forage Grasses

Leaders: J. S. Shenk, R. W. Cleveland, and M. L. Risius, Pennsylvania

The orchardgrass recurrent selection program was continued with four populations (A, B, C, D) to increase the economic yield of animal products/acre. Medium and late maturity groups are being developed in each population. Seed from selected A clones were bulked and planted along with other selections and commercial cultivars in a replicated trial at two locations. Progeny from 150 individual clones selected from population B were planted in field plots. A total of 119 clones selected from population C were evaluated using the Dairy Herd Simulation Program (DHSP II). This program requires input data of yield, protein and digestibility with output in terms of milk $/acre. The four best clones in this selected group had simulated values of $57 more milk/acre than the average for the population. Polycross

isolation nurseries were established with selected clones from population C.

These studies from populations A, B, and C and related genetic studies suggest that the most efficient method of making improvements in these complex yield and quality traits would be to (1) select plants on the basis of agronomic traits in the first generation, and (2) evaluate progeny in field plots with the DHSP II program in following generations. Therefore, population D was only evaluated for agronomic characteristics. Clones were selected on the bases of these parameters in two harvests, and established in polycross isolation nurseries for seed production next year.

Title: Breeding Crownvetch for Forage and Slope Stabilization Usage

Leaders: M. L. Risius, J. S. Shenk, and R. W. Cleveland, Pennsylvania

In the first harvest year of a forage yeild trial, the yield of the three standard crownvetch varieties, Penngift, Chemung and Emerald, was comparable to a Pennsylvania crownvetch synthetic. All crownvetch varieties were comparable in yield to birdsfoot trefoil. Yield of crownvetch significantly exceeded that of two milkvetch varieties and diploid Kura clover.

Investigations into the seasonal changes and genetic variation for levels of β-nitropropionic acid (BNPA)--a compound reported to be an antiquality constituent in crownvetch forage--were continued. Seed was produced in two groups of plants selected for high and low levels of BNPA.

Title: Breeding and Genetics of Corn

Leader: M. W. Johnson, Pennsylvania

Work is in progress on line development, development and improvement of germplasm pools, hybrid screening, disease and insect resistance, improvement of plant type, conversion to modified endosperm types such as waxy and opaque, selection of genotypes for high density planting, selection of superior forage types and selection studies on differential element uptake and accumulation in various genotypes. Two medium-short,

two long-season inbreds and four hybrids were released. Leaf area studies of diallel sets of single crosses and their inbred parents have shown significantly positive relationships between leaf area, grain yield and plant height for the crosses but not for the inbreds. In these studies total leaf area of different genotypes appears to be controlled primarily by additive gene action. Magnesium levels of different genotypes are inherited quantitatively. Hybrids with higher levels of total plant magnesium can and have been selected. The ability of selected populations to take up higher amounts of phosphorus continues to show a positive association with yield and improved stalk quality. Selection studies for resistance to leaf blights and bacterial wilt were continued with significant progress. Two short-season and two long-season synthetic populations involved in a reciprocal recurrent selection program for improved yield, stalk quality and disease resistance have shown improvement over four cycles of selection. Lines are being selected from each cycle. Several other populations are currently being improved by different modified mass selection techniques.

Title: Kentucky Bluegrass: Effects of Origin of Clones and Latitude of Seed Production on Frequency of Aberrant Progenies.

Leaders: A. W. Hovin, C. C. Berg, E. C. Bashaw, R. C. Buckner, D. R. Dewey, G. M. Dunn, C. S. Hoveland, C. M. Rincker and G. M. Wood

The purpose of this study was to determine the effects of geographical origin of clones and latitude of seed production on the frequency of atypical aberrant progenies of clones of Kentucky bluegrass (*Poa pratensis* L.). A high frequency of aberrants could adversely affect the certification of seed production fields of apomitic cultivars. Open-pollination seed was produced at seven locations. The progenies from five clones were grown at Beltsville, MD, while progenies from four other clones were grown at Rock Springs, PA. Plants of each progeny were classified as typical apomictic, aberrant or weak. The frequency of aberrant plus weak plants (13.6%) was higher at locations (Alabama and Kentucky) with wide overall anthesis range (at least 4 weeks) than it was (7.2%) at locations (Maryland, New Hampshire, and Vermont) with narrow anthesis range (6 to 9 days). The frequency of aberrant and weak plants was considerably higher for 4 clones (13.6%) than for the remaining 5 clones (5.0%). Because the clones with high frequency of aberrant and weak plants trace to diverse origin, we concluded that clonal source did not affect the frequency of aberrant progeny when seed was produced outside the area of origin.

Open-pollination seed was used to further examine 40 plants scored as weak. Only two plants produced typical progeny; the remaining 38 produced segregating apomictic or sexual progenies. We concluded that most weak plants were aberrant but would probably not become established under competitive conditions with typical apomictic progeny. However, aberrant plants should be rogued from space-planted fields that are used for the production of breeder seeds.

Cytological examination of megasporogenesis did not reveal any influence of genotype or environments on the initiation of aposporous nucellar cells. Examination of embryo development failed to distinguish possible effects of genotype or environment on frequency of apomictic and sexual reproduction of ovules.

Title: Breeding and Cytogenetic Investigations and Improvement of Cool Season Perennial Forage Species

Leaders: R. P. Murphy and C. C. Lowe, New York (Cornell)

The comprehensive study of yield and forage quality for alfalfa was continued through the second full production year. Nine varieties covering the range of growth types used in the Northeast are being evaluated under three systems of intensive management in each of three distinct production environments. The purpose is to identify combinations for producing most usable feed per acre and to indicate most promising directions for future breeding effort. Protein content, leaf percentage and in vitro digestibility are quality parameters being used with yield to measure usable feed potential.

From data collected to date, no differences of practical value exist between current varieties for average feeding value over a range of production environments. Growth types and several genetic traits do affect yield potential, survival and distribution of production, but do not produce any average forage quality differences on a total-season basis. Dry matter yield potential for varieties is therefore the primary determinant of usable feed per acre and utilization of varieties capable of sustained highest dry matter production under cultural and cutting managements that assure high average feed quality is the most probable means of improving usable feed per acre.

Breeding effort has been directed to use of new germplasms to broaden the genetic base in alfalfa. Preliminary efforts show several diploid species not in cultivated alfalfas can be utilized to produce new combinations at different ploidy levels. This appears to be a logical approach for creating source populations which might have a greater range for forage quality parameters.

The multifoliolate character has been studied extensively and found highly heritable. Synthetics have been produced with a high incidence of expression for this character. Comparisons of these with current cultivars showed them 5-10% higher in average leaf fraction of forage but only slightly higher in average protein (up to 2%) and not different at all in average in vitro digestibility. The multifoliolate synthetics also averaged 12-25% lower in forage yield and had unexplained difficulties in seed production. One multileaf variety was observed in 1975 to show a high incidence of frost heaving relative to standard varieties. In total, the multifoliolate character has been used to produce highly attractive, unique and distinctive varieties with serious deficiencies that must be corrected before the trait can be successfully exploited for alfalfa improvement.

SECTION II

ENTOMOLOGY RESEARCH

Title: Nutrient Slant Board Technique of Rearing the Clover Root Curculio, Sitona hispidulus (F.)

Leaders: P. B. Baker and R. A. Byers, U.S. Pasture Research Laboratory

A Nutrient slant board technique (Kendall, W. A. and K. T. Leath. 1974. Crop Sci:317-320) was modified to rear the clover root curculio, Sitona hispidulus (F.). This technique allows plants to grow without soil to provide frequent and noninjurious access to the roots. Half-strength Hoagland's solution with the other half distilled water was used to furnish nutrients required by the plant. Penicillin and streptomycin additives did not increase survival of larvae, but surface sterilization of the eggs with laundry bleach increased: (1) larval to pupal survival by 30%, (2) egg to pupal survival by 20%, and (3) egg to adult survival by 10%. Nine out of 40 eggs reached adult stage on Lahontan alfalfa. Emerging adults were mated and laid viable eggs. The nutrient slant-board is a potential rearing technique for this species and other subterranean insects.

Title: A Technique for Sampling Eggs of the Clover Root Curculio

Leaders: R. A. Byers and P. B. Baker, U.S. Pasture Research Laboratory

Eggs of the clover root curculio, Sitona hispidulus (F.), were collected by a modified vacuum sampling machine (D-Vac) from soil at the base of alfalfa plants. Samples of soil and plant debris were dried, sieved, and the eggs were separated by flotation with magnesium sulfate solution.

There was a decrease in egg density from the October to the December samples, probably due to hatching of the eggs. Thereafter, egg density remained at about 10-12 per square foot until spring. No significant differences were found between an old or new stand of alfalfa. Eighty-five percent of the eggs collected hatched after an incubation period at 22-25 C.

This sampling method could be used to predict when to apply insecticides or for surveys of clover root curculio abundance.

Title: Toxicity of β-nitropropionic Acid to the Cabbage Looper

Leaders: R. A. Byers, D. L. Gustine, and B. G. Moyer, U.S. Pasture Research Laboratory

The cabbage looper, Trichoplusia ni (Hubner), was reared on pinto bean artificial diet (Shorey, 1963. J. Econ. Entomol. 56:536-537) to which was added the following: β-nitropropionic acid (BNPA), 1-6-di-3-nitropropanoly-β-D-glucopyranoside (Di-ester of BNPA), and a mixture of tri-esters, 1, 2, 6-tri-3-nitropropanoyl-β-D-glucopyranoside and 1, 2, 6-tri-3-nitropropanoyl-β-D-glucopyranoside. BNPA and its esters are found in the crownvetch plant and may act as feeding deterrents to insects.

All compounds tested increased the length of the larval period, pupal period, reduced pupal weight, and eggs/female/day, but increased adult life over untreated controls. BNPA was the most toxic followed by the tri-esters, and di-ester in descending order. Mortality of the cabbage looper increased with increasing concentrations of the compounds. The concentrations used in the experiment were in the range of those found in fresh crownvetch leaves.

Title: Nematicidal Effects of Soil Pesticides When Applied to Alfalfa

Leaders: E. R. Jones, R. H. Swain, K. W. Bell, and R. B. Carroll, Delaware

Nematicidal effects of Furadan and Mocap were evaluated on 5 x 20 ft plots of Saranac alfalfa seeded April 22, 1975. Each material was evaluated independently using a randomized complete block design with four replications. Data were not normally distributed; therefore, a logarithmatic transformation was made before an analysis of variance was computed on populations of pin, lesion, and total parasitic nematodes. Untransformed means are reported. Parasitic nematodes were determined from three subsamples, each made up of 10 6-inch cores taken at random from each plot. Mocap 10G treatments were preplant incorporated and preplant incorporated plus a topdress application four weeks later using a Gandy spreader. Nematode samples were taken preplant and at 4-week intervals throughout the growing season. Furadan treatments were 10G preplant incorporated, 4F at the first trifoliolate leaf stage, and 4F at the first trifoliolate leaf stage plus a second application on first harvest stubble. Flowable treatments were applied with a wheelbarrow sprayer. Nematode samples were taken preplant and 6 weeks after treatment. In addition to soil nematode analysis, the presence of lesion nematodes on roots was determined for Furadan treatments.

Both Mocap treatments significantly reduced total parasitic and pin nematode populations at the June 19 sampling date. Populations of lesion nematodes on roots were not significant for Furadan treatments. No clearly defined response to Furadan or Mocap was obtained.

Title: Impact of Alfalfa Harvest on Microctonus aethiopoides a Parasitoid of the Alfalfa Weevil

Leader: A. A. Hower, Pennsylvania

Studies were begun in 1975 to investigate the impact of alfalfa harvest on the alfalfa weevil parasitoid M. aethiopoides. Indications from previous studies on life history of this insect suggested adult parasitoids were most prevalent after the alfalfa crop would normally have been removed from the field in Pennsylvania. Fields not harvested so the M. aethiopoides adult activity was uninterrupted contained .31 and .81 immature parasitoids per ft^2 on June 24 and July 2, respectively in Centre County. On the other hand, in fields harvested at a recommended harvest date, .002 and 0 larvae per ft^2 were found on those sample dates, respectively. Apparently M. aethiopoides survival is severely influenced by crop harvest. The major impact from cutting appears to be the removal or death of host alfalfa weevil larvae which, when left undisturbed, develop into the adult host stage sought by the parasitoid for oviposition.

Research is being continued to determine ways of implementing increased M. aethiopoides survival into acceptable crop management systems.

Title: Control and Bionomical Studies of Livestock and Animal Food Crop Insects in West Virginia

Leaders: Linda Butler and Joseph E. Weaver, West Virginia

Studies on the distribution and impact of parasites in bio-control of the alfalfa weevil were continued. Bathyplectes curculionis and Microctonus colesi remain the most prevalent parasites. Bathyplectes anurus was recovered from 10 of 14 farms where releases were made in 1974; this species is now established in 9 counties of the state, but is not yet numerous at any location. Weevil larvae parasitized by B. anurus were collected in Pennsylvania in 1975; an estimated 36,000 parasites were released in 8 counties of the northern panhandle and extending south along the Ohio river.

Insect growth regulators Stauffer R-20458 and Thompson-Hayward Dimilin and 6042 were applied for alfalfa weevil and leafhopper control. R-20458 gave many larva-pupa and pupa-adult intermediates with the weevil and reduced the number of normal adults by 65%. Dimilin and TH-6042 had little effect.

Title: Effect of the Alfalfa Weevil on the Alfalfa Crop

Leaders: Gary W. Fick, Beverly Wen-Yuh Liu, and George A. Maybee, New York (Cornell)

Earlier work indicated that large reductions in second cutting yields of alfalfa could occur when larvae of the alfalfa weevil fed on the stubble following the first harvest. To study the problem, known populations of larvae were transferred to alfalfa plots with low background weevil populations after the first cut. The larvae fed on the basal buds, and at the highest population (about 10,000/m^2) they completely destroyed active growing points in the stubble within two days. The effect was to delay regrowth so that after 40 days, each increment of weevil population was associated with younger herbage. The maximum delay in regrowth was 6 to 10 days, and up to one third of the yield potential of the 40-day regrowth period could be lost. The regression equation to predict percentage of maximum loss (Y) from the insect population in larvae/m^2 (X) was as follows: $Y = 0.0531X$. $R^2 = 0.868$. When stubble spraying is indicated, it should occur as soon after harvest as possible.

When the first harvest of alfalfa is delayed so that the bulk of weevil feeding occurs on the developed canopy instead of the stubble, the resulting defoliation influences root reserves, morphological rate of development, and canopy structure. Further work verified our earlier hypothesis of limited influence on leaf percentage because of concurrent reductions in leaf and stem growth. However, sampling techniques that reduced variation in weevil populations within treatments showed statistically significant decreases in leaf percentages in early June at populations as low as 2 larvae/stem. During the post-defoliation recovery period, such moderately damaged plants actually increased in leaf percentage and produced more branches than lightly defoliated plants. Large differences in canopy structure resulted and could be important in altering canopy photosynthesis.

A first-generation computer model (ALSIM 1 - LEVEL 1) has been used to study alfalfa management. Deficiencies in model predictions were traced to inadequate understanding of regrowth mechanisms. A series of regrowth models (REGROW) are being studied to identify research priorities in the area of regrowth physiology.

SECTION III

PLANT PATHOLOGY RESEARCH

Title: Mechanism of Resistance of Reed Canarygrass to Leafspot Fungi

Leaders: C. P. Vance and R. T. Sherwood, Pasture Research Laboratory

The role of papilla formation in resistance of reed canarygrass leaves to fungi was extensively investigated. Reed canarygrass leaf-discs were floated on water and inoculated with spore suspensions of Helminthosporium catenarium, H. avenae, Stemphylium botryosum, Leptosphaerulina trifolii, Botrytis cinerea and Ascochyta sp. Only H. catenarium was pathogenic on reed canarygrass. With the noninfecting species, a papilla (host cell wall thickening) formed in the epidermal wall beneath each fungal appressorium from which penetration was attempted, and no penetration occurred. With H. catenarium most appressoria induced papilla formation and did not initiate penetration, but about 1% of appressoria initiated direct penetration through a thin-walled, poorly-formed papillar swelling.

When leaf-discs were floated on aqueous solutions of cycloheximide (10-25 μg/ml), protein synthesis was inhibited, papilla formation was prevented, and more than 80% of appressoria of all fungi gave rise to direct penetrations. Primary infection hyphae grew well and invaded adjacent epidermal cells. Transfer of leaf-discs from cycloheximide solutions to water prior to appressorial formation, restored protein synthesis, restored papilla formation and prevented penetration. Thus, papilla formation appeared to be a defense mechanism against fungal penetration that requires response-dependent protein synthesis.

Around the sites of attempted penetration and papilla formation the epidermal walls became histochemically modified in disc-shaped areas, up to 60 μm in diameter. Any lateral epidermal walls beneath the discs (disc-shaped areas) became swollen and histochemically modified. Papillae in leaves inoculated with Helminthosporium avenae gave histochemical reactions, indicating that lignified material was a major structural component of the core of the papillae and the altered lateral walls and a minor component of the discs. Histochemical tests indicated that callose was present in the papillae, lateral walls and discs, and that cellulose was a significant structural component of the discs, the altered lateral walls and the cover layer of the papillae. Tests for cutin, suberin, tannins, gums and pectic compounds were negative.

Lignin content and enzymes involved in lignification were measured in leaf discs inoculated with Helminthosporium avenae and floated on water or cycloheximide solutions. Within 18 hr, inoculated discs on water had higher lignin content and higher activity of the enzymes

phenylalanine ammonia lyase (PAL), tyrosine ammonia lyase (TAL), hydroxicinnamate-CoA ligase and peroxidase than noninoculated discs on water. When inoculated tissues were floated on cycloheximide solutions increases in lignin content and enzyme activities associated with lignin biosynthesis were inhibited, and the tissue was susceptible to fungal penetration. We concluded that lignin biosynthesis at the site of attempted fungal penetration may play an important role in the resistant response of reed canarygrass to leaf-infecting fungi.

Title: Phytophthora Root Rot of Alfalfa in Pennsylvania

Leaders: K. T. Leath and J. E. Baylor, Pasture Research Laboratory and Pennsylvania

Alfalfa plants in a field in Bradford County, Pa. were stunted, chlorotic and dying. Their roots had rot that was typical of that caused by Phytophthora megasperma on alfalfa in other parts of the U.S. Fungi isolated from the roots and soil caused typical Phytophthora root rot symptoms on DuPuits and Saranac alfalfa in greenhouse tests. Oogonial, oospore and sporangial characteristics of the Pennsylvania isolate were within the size range reported by other workers for P. megasperma pathogenic on alfalfa. This is the first documentation of Phytophthora root rot of alfalfa in Pennsylvania.

Table 1. Dimensions of oogonia, oospores and sporangia of isolate B-12 of Phytophthora megasperma from diseased alfalfa roots obtained in Bradford County, Pa.

Structures	Length (μm)	Width (μm)	Diameter (μm)	Average (μm)
Oogonia	--	--	26.2-39.4	31.5
Oospores	--	--	17.0-29.6	24.3
Sporangia	24.6-57.8	17.2-36.9	--	37.0 X 30.2

Title: Interaction of Fusarium Root Rot with Pea Aphid and Potato Leafhopper Feeding on Forage Legumes

Leaders: K. T. Leath and R. A. Byers, Pasture Research Laboratory

The interaction of insect feeding and Fusarium root rot was investigated in greenhouse, growth chamber and field insectary tests with red and white clovers and alfalfa. In every experiment, significantly more rot developed in plants subjected to pea aphid feeding and inoculated with Fusarium than in plants without aphid feeding but inoculated with Fusarium. More red clover plants died in the combined Fusarium-aphid treatment than in any other treatment. The combination of potato leafhopper feeding with Fusarium root rot resulted in a significantly higher rate of alfalfa plant death over the following winter, than occurred in the untreated control, Fusarium alone, or potato leafhopper alone treatments. Significant interaction between insect feeding and Fusarium was demonstrated for days till death of red clover and alfalfa, winterkill of alfalfa, and internal rot incidence with all forage species.

Table 1. Severity of Fusarium root rot of forage legumes grown with and without the stress of pea aphid feeding.

Stress treatment	Root rot rating			
	Red clover	White clover	Alfalfa	All species
None (control)	2.3 a	1.4 a	1.5 a	1.7 a
Fusarium	3.2 ab	2.1 b	2.1 b	2.4 b
Aphids	3.8 b	1.9 b	1.8 ab	2.3 b
F + A	5.0 c	3.1 c	3.1 c	3.6 c

Table 2. Yield and stand counts of alfalfa grown under separate and combined stresses of Fusarium root rot and leafhopper feeding.

Stress treatment	Dry wt yield g/row		No. of plants/row		
	7/26/74	9/6/74	7/26/74	9/6/74	4/1/75
None (control)	29.7 a*	18.8 a	14.2 a	13.0 a	8.8 a
Fusarium	32.2 a	22.4 a	14.4 a	12.6 a	8.8 a
Leafhopper	21.6 b	10.6 b	13.8 a	12.1 a	7.4 a
F + L	22.8 b	10.5 b	14.1 a	12.1 a	3.5 b

* Values followed by the same letter within a column are not significantly different (P = 0.01). Duncan's new multiple range test.

Title: Resistance to Purple Leafspot in Orchardgrass

Leaders: K. E. Zeiders, C. C. Berg, and R. T. Sherwood, Pasture Research Laboratory

The second cycle of recurrent phenotypic selection for resistance to purple leafspot in orchardgrass was completed. About 12,000 progeny from the first cycle were grown in greenhouse flats, and were screened twice for disease resistance by artificial inoculation with Stagonospora arenaria. Clones showing resistance to purple leafspot (1824 selected) were inoculated a third time. From this group 350 clones which had least disease and good vigor were selected. Four ramets of each clone were established in a replicated field planting in July 1975 for seed production in 1976 and to evaluate disease reaction and agronomic traits.

Title: Field Reaction of Disease-Resistant Smooth Bromegrass Selections

Leader: K. E. Zeiders, Pasture Research Laboratory

Single plants of 34 clones selected for low disease ratings after two artificial inoculations with Helminthosporium bromi were transplanted to the field in the spring of 1974. These clones were selected from five commercial cultivars, principally Fox and Saratoga. Plants were rated for severity of brown leafspot in August 1974, and in July and October 1975. On each date, ratings ranged from resistant to highly susceptible. In artificial inoculations, 28 of the 34 clones were rated resistant, 5 susceptible, and 1 intermediate. Means for the two 1975 field ratings indicated that 10 clones were resistant, 14 susceptible, and 10 intermediate in severity of brown leafspot. Nine of the 10 clones rated resistant in the field on all dates were also rated resistant in artificial inoculations. These clones possess good potential for use as parents in breeding for resistance to brown leafspot in bromegrass.

Title: Fungi Associated with Leaf Disease on Reed Canarygrass Irrigated with Municipal Sewage Effluent

Leader: K. E. Zeiders, Pasture Research Laboratory

The prevalence of foliar diseases on both irrigated and nonirrigated reed canarygrass clones, and on Common reed canarygrass at the Pennsylvania State Waste Water Renovation and Conservation Project was monitored by weekly or biweekly surveys from April to November 1975. Numerous isolations were made from diseased leaf and stem material collected during the growing season. From these, 25 new isolates from among six fungus genera were added to the working collection maintained at the U.S. Pasture Research Laboratory. The genera were: Stagonospora (13 isolates), Septoria (3), Fusarium (3), Epicoccum (4), Helminthosporium (1), and Myrothecium (1). Seven of the Stagonospora isolates were S. foliicola which causes tawny blotch, the most prevalent disease of reed canarygrass.

Epicoccum spp., which are associated with leaf mold and secondary leafspot on some Gramineae, were isolated more frequently from diseased leaves collected November 17, 1975 than earlier in the growing season. It was isolated more often from irrigated than from nonirrigated reed canarygrass. It was probably growing saprophytically on tissue killed by Stagonospora foliicola, which was also isolated frequently. Among forage grasses Epicoccum has been reported only on tall fescue, where it causes a secondary leafspot. It has not been reported on reed canarygrass. It seems significant that this species was isolated more frequently (1) late in the growing season and (2) from grass irrigated weekly with sewage effluent. In cultural studies of 11 Epicoccum isolates, there was wide variation in color of pigment produced in the potato-dextrose agar medium, ranging from lemon yellow-brown-orange-deep red. The cause of this variation is not known. There was little variation in spore size and morphology among isolates of Epicoccum.

Title: Diseases of Annual Grasses at University Park, Pa.

Leaders: K. E. Zeiders, Pasture Research Laboratory

Disease epiphytotics occurred on two annual weed grasses in the vicinity of the Pennsylvania State Waste Water Renovation and Conservation Project. The area under observation included a 6.1 ha field of reed canarygrass (Common) which was spray-irrigated throughout the year with 5.1 cm per week of municipal sewage effluent, and an adjacent field of row corn of about equal size which was irrigated weekly with 0 or 5.1 cm of effluent from May 22 to September 3, 1975.

Purple-brown spotblotch caused by Helminthosporium monoceras Drechs. was observed on August 12, 1975 on barnyardgrass (Echinochloa crus-galli). Thick patches of this grass were growing in moist soil along the border of the reed canarygrass field, including one irrigated strip where reed canarygrass was not established. On many plants, spotblotch was severe on all leaves; it was often most severe on the younger (top) leaves (unusual on grasses); some leaves were heavily blighted or destroyed. There did not appear to be any other disease on the grass. Barnyardgrass is cosmopolitan, occurring in moist habitats throughout the United States. It is a coarse annual, sometimes used for forage, but is a weed in cultivated ground. Within the Northeastern Region, H. monoceras on barnyardgrass has been reported only in New York.

Panicle smut caused by Ustilago rabenhorstiana Kuehn was observed in late September on fall panicum (Panicum dichotomiflorum Michx.) within the field of corn. An estimated 70% of plants was affected. The disease is systemic as evidenced by the fact that plants were either severely infected or not at all. On infected plants, 80-90% of panicles were smutted; on one stem, 26 smutted panicles were counted. Plants were quite large; 25 stems were counted on one noninfected plant. No seeds were produced on smutted panicles. This consequence of the disease may be considered economically beneficial in that the quantity of seed for propagation of this undesirable weed grass in 1976 will be substantially reduced. In the Eastern and Central United States, U. rabenhorstiana has previously been reported only in Pennsylvania.

Title: Resistance Mechanisms Associated with Foliar Infections of Forage Crops

Leader: R. L. Millar, New York

The location of β-glucosidase activity in healthy trefoil, infected trefoil, and S. loti was determined histochemically by a simultaneous coupling technique using 6-bromo-2-naphthyl-β-D-glucoside (BNG) and fast garnet salt. Activity was localized in healthy and infected tissues in the phloem, guard cells and other epidermal cells, and palisade and spongy mesophyll cells, and in S. loti hyphae growing either on the surface or in infected tissue. Both host and pathogen β-glucosidases were located at the infection site.

Host and pathogen linamarases from white clover leaves infected by Stemphylium sarciniforme were separated from each other by column chromatography on CM-sephadex C-25 and DEAE-sephadex A-25 and showed differential specificity for the substrates linamarin, amygdalin, salicin and p-nitrophenyl-β-D-glucopyranoside. Extracts from healthy HCN-positive plants contained linamarase and cyanogenic substrates. Pathogen linamarase was obrained from diseased leaves of HCN-positive

plants and from S. sarciniforme grown in liquid medium. Linamarase activities for pathogen and host were measured at 0, 48 and 96 hr after inoculation. Pathogen linamarase activity was detected in diseased tissue 48 and 96 hr after inoculation. Host linamarase activity was present but did not change with time.

The significance of a constitutive cyanide-resistant, alternate terminal oxidase in Stemphylium loti is under investigation in terms of its contribution directly to the cyanide tolerance of the pathogen and indirectly to making possible the synthesis of formamide hydrolyase by which the pathogen transforms cyanide.

SECTION IV

GROWTH, PHYSIOLOGY, AND CLIMATIC EFFECTS

Title: The Effects of Environment on Carbon Dioxide Exchange and Assimilate Distribution of Timothy, Orchardgrass and Alfalfa

Leader: D. M. Vietor, Massachusetts

The initial objective of the experiment was to determine the effect of temperature and photoperiod on assimilate distribution in alfalfa and orchardgrass. Plants of each species were transplanted from field plots to pots in the greenhouse during September. Day/night temperature regimes of 33/29, 22/18 and 12/8 C, each with a 14-hr day length, were imposed on potted plants of each species during early November. In addition, potted plants of each species were selected for growth under a 10-hr light period or a 9-hr light period with 1 hr of light during the dark period of each day.

A closed system was used for labeling the potted plants of orchardgrass and alfalfa with radioactive carbon. Plants of each species were radioactively labeled at an early vegetative stage and a prebud or preflowering stage to determine the relative effects of the three temperature regimes or the two photoperiod treatments on assimilate utilization.

Plants are being destructively sampled and the samples assayed by liquid scintillation techniques. Plants will also be labeled at the bloom stage.

Title: Ecology of Grasses and Legumes

Leader: M. A. Sprague, New Jersey

A planting of Saranac AR alfalfa was made in September as part of the microclimate study to monitor air and soil temperature and solar radiation during fall months on areas cut at weekly intervals. The objective is to establish a formula relationship between climatic changes during fall, progressive cold hardening and winter survival. As a prediction tool this will aid in establishing fall cutting schedules more suitable for winter survival and persistence of stand.

Plantings were made at Adelphia and Cream Ridge of seven strains of berseem clover (Trifolium alexandrium) in an ongoing search for a suitable annual legume for the light soils of southern New Jersey. None were sufficiently well adapted to be promising.

Title: Accumulation of Magnesium,Calcium and Potassium in the Herbage of Some Temperate-Origin Forage Species as Affected by Temperature and Magnesium Fertilization

Leaders: C. F. Gross and G. A. Jung, U.S. Pasture Research Laboratory

Twenty-two temperate origin grasses and legumes were grown in the greenhouse under natural daylength at cool (12-15 C), intermediate (15-20 C) and warm 22-26 C) ambient temperatures in a Mg-deficient Hagerstown silt loam (a typic Hapludult) fertilized with 0 and 672 kg Mg/ha at pH 6 and 7 to ascertain their response to temperature and identify Mg accumulator species and/or cultivars.

Supplemental fertilizer was N as NH_4NO_3 on grasses and K as K_2SO_4 to grasses and legumes. Plants cut to 5-cm at 2-week intervals assured vegetative tissue for mineral analysis for 11 legume and 13 grass harvests. Clippings were oven dried (70 C), ashed (475 C), acid-solubilized in 1:5 HNO_3 + CH_3COOH and analyzed for Mg^{2+}, K^{+} and Ca^{2+} by atomic absorption spectrophotometry.

Adding 672 kg Mg/ha to the soil significantly (P=0.01) increased herbage Mg. Absolute maximum Mg responses were 0.33 for grasses and 0.40 for legumes. Under cool spring temperatures, smooth bromegrass (Bromus inermis Leyss.) and tall fescue (Festuca arundinacea Schreb.) increased herbage Mg by 71 and 36%, respectively. Corresponding legume increases were 77, 53 and 49% for ladino clover (Trifolium repens L.), Saranac alfalfa (Medicago sativa L.), and birdsfoot trefoil (Lotus corniculatus L.). Some species responded differentially to Mg fertilizer at cool spring vs. warm summer or cool autumn temperatures. Significant differences occurred in herbage Mg among three orchardgrass (Dactylis glomerata L.) and two timothy (Phleum pratense L.) cultivars under cool spring and autumn temperatures in response to Mg fertilizer; response of four alfalfa and two crownvetch (Cornilla varia L.) cultivars was inconsistent.

Under cool spring temperatures herbage Mg levels reached 0.37 and 0.51% for grasses and legumes, respectively, exceeding the 0.20% critical Mg value. Warm temperatures and high Mg accumulation were concomitant. Marked differences occurred in herbage Mg within species in response to temperature. At cool spring temperatures a difference of 0.15% Mg between timothy cultivars was noted. Temperature influenced (P=0.01) grass K/Ca + Mg (meq) ratios at each harvest and

reached 2.5 under cool spring temperatures. Cool autumn temperatures were associated with low grass ratios. Temperature affected (P=0.01) legume K/Mg ratios. Under cool spring temperatures higher ratios prevailed from greater accumulation of K than Mg; at warm temperatures the reverse was true.

Timothy and orchardgrass cultivars differed in Mg and K under cool spring temperatures; K/Ca + Mg ratios were 2.0 for timothy and 2.2 to 2.5 for orchardgrass but under cool autumn temperatures lower ratios prevailed. Herbage Mg, K and Ca concentrations and mean K/Mg ratios were similar for Saranac, Team and Iroquois alfalfa. Vernal alfalfa, however, had lower Mg and K levels and a higher mean K/Mg ratio than the other cultivars. Herbage Mg concentration differed by 0.13% among alfalfa cultivars at cool spring temperatures. Crownvetch herbage had low K/Mg ratios and large differences in Mg, K and Ca concentrations at elevated temperatures.

Temperature significantly affected (P+0.01) herbage DM yields. Combi perennial ryegrass (Lolium perenne L.) was the most productive grass; no grass, however, was the highest yielder at all temperatures. Total DM yield among orchardgrass and timothy cultivars was similar. Alfalfa cultivars, particularly Vernal, had the highest total legume DM. Crownvetch cultivar DM yields were low. Magnesium fertilizer did not affect herbage DM yields.

Temperate-origin forage species differ markedly in Mg, K and Ca content and in their response to temperature and Mg fertilizer. Utilization of grasses and legumes innately high in Mg and/or response to Mg fertilization, particularly under cool temperatures, and species with low K/Ca + Mg ratios are valuable for alleviating grass tetany.

Title: Biosynthesis of Medicarpin in Jackbean Callus Tissue Cultures

Leader: D. L. Gustine, U.S. Pasture Research Laboratory

A system for activating production of fungitoxic compounds (phyto-alexins) in callus tissue cultures was developed to study the biochemistry of phyto-alexin formation. Jackbean (Canavalia ensiformis L.) callus tissues synthesized the phyto-alexin, medicarpin (3-hydroxy-9-methoxypterocarpan), when treated with $HgCl_2$ solutions or Pithomyces chartarum (Berk. Curt.) M. B. Ellis spore suspensions. Medicarpin was isolated from treated callus tissue and identified by its ultraviolet (UV) and massspectra. Medicarpin was assayed in callus tissue by thin-layer chromatography of methyl ethyl ketone extracts and subsequent UV analysis of the isolated medicarpin. Maximum production occurred at 3.15 mM $HgCl_2$; no maximum occurred for up to 10^6 spores/ml. In $HgCl_2$-treated tissues, medicarpin was detected

with 12 hours after treatment, reached a maximum level by 36 hours, and remained constant for an additional 24 hours. The maximum level was 560 μg/g dry tissue, which is equivalent to that reported in plant parts. In 48-hour incubations of spore-treated tissues, a linear increase in medicarpin production was found from 0-10^6 spores/ml. The concentration of medicarpin at 10^6 spores/ml was about half that found in tissues treated with 3.15 mM $HgCl_2$. These data suggest that the concentration of the spore factor(s) was not high enough to saturate activation sites for the biosynthetic system.

Title: Nonstructural Carbohydrate in the Spring Herbage of Temperate Grasses

Leaders: G. A. Jung, R. E. Kocher, C. F. Gross and C. C. Berg, U.S. Pasture Research Laboratory; and O. L. Bennett, West Virginia

Nonstructural carbohydrates are sources of readily available energy that enhance remen microbial activity and forage utilization. Experiments were conducted in Pennsylvania and West Virginia to determine the effect of maturity on total nonstructural carbohydrate (TNC) concentrations in spring herbage of eight grass species and determine TNC concentrations in herbage at immature and mature growth stages on a given day. The grasses were fertilized early each spring and summer with 0, 60, 120, or 240 kg N/ha.

Determinations for TNC were made using the Smith takadiastase technique. Mean TNC concentration in the spring herbage of Masshardy orchardgrass (Dactylis glomerata L.), Climax timothy (Phleum pratense L.), and Sac smooth bromegrass (Bromus inermis Leyss.) decreased 7 or more percentage units with maturation from vegetative to full bloom stage, but decreased less than 4 percentage units in Fawn tall fescue (Festuca arundinacea Schreb.), Kenblue Kentucky bluegrass (Poa pratensis L.), and redtop (Agrostis alba L.). Mean TNC concentration was 50% higher in Pennfine perennial ryegrass (Lolium perenne L.) than in Kenblue Kentucky bluegrass or redtop. Concentration of TNC was inversely related to maximum air and soil temperatures and was affected much more by harvest data than by maturation of the herbage. Concentration of TNC was usually lower in N-fertilized herbage than in unfertilized controls at early growth stages, but N had little effect on TNC concentration of herbage at full bloom.

Maximum yields of TNC were obtained at the stem elongation stage with ryegrass, at flower-head emergence with Pennmead orchardgrass and Ky 31 tall fescue, and at full bloom with other grasses. N fertilization increased TNC yield of orchardgrass, tall fescue and reed canarygrass; decreased TNC yield of smooth bromegrass and tedtop; and had little effect on TNC yield of ryegrass and timothy.

Title: Morphology, Physiology, and Cultural Responses of Perennial Forages

Leaders: G. W. Fick, R. R. Seaney, and C. H. Darrah, III, New York (Cornell)

Although the subject has received a great deal of attention, the primary physiological changes conferring cold hardiness are still poorly understood. Recently, attention has focused on changes in the lipid fraction associated with cell membranes. Taproots and crown buds of field grown Iroquois alfalfa were harvested through the fall hardening season and analyzed for total lipids, total phospholipids, and fatty acid constituents in the major lipid fractions. Total lipids showed no significant changes throughout the sampling period; however, increasing phospholipid concentrations were observed. No major shift in the percentage of saturated and unsaturated fatty acids was detected in the neutral lipid fraction, but polar lipids showed an increase in the percentage of unsaturated fatty acids. Theoretical considerations predict that the increase in unsaturation is conducive to low-temperature survival.

Samples of taproots collected during the summer of 1975 are currently under analysis. Lipid analysis of root and crown buds from alfalfa grown under hardening conditions in controlled-environmental chambers is also in progress, and alfalfa ecotypes expressing three degrees of hardiness are presently being acclimated for similar tests.

Under field conditions, heaving is also a major reason for alfalfa to fail to survive the winter. In 1972, Iroquois alfalfa and a mixture of Iroquois alfalfa and common timothy were seeded to study the effects of soil drainage and cutting management on yield and persistence. At locations where heaving has been a problem, more heaving of alfalfa plants has occurred in the clear alfalfa than in the alfalfa-grass mixture. In 1975, yields of the alfalfa-grass mixtures were 8 to 20 percent greater than the yields of clear alfalfa.

SECTION V

WEED INVESTIGATIONS

Title: Annual and Perennial Weed Control in Corn and Forages

Leader: N. L. Hartwig, Pennsylvania

Fall panicum (Panicum dicotomiflorum) was best controlled in no-tillage corn on a silt loam soil, 2% O.M. and a pH of 7.1 with combinations of atrazine 1 lb ai/A + simazine 1 lb ai/A, atrazine 1 lb ai/A + cyanazine 2 lb ai/A, simazine 1 lb ai/A + alachlor 2 lb ai/A, and penoxalin 1.5 lb ai/A + cyanazine 2 lb ai/A applied in early May before fall panicum had germinated. Two to four inch fall panicum was effectively controlled with these same treatments except for atrazine + simazine; which was ineffective when applied late.

Yellow nutsedge (Cyperus esculentus) can be controlled in no-tillage corn with preemergence treatments of atrazine 1 lb ai/A + simazine 1 lb ai/A or cyanazine 3 lb ai/A followed by atrazine 1 lb ai/A with 1 qt/A of nonphytotoxic oil post emergence after nutsedge has 6 to 8 inches of growth. Excellent yellow nutsedge control and best corn yields were obtained with a granular formulation of butylate 3 to 4 lb ai/A with safener + atrazine 1 to 1.33 lb ai/A disked into unplowed grain stubble.

No-tillage legume seedings into bluegrass pastures were best obtained when early fall treatments of 2,4-D and dicamba were used to eliminate broadleaved weeds followed by treatments of glyphosate 1 lb ai/A or paraquat 0.25 lb ai/A to suppress the bluegrass (Poa pratensis). Of the legumes seeded the following spring, red clover (Trifolium pratense) was the easiest and quickest to establish followed by birdsfoot trefoil (Lotus corniculatus), alfalfa (Medicago sativa) and crownvetch (Coronilla varia) in that order.

Title: No-tillage Establishment of Forages

Leaders: Dean L. Linscott, USDA-ARS, New York (Cornell)
R. F. Lucey, R. R. Seaney, New York (Cornell)

Investigations on the no-tillage seeding of legumes for forage and pasture with emphasis on vegetation control were continued at several locations in central New York, Glyphosate and paraquat were applied separately to pastures leavily grazed prior to treatment. Following herbicide treatment birdsfoot trefoil was seeded with a Midland sod-seeder. Additional weed control treatments across glyphosate-paraquat main blocks included 2,4-D, 7-10 days prior to planting, and 2,4-DB or dinoseb after legume emergence. Legume emergence was satisfactory on all plots receiving glyphosate or paraquate. However, birdsfoot trefoil established successfully only on plots receiving 2,4-DB at 1 1/2 kg/ha in addition to glyphosate or paraquat at 1 kg/ha and above. This was because only 2,4-DB satisfactorily controlled perennial dicots without inordinate damage to trefoil.

In fields heavily infested with quackgrass, glyphosate at 1 kg/ha and above, glyphosate plus paraquat at 1/2 kg/ha, or split applications of paraquat gave satisfactory control. Mid-summer plantings of alfalfa with John Deere Power-till planter following weed control were very successful. Seedbed preparation and seed placement by the power-till planter was excellent. Establishment was directly related to quackgrass control. In this particular study, 2,4-D applied 10 days in advance of seeding for broadleaf weed control had no damaging effect on alfalfa. However, in a separate study with 2,4-D applied 21 days in advance of planting alfalfa and birdsfoot trefoil, the herbicide damage prevented successful establishment. It is evident that emphasis should be given to fall applications of 2,4-D prior to establishment the following spring.

Comparisons of no-tillage establishment vs conventional establishment of alfalfa and birdsfoot trefoil in one study showed little difference in plant numbers in October but a highly significant advantage for the conventional system in terms of top growth and root weights. It is questionable whether the no-tillage plants in this trial will survive the winter because of limited root development.

Title: Improvement of Birdsfoot Trefoil Seed Production Practices

Leaders: D. L. Linscott, H. M. Schaaf, USDA-ARS, New York (Cornell)

Weed control: In established seed fields, quackgrass was controlled satisfactorily by pronamide at 2 lb/A applied in the fall. Fall

applications of metribuzin controlled many annual and perennial weeds including dandelion, chicory, astor, and dock. Spring applications of metribuzin were more efficacious but also damaged trefoil. Combinations of pronamide and metribuzin have practical merit. In row culture, fall treatment of pronamide-metribuzin followed by shielded spray applications of paraquat controlled weeds with no significant damage to trefoil. Pronamide-dalapon combinations also were effective in controlling a wide spectrum of weed species. Postemergence dalapon-2,4-DB applications gave excellent weed control in new plantings of trefoil. Insect control: Spittlebug was reduced by burning of fields. Insecticide control measures for tarnished plantbug were inconclusive. Disease control: Methyl bromide fumigations increased numbers of plants established, improved vigor, increased winter survival. Several breeder selections of trefoil showed more field tolerance to rot organisms than the variety Viking. Birdsfoot trefoil seed fields under a rotation system were less affected by disease. Fertilization: Seedling trefoil responded positively to fertilizer phosphorous at planting. Phosphorous greatly improved seedling vigor, winter survival and seed production. Many of the trefoil establishment problems in region will be solved by proper use of phosphorous.

Title: Long-Term Comparisons of No-Tillage and Conventional Corn Production

Leader: R. A. Peters, Connecticut (Storrs)

Comparisons of no-tillage vs conventional corn production has continued at Storrs in an experiment initiated in 1969. No-tillage yields of both silage corn and grain corn remain comparable to those in the conventional plots after 7 years of production. Soil samples taken at 0-3 and 3-6 inches have shown some stratification; P, Ca and Mg levels in lb/acre at the 0-3 inch level are over twice as high as on the conventional plots. At 3-6 inches there is a reversal with the level greatest in the conventional plots. Levels of K have been less consistent with a higher level at 0-3 inches in the no-tillage than on the conventional plots in some samplings but similar in others. At 3-6 inches little difference is found. The greatest variation in K is associated with the type of harvest with the grain plots with all corn stalks remaining on the field having 1/3 greater K level than the silage plots.

Title: No-Tillage Forage Crop Seedings in Established Sods

Leader: R. A. Peters, Connecticut (Storrs)

No-tillage forage seedings using a Zip-seeder from the Midland Manufacturing Company were made under a variety of conditions in old mixed established sods. Paraquat at 1/2 lb ae/acre gave erratic control especially of quackgrass and orchardgrass. Glyphosate at 1 1/2 lb ae/acre gave much more consistent kill. Alfalfa seedings made with the Zip-seeder were quite variable due in part to the variability in placement of the seed with the Zip-seeder. If the old sod was not quite short the furrow opener on the seeder tended to push vegetation into the slit which prevented soil-sod contact. Penetration of the planter was inadequate on uneven or hard ground.

SECTION VI

MANAGEMENT AND PRODUCTION RESEARCH

Title: Pasture Management on Poorly Drained Coastal Plain Soils

Leaders: E. R. Jones and R. H. Swain, Delaware

Research is being conducted to determine if poorly drained coastal plain soils that are too wet for row crop cultivation can be used as improved pastures. Tall fescue and reed canarygrass pastures were established in 1972 and 1973. One paddock of cleared unimproved land was included in the rotation. Cattle were grazed during the 1973 growing season and continuously since May 24, 1974. Carrying capacity and resistance of the grasses to compaction are being evaluated. Stockpiled fescue in conjunction with fescue in small round bales is being used for winter feed.

Title: The Evaluation of Several Alfalfa Varieties, Fertility, and Cutting Management Treatments in Delaware

Leaders: E. R. Jones, R. H. Swain, K. W. Bell, and R. B. Carroll, Delaware

Studies previously reported (1974 Report, p. 45) were continued. Anthracnose resistant material had a much lower incidence of anthracnose than parent susceptible material. Although the stand declined significantly between 1974 and 1975, varieties were not significantly different for total forage production during the second year. Response to fertility was not evident in incidence of disease or forage production.

Sampling of forage harvest equipment on eight farms indicated that Colletotrichum trifolii had overwintered under Delaware conditions. The fungus also overwintered in hardware cloth envelopes located at several heights in an alfalfa canopy. Analysis of labeled plants, both anthracnose infected and anthracnose free, indicated 100% winter survival of anthracnose free plants and 15% winter survival of plants having stem lesions in the fall.

Title: Establishment and Longevity of Birdsfoot Trefoil Stands Grown for Seed

Leaders: G. B. MacCollom and A. R. Gotlieb, Vermont

Sites with histories of poor trefoil stand establishment were compared. Soil surveys were made of sites having histories of normal and poor trefoil stand establishments. This survey showed a distinct correlation of low soil pH, and low phosphorus availability with sites having poor stand establishment.

1975 seedings of birdsfoot trefoil, utilizing a number of different seed treatments will be evaluated for stand establishment after wintering.

Degradation of dimethoate residues on trefoil are being analyzed at the New York State Agricultural Experiment Station at Geneva, N.Y., in cooperation with IR-4.

The studies in progress will continue under Hatch project #271.

Title: Evaluation of Perennial Ryegrass-Tall Fescue Hybrids as Forage for Northern Areas

Leaders: G. M. Wood, W. M. Sullivan, and J. G. Welch, Vermont

Lack of cold tolerance has been in the past the limiting factor relative to the use of perennial ryegrass as forage in northern areas. Now that ryegrass with considerably greater cold hardiness is available, the first task is to identify such, so that further evaluations for quality and yield can be made. Methods of determining cold tolerance in these experiments so far have been slow and largely weather dependent (see 1974 Report, p. 46). Difficulty in obtaining uniform results was experienced in earlier artificial freezing trials (see 1972 Report, p. 24). A refinement which uses soil as a buffering agent around pots of grasses to be frozen artificially has greatly improved uniformity of results and created new confidence in this quick method of determining cold tolerance. A number of perennial ryegrasses have been identified as being more cold tolerant than Pennmead orchardgrass and Ky. 31 tall fescue, approaching the hardiness of Kentucky bluegrass.

Field plots have been established to correlate the results of freezing trials with field performance. Yield data will be taken and plots grazed with sheep to determine animal preference and grazing tolerance. In vitro artificial rumen digestion and standard chemical analyses will be used to measure quality differences.

Title: Harvest Schedules for Immature Alfalfa Forage

Leaders: C. S. Brown and R. F. Stafford, Maine

A study was initiated with a pure stand of Iroquois alfalfa to determine the most suitable seasonal schedule to produce immature (early bud stage) alfalfa forage for possible pelleting. A total of six different schedules was studied, with most of these including at least one cut at bloom stage to restore root reserves. The schedules were as follows, with regrowth interval (days) approximating 30 to early bud, 40 to early bloom and 50 to full bloom.

Schedule	Cut 1	Cut 2	Cut 3
A	Early bud	Early bloom	Early bud
B	Early bud	Full bloom	Early bud
C	Full bud	Early bud	Early bud
D	Full bud	Early bloom	Early bud
E	Mid-bloom	Early bud	Early bud
F	Mid-bloom	Early bud	Early bloom

Forage yields and stand persistence are being determined. Detailed studies of forage quality of the immature (early bud) harvests will be carried out by the animal nutritionists participating in this interdisciplinary project.

Title: The Response of Alfalfa to Fertility, Irrigation and Cutting Management

Leaders: J. H. McNemar and N. A. Clark, Maryland

The alfalfa management study seeded in the fall of 1973 was continued during the summer of 1975. This study is comparing an old reliable alfalfa variety with a popular new variety under three conditions: (1) irrigated and nonirrigated; (2) current soil test fertilizer recommendations, one half recommendations, and twice recommendations; (3) four levels of intensity in cutting management.

During 1975 two of the cutting managements were harvested five times and two were harvested four times. All plots were allowed at least 30 days of growth prior to the final harvest, which was taken just before the first killing frost. The seasonal yields of dry matter ranged from 0.58 T/A to 5.20 T/A of weed-free alfalfa. The plots are also being evaluated for forage quality.

Title: Effect of Management Factors on Alfalfa Productivity and Persistence

Leaders: J. B. Washko, K. T. Leath, and A. A. Hower, Pennsylvania

Alfalfa varieties with resistance to Southern Anthracnose were the most productive in the third year after seeding in an experiment with 28 entries. The highest yielding variety, WL311, with anthracnose resistance yielded 1.04 tons/acre more hay than the lowest yielding nonanthracnose variety, Anchor. The losses in alfalfa production due to anthracnose is illustrated in a new 1975 seeding comparing varieties with and without anthracnose resistance. Saranac-AR incorporating the anthracnose resistant gene yielded 1/2 ton more alfalfa hay during the seeding year than its counterpart, Saranac, without resistance to this disease. In a fertility experiment with an anthracnose resistant variety, WL 305, on a Washington silt loan, an application of 300 lbs/acre of K_2O at seeding increased hay yields by 1.10 tons/acre. There was no advantage in splitting this application, 1/2 applied after the 1st harvest and the 2nd in the fall. There was no yield response to applications of P_2O_5 or to sources of K_2O, muriate of potash and sulphate of potash carriers yielded the same.

Title: Minimum Tillage Pasture Renovation

Leaders: A. M. Decker and R. F. Dudley, Maryland

Three sod-seeding experiments started in 1974 were continued (38th Annual Report, page 49). Three harvests were made during the 1975 growing season; estimates of botanical composition were made on the last two harvests.

Red clover was the highest yielding sod-seeded species followed by alfalfa, birdsfoot, crownvetch and tall fescue, in that order. However, by the second harvest, crownvetch was contributing more than trefoil and nearly as much as red clover. Stands of red clover were declining rapidly while those of crownvetch, and to a lesser degree, trefoil were improving.

Total yield and yield of the seeded species increased as paraquate was increased from 0.25 to 0.50 lb per acre; there was no improvement beyond 0.50. The use of roundup was never better than paraquat, and in some cases (particularly when broadcast) was inferior. Total forage yields were higher when herbicide was banded; there was usually higher legume yields with broadcast application, especially when seeded stands were weak.

Title: Evaluation of Sod-Seeded Pastures Using Dairy Steers and Heifers

Leaders: A. M. Decker, J. H. Vandersall, N. A. Clark, Maryland

Orchardgrass pastures that had been abandoned for approximately 8 years had reverted largely to bluegrass and significant amounts of annual weeds and perennial woody species; many of the wild cherry and pine trees in the area had stump diameters of over 3 inches. The area was cleared with a bush hog and a few larger trees were removed where necessary. The area was sod-seeded in the early fall of 1974, using alternate rows of red clover with crownvetch for one treatment and red clover and spreading alfalfa for a second treatment. The remaining pastures were not treated beyond the brush and weed removal. All pastures were uniformly fertilized. Two dairy steers and two dairy heifers were used as test animals on each treatment and grazers were added as needed to uniformly utilize all pastures. The pastures were grazed rotationally in a split-plot design with two complete replications and three grazing cycles in each replication (whole plots).

It was not possible to put animals on the pastures until June 12 after the spring flush of growth. The check pastures (cleared and fertilized only) produced only 62 lb of beef while crownvetch and alfalfa pastures produced 167 and 144 lb, respectively. The average daily gain was more than doubled on the sod-seeded pastures.

Title: Evaluation of Pastures for Dairy Heifers

Leaders: E. M. Kesler and J. B. Washko, Pennsylvania

Plots originally had consisted of Iroquois alfalfa-Pennmead orchardgrass or Pennmead alone. One of each was combined to make two larger areas. The proportion of alfalfa had declined but the orchardgrass stand was thrifty. The areas were grazed rotationally by yearling dairy heifers. To one area, 56 kg/ha of nitrogen were applied after first and third grazings. During the season there were four grazings from each area. The treated plot afforded 608 grazing days, the untreated 508. Yields of dry matter were 5.8 and 5.2 metric tons per hectare, respectively.

Title: Productivity and Quality of Fertilized Perennial Forages

Leader: L. F. Marriott, Pennsylvania

Continued annual applications of 50 and 100 lb P_2O_5, 100 and 200 lb K_2O/A to a 1970 seeding of crownvetch again resulted in no differential yield response in 2 cuttings. First harvest schedules at early bud (6/5), early bloom (6/19) and full bloom (7/2), followed by a second harvest 10 weeks later resulted in dry matter yields of 3.8, 4.4 and 4.6 T/A, respectively. The early bloom schedule provided the most uniform distribution of forage. The 1974 crude protein in forage from that schedule was 20.3% and 19.2% for the 2 cuttings. Herbicide treatments have been necessary to help control Canada thistle, dandelion, grasses and other weeds.

The grasses established in 2-year old crownvetch in 1972 comprised 65 to 75% of the harvested associations. This represented no change for orchardgrass or tall fescue, but an increase in grass component for bromegrass and timothy. Grasses can be successfully introduced into a crownvetch stand and continue to thrive.

Crownvetch has been grown in association with orchardgrass, bromegrass, tall fescue or timothy since 1972. Where crownvetch comprised 20 to 25% or more of the harvested forage, dry matter yields and crude protein contents were equivalent to or greater than those of the grasses fertilized with 150 lb N/A. Where crownvetch comprised 10 to 15% of the harvested forage, the N-fertilized grass equivalent received 100 lb N/A. Application of 50 or 100 lb N/A to the associations generally reduced the proportion of crownvetch, but did not significantly increase yields.

Title: Development of Seeding Techniques and Management Systems for Feed Crops in Southwestern Pennsylvania

Leaders: W. G. Downs, III., J. B. Washko, and L. F. Marriott, Pennsylvania

Efforts were made to develop a pattern of post-seeding management for sod-seedings of previous years. Weed control materials showing greatest promise were simazine and 2,4-DB. Limited grazing and clipping were most effective for weed control. Removal of dandelion and plantain from established legume stands has not been successful with any material or method. Elimination of dandelion, plantain and bull thistle was effective when 2,4-D plus banvel were fall applied previous to a July sod-seeding of birdsfoot-trefoil-timothy into a deteriorated stand of orchardgrass. This 6 acre field provided 1500

cow grazing days before and after a highly successful sod-seeding in which the field was out of production for 6 weeks. A 4-acre field sod-seeded to alfalfa or birdsfoot-trefoil by various methods in 1974 produced over 14 tons of legume hay. This field was primarily quackgrass prior to no-till corn in 1973. A deteriorated stand of bromegrass was treated with 1 lb per acre of glyphosate April 28 to retard growth of bromegrass for a July sod-seeding to birdsfoot-trefoil. This treatment appeared to be less economically and agronomically sound than removal for hay or pasture. Various rates of ammonium nitrate were applied at planting time to a no-till cornfield to approximate rate applied plow-down to a conventionally planted adjacent field of the same imperfectly drained soil type. As in previous years the placement or rate of nitrogen fertilizer did not overcome the effect of imperfectly drained soil for no-till corn. Stand, standability and production were reduced in the no-till corn.

Title: Establishment and Management of Several Grass and Other Species for Forage and Ground Cover

Leader: J. B. Washko, Pennsylvania

Six cool-season grasses were grown with 50/50/50 lb per acre of nitrogen applied prior to harvest for dry matter production and feeding trials. Of the grasses, reed canary, Ky 31 tall fescue, Pennlate and Pennmead orchardgrasses, Saratoga smooth brome and Climax timothy, the reed canary produced the highest dry matter yields, 6.66 tons/acre, in 3 harvests and Climax timothy the lowest, 5.27. Of the summer annuals, Agway 44, a sudan-sorghum hybrid, was highest yielding when compared with sudangrass hybrids; 8.44 tons/acre and 7.05 and 6.74 for S100X and RS II sudangrass hybrids. The management work scheduled for Blackwell switchgrass was cancelled due to winter killing of this warm-season grass. Lathco flat pea, a legume developed for ground cover produced 4.91 tons/acre of dry matter per acre so is useful for heavy ground cover. Wild turkeys found ripened seed of this legume much to their liking. In forest clearings, a Viking trefoil-Ky 31 fescue mixture was successfully established and produced up to 1.3 ton/acre deer forage with an application of 1 ton of limestone and 30 lb each of P_2O_5 and K_2O per acre.

Title: Evaluation of Permanent Pastures for Species Composition, Yield, Ground Cover, Grazing Pasture, and Other Management Practices

Leaders: B. S. Baker and R. L. Nestor, West Virginia

The species composition, amount of available forage, ground cover, and grazing pressure were estimated in selected permanent pastures in seven counties in central West Virginia during 1975. The pastures varied in soil type, fertility levels, exposures, and other factors, but were typical of the study area. Some pastures were grazed closely throughout the year and in others an abundance of forage was always present. In most pastures many species were present. In most cases, the most abundant species accounted for less than one fourth of the available forage and only rarely did one species account for as much as 50% of the available forage. The importance of most species as a source of forage varied considerably during the growing season.

The evaluation will be continued to determine if there is appreciable yearly variation in the same pastures. Data will be examined in relation to management practices and animal performance.

Title: Effectiveness of Use of Bluegrass-White Clover Pastures

Leader: G. C. Anderson, West Virginia

Stocking rate and method of grazing effects on performance of pure stands of fescue (K 31) were studied. Initial stocking rates were 1460, 1240 and 1070 lb animal bodyweight per acre representing 8, 5, 9; 7, 4, 6; 6, 3, 5 heifers, ewes and lambs, respectively. Grazing was continuous or on a 14-day rotation basis beginning May 2. Sheep were removed 157 days later. Grazing under high stocking rate was ended on Oct. 27 (192 days). Using these periods for evaluation, animal bodyweight gain per acre for the rotation systems was 265, 296, 245 lb for high, medium and light stocking rates, respectively. Corresponding values for continuous systems were 172, 238 and 284 lb. With performance of the high continuous system equivalent to 100, high rotation is 154, medium-continuous 139, medium rotation 172, light continuous 165 and rotation 143. To utilize accumulated forage, grazing was continued in the medium and light systems as long as 192-day weights were maintained or for 203 and 210 days, respectively. Animal unit grazing days for high, medium and light rotation systems were 272, 244 and 219 with equivalent values for continuous systems being 270, 244 and 215. Estrous was synchronized and the heifers were inseminated on days 11 and 12. A 69% conception rate at day 56 was recorded (high-rotation 87; high-continuous 50; medium-rotation and continuous 50 and light rotation and continuous 83). It is doubtful if these differences relfect controlled variables.

Title: Evaluation of Organic Preservatives for Stored Forages

Leaders: C. C. Sheaffer, J. H. McNemar, and N. A. Clark, Maryland

Application of ammonium isobutyrate (AIB) to alfalfa hay during baling was evaluated. Four nozzles sprayed the preservative on the hay as it was lifted from the windrow. Hay was sprayed with the preservative at rates of 0, 1.5, 2.0 and 3.0%. Average moisture content of the hay was 37.6% with a range of 33 to 43%. The hay was stacked according to treatment. One week after baling, temperatures for the four rates of preservative were 44, 38, 34 and 28 C, respectively. After two weeks temperatures were 16, 23, 20 and 18 C.

Title: Seed Production by Ryegrass-Fescue Hybrid Derivatives in Muslin-Covered Cages

Leaders: C. C. Berg and R. R. Hill, Jr., U.S. Regional Pasture Research Laboratory

Clones of ryegrass-fescue (Lolium-Festuca) hybrid-derivative origin were used to produce syn-1 generation seed of eight 4-clone synthetics under muslin-covered isolation cages. Cages, about 1.5 m wide X 5.2 m long X 1.5 m high, were constructed over plots containing 16 space-planted ramets of each of the four clones of each synthetic. The cages were covered with muslin a few days before anthesis.

Very large differences, which could be attributed to cages (or synthetics) and to clones within synthetics, were observed in 1966 and 1968. Some clones produced very little seed. Although differences between years were large, the correlation between seed production in 1966 and 1968 was highly significant ($r = 0.478$).

The effects of several cage treatments on seed production were evaluated on plots established to one 4-clone synthetic. The cage treatments were: no fan, fans, and fans plus dehumidifier in 1970; open cage, no fan, and fans in 1971; and open cage, no fan, one fan, and two fans/cage in 1972.

The presence of fans in the cages significantly increased seed yields in 1970, but not in 1971 or 1972. Using a dehumidifier did not increase seed production over that with fans alone. Seed production outside cages was always significantly greater than production in cages, regardless of the cage treatment. Although smaller than variations due to cage treatments and clones, significant clone by cage treatment interactions were observed each year. This interaction suggests that

seed produced under different conditions could be genetically different. Seed of experimental ryegrass-fescue hybrid-derivative populations can be produced in isolation under muslin-covered cages. However, more research is needed to determine the effect of cage environments on the genetic composition of the seed produced and on techniques to reduce interactions.

SECTION VII

ENGINEERING RESEARCH

Title: Regional Project NE-70 -- Engineering Systems for Forage Crop Production and Use

Leaders: W. L. Kjelgaard (Pa.), Chairman, Research Committee; G. F. Rehkugler (NY); R. J. Rowe (Me.); D. R. Mears (N.J.) and L. F. Whitney (Mass.)

Contributors: The Maine, Massachusetts, New Jersey and Pennsylvania Agricultural Experiment Stations

Work was initiated to evaluate the potential of various forages as a replacement for concentrate feeds in dairy production. Harvest equipment was adapted for use on small plots. After mowing and field drying, forage samples were carried to a modified field chopper, avoiding the use of heavy equipment on the plots. Grinding and pelleting runs were made to determine the best particle size and techniques for pelleting young leafy grass. A screen size of 1/8 inch seems to be the best comprimise between free feeding and pellet durability. (Me)

A basic thrust was to increase protein yields of alfalfa juice extract for human food with minimum energy cost. Physical properties of interest for alfalfa juice were viscosity and specific gravity. Increasing viscosity with temperature was attributed to biochemical and thermal-related reactions such as heat coagulation. Ultrafiltration pilot studies have been conducted on alfalfa juice as affected by stage of maturity and processing parameters. Approximately 50% of juice protein was recovered in the precipitant after ultrafiltration. Work began on effect of solid state fermentation as a means of biologically releasing protein from within the cell. Early indications are for increase of 50% over mechanical extraction. (Ma)

The use of the circular dairy barn as a production unit was discontinued during September 1974. Studies of the barn's ventilation pattern revealed that restrictions reduced the air flow to approximately half the design quantity. The records maintained during operation of the barn contains information regarding labor required, cow activities, milk production and building performance. This information is being compiled and organized for a final report. A mathematical model of the flow of particulate materials was developed to categorize properties and develop the shape of a container for mass flow. (NJ)

A linear program model of forage movement and machine activities from field to storage has been developed. Factors of energy use, working rate, capacity, number of machine units, time and field drying were incorporated in model structure input. Outputs are the routes, tonnage and machines needed for minimum energy use. An alternative program which includes weather, machine and storage losses is being prepared for monitoring feed energy retention. These programs will be compared for compatability of systems for minimum mechanical energy use and requirements for maximum feed energy output. The model system for estimating capacity, energy and labor needs for forage transport and handling has been completed and reported. (Pa)

Title: Engineering Systems for Forage Crop Production and Use

Leader: R. J. Rowe, Maine

Work was continued on a cooperative project (1974 Annual Report, p. 80) the potential of pelleted forages as a replacement for concentrate feeds in dairy production. A master project has been prepared to coordinate work in animal science, agricultural engineering and plant science. Harvesting of immature alfalfa for engineering studies was initiated in 1975.

A pilot-scale cross flow dryer was tested at several temperatures covering the planned operating range of 60 C to 140 C to establish feed rate settings for subsequent runs. Second cutting alfalfa samples were dried at each of two temperatures, 60 C and 140 C. Part of each temperature treatment was ground and pelleted. Samples of both ground and pelleted material were forwarded to the Animal Science Department for nutritive analysis.

A low cost solar air heater, 10 ft by 40 ft in area, was constructed and used to heat ambient air for drying. One batch of second cutting alfalfa was dried over a period of several days using solar heated air. Maximum air temperature observed was 46 C. Samples of ground and pelleted forage from this batch were also prepared for nutritive analysis.

A series of grinding and pelleting runs were made to determine the best particle size and techniques for pelleting young leafy grass. For the pelleter used, a screen size of 1/8 inch seems to be the best compromise between free feeding of the pelleter which is enhanced by small particle size and pellet durability. The standard durability test index, using 1/8-inch ground grass, was about 90.

Equipment and techniques have been developed sufficiently to permit harvest and preparation of samples for in vitro and sheep digestion trials during 1976.

SECTION VIII

NUTRITIVE EVALUATION AND UTILIZATION

Title: NE-24 - The Nutritive Evaluation of Forages

Principal Leaders and Cooperating Agencies: J. G. Welch, A. M. Smith, Dept of Animal Sciences and R. T. Wetherbee, Regulatory Service, Vermont Agriclutural Experiment Station

Objectives: The objectives are to determine the factors that limit rate of passage and intake of forages.

Progress of Work and Principal Findings: (A) Feeding increasing levels of hay to sheep resulted in increased efficiency of rumination as indicated by rumination per unit of hay ingested. Rate of chewing also increased with increasing hay intakes. (B) Using cattle, sheep and goats of different sizes, it has been determined that animals with larger body size are more efficient ruminators as indicated by rumination required per unit of CWC intake. Additional data from mature cows of varying body sizes reinforce this observation and indicate that smaller cows require more rumination time per unit of CWC ingested than do larger ones. These data corrected for metabolic body size show the same relationship. (C) Rumen ingesta consistency and fecal particle size have been measured. A device has been developed to measure rumen ingesta consistency in fistulated animals by measuring the rate of assention of a weight under constant force, through the rumen ingesta. In hay-fed steers, there are three identifiable layers in the ingesta. The hard packed layer is the most variable. Although fecal particle size has been variable to date, there is some evidence that the particles derived from loose rumen ingesta are coarser than those derived from hard packed rumen ingesta. Steers fed five small meals per day ate 20% more than steers fed only one meal per day. The steers fed more often had more constant rumen ingesta consistency.

Title: Studies on Allelochemical Properties of Crownvetch and Their Effect on Forage Quality

Leaders: J. S. Shenk, P. J. Wangsness, R. M. Leach, J. L. Gobble, Pennsylvania; D. L. Gustine and R. F. Barnes, U.S. Pasture Research Laboratory

Feeding trials were conducted to establish the effects of feeding crownvetch forage containing β-nitropropionic acid (BNPA) to weanling meadow voles, chicks, and young pigs. Various degrees of toxicity were observed in all animals when the diet contained $\geq$ .15% BNPA, either as naturally occurring BNPA in crownvetch forage or as commercially purified BNPA added to the diet. The first indication of toxicity was a 60-70% reduction in feed intake, accompanied by reduced weight gains or weight loss and the onset of abnormal behavioral symptoms. The main symptom was ataxia and the severely affected animals often died. The study with young pigs substantiated that reduced feed intake was not the cause of the abnormal behavioral symptoms. These experiments demonstrate that crownvetch forage is toxic to young growing nonruminant animals and that the toxic response is associated with the concentration of BNPA in the forage. On the basis of these findings, we believe that crownvetch forage should not be used as a component of nonruminant diets unless the BNPA concentration is extremely low.

Title: The Palatability of Crownvetch

Leaders: W. A. Kendall and R. T. Sherwood, U.S. Pasture Research Laboratory

A meadow vole bioassay for forage palatability was used to identify factors affecting the taste of crownvetch. Normal colored green leaves from the top of the plant were less palatable and had higher levels of β-nitropropionic acid (BNPA) than yellow leaves from the bottom of the plants. Plants grown with low levels of nitrogen or minor elements had less BNPA than plants grown with optimum nutrients, however, palatability was not directly related to concentrations of BNPA. Thus, some other inhibitory substance(s) is probably involved. The palatability of synthetic diets was reduced about 50% by BNPA at concentrations which approximate the range found in intact leaves.

Title: Fermentation to Increase Food Protein Yield

Leader: R. E. Mudgett, Massachusetts

Fermentation is an effort to further increase protein yields beyond that obtainable by mechanical means which of necessity involve relatively high energy inputs. A project has been initiated and funded by NSF to investigate the effects of solid state fermentation as a means of biologically releasing protein from within the cell. The work is in its initial stages, but early indications are for increases of 50% improvement over mechanical extraction. Levels of 69% of total leaf protein were obtained by enzymatic action as compared to 45% by mechanical extraction. The enzyme employed initially is Aspergillus niger Cellulast obtained from Miles Laboratory. A large library of enzymes is available from the US Army Laboratories at Natick which will further enhance the investigation and expand the scope. Two levels of enzyme activity were investigated initially, but the work will continue as an NSF funded project for 2 years.

Title: Forage Soluble N Effects on Fiber Digestion by Rumen Microorganisms

Leaders: W. P. Apgar and R. E. Goodnow, Maine

Artificial rumen incubations using purified cellulose as the substrate were conducted with addition to the media of soluble N extracts from alfalfa, red clover, timothy, orchardgrass and reed canarygrass. The alfalfa extract had a significantly greater effect on ADF disappearance than any of the other extracts. Orchardgrass extract resulted in significantly lower ADF disappearance than any of the others, with no significant difference among the remaining forage extracts.

Soluble protein N content of the forages was significantly negatively correlated with in vitro ADF disappearance at 6- and 21-hr incubation times ($r = -0.68$ and $4 = -0.77$, respectively) and approached significance for 3- and 9-hr incubations ($r = -0.45$ and $4 = -0.51$, respectively). In contrast, soluble protein N was significantly positively correlated with ADF digestibility in vivo ($r = 0.55$). This discrepancy may be associated with the difference in carbohydrates contributed by the artificial substrate in vitro as compared from those from the natural forage substrate in vivo. Among the amino acids present in the soluble fraction, proline, isoleucine, leucine and aspartic acid contents were found to be significantly correlated with ADF disgestibility in vivo ($r = 0.46$, $4 = 0.52$, $r = 0.46$ and $4 = 0.39$, respectively).

Title: Control Measures for Winter and Spring Tetany in Beef Cows

Leader: R. L. Reid, West Virginia

Previous trials with mineral mixes and compressed high Mg blocks fed free-choice to beef cows indicated (1) that consumption is variable during the winter period and seldom supplies the level of Mg (10-15 g/day) desirable as a supplement for beef cows in late pregnancy or early lactation; (2) that use of the blocks or mixes by individual cows is highly variable and that some cows use the supplements only at lengthy intervals. Cases of winter tetany have been noted under such conditions. Present trials are designed to examine (a) the feasibility of supplying supplementary Mg in the water; (b) the effect of a high versus a low plane of Mg nutrition during the winter on serum Mg changes when cows are turned on to fertilized spring pasture. Two groups of 16 cows are maintained on hay, salt, and either water or a dilute solution of Epsom salts (3.78 kg/200 gal). This solution supplies approximately 12-15 g Mg per head/day. Blood Mg values taken at 2-week intervals in the control group have ranged from 1.15-1.53 mg/100 ml, compared to a range of 1.63-1.88 mg/100 ml in the treated group. Cows in the treated group consume the same volume of solution as the control group, and there has been no indication of scouring or metabolic disturbances.

Title: Comparative Feeding and Balance Trials with Lactating Beef Cows and Lambs

Leaders: R. L. Reid and Charles McCormick, West Virginia

Trials were run in 1975 to compare the digestibility, intake and mineral utilization for four perennial grass species (perennial ryegrass, orchardgrass, smooth bromegrass and tall fescue), each at two growth stages, by lactating beef cows (3 per treatment) and growing lambs (6 per treatment). The grasses were cut daily, chopped and fed ad lib. Fecal output by the cows was estimated by total collection and by grab-sampling using chromic oxide impregnated paper. As in previous years, dry matter digestibility (DMD) of tall fescue was lower than that of the other species at an early growth stage (early heading) but not later in the season (full bloom), and this was true for both cattle and sheep. Intake of fescue by cows was lower than for other grass species in both trials, but this was not the case for lambs. Intake, expressed as $g/kg^{.75}$, was markedly greater for mature cows than for lambs. Mineral balance data for the trials are not complete, but apparent absorption data for Mg, Ca, P, K and S have been determined. Absorption data for Mg, S and K are comparable for cattle and sheep, while availability values for Ca and P are much higher for cattle than for lambs. Results also confirm

previous findings that there are differences between grass species and growth stages in mineral availability, and this seems to be particularly true for Ca and P.

Title: Effects of Roughage Preparation

Leaders: E. C. Leffel and S. C. Wheland, Maryland

Application of propionic or acetic acid to high moisture (30-35%) hay before baling did not prevent mold growth in or deterioration of the hay in storage. When ground alfalfa hay was reconstituted to 20, 30 or 40% moisture, the addition of 1.5% propionic acid by weight did prevent temperature rise during storage and prevented dry matter losses which were 15, 28 and 30%, respectively from the 20, 30 and 40% moisture controls. Ground alfalfa hay reconstituted to 35% moisture was treated with 1 or 2% propionic or stored untreated as a control and compared to air dry ground alfalfa also stored without treatment. Both acid treatments prevented temperature rise in storage while the high moisture control rose to 48 C within 6 days and remained above 48 C for 54 days.

Sheep consumed the acid-treated forages more readily than they did the untreated control and failed to maintain weight on the latter diet. Digestibilities of dry matter and nitrogen were similar for the air dry control and the acid treated forages, while digestibility was depressed in the untreated high moisture material.

Acid detergent fiber, neutral detergent fiber, lignin and pepsin insoluble nitrogen concentrations were all higher in the untreated high moisture forages, indicating that the more digestible fractions of the feedstuffs were lost during storage of the high moisture material. Results to date indicate that the most important single effect of organic acid treatment of high moisture feedstuffs may be the prevention of dry matter loss during storage.

A rapid and simple method for establishing permanent ruminal fistulae has been developed. A frozen cannula is forced into the rumen in a manner similar to the use of a trocar. Minimal equipment is required and the operation can be performed in 15 to 20 minutes in sheep or 30 minutes in cattle.

Title: Feeding of Alfalfa Hay Preserved with Ammonium Isobutyrate

Leader: J. H. Vandersall, Maryland

Sixteen Holstein cows were paired on the basis of production of 4% fat-corrected milk (FCM), body size, stage of lactation and hay intake during a 2-week preliminary period. One member of each pair was randomly assigned to be fed AIB-treated hay and the other a high quality sun-cured alfalfa hay. Concentrates were fed on a 3:1 FCM to concentrate ratio according to the production of the higher producing member of each pair.

When adjusted for the preliminary period there were no differences between the forage treatments in milk production (FCM) 22.6 kg; fat percentage (3.8%); protein percentage (3.42%); or hay dry matter consumption (13.4 kg). There was a slight tendency in favor of the AIB treated hay. This indicated that if heat damage and mold is prevented by AIB the forage is as good as that harvested when it could be fully sun cured.

Title: Ratios of Alfalfa Hay to Corn Stover for Growing Dairy Animals

Leader: J. H. Vandersall, Maryland

An 8-week trial with nine Holstein heifers and six Holstein steers weighing approximately 200 kg each is being conducted to compare corn stover to alfalfa hay ratios of 2:1, 1:1, and 1:2. The animals were blocked into groups of three based upon their sex, weight, age and alfalfa hay intake during the last 2 weeks of a 3-week preliminary period. The forages are fed ad libitum and the concentrates limited to 1.36 kg per head per day. The group fed the stover to hay ratio of 1:2 is fed ground shelled corn plus 1% each salt and dicalcium phosphate. Soybean meal (48%) replaces 6% of the corn in the concentrate fed the 1:1 ratio and 16% in that fed the 2:1 stover-alfalfa ratio.

The experiment has not progressed far enough to tell trends. It is hoped that by the use of younger animals and limiting the concentrates the replacement value of corn stover for alfalfa hay can be more critically evaluated than in trial reported last year.

Title: Addition of Newspapers to Direct-cut Alfalfa Silage

Leaders: T. L. Horn and J. H. Vandersall, Maryland

Newspapers were added to direct-cut alfalfa silage to reduce the moisture content and hopefully get a desirable fermentation. At the time the newspapers were selling for $3.00 per ton and thus offered an inexpensive forage. In glass jar silos the addition of newspapers at the rate of 15% of the wet weight gave a good fermentation and appeared to yield a better silage than higher and lower rates.

Newspapers (no magazines) were collected at the University's recycling center. Part of a load of alfalfa was chopped directly into a wagon, then, newspaper was chopped through the field chopper on top of the partial load. Finally, the load was finished with the amount of fresh forage to give the rate of 15% newspapers (300 lb/ton). The silage was blown into an upright silo and topped with direct cut silage.

This silage was not satisfactory for steers since when it was fed along or mixed with an equal weight of wilted silage from the same cutting, the amount consumed was not large enough to maintain weight of the steers. The fermentation was not as good as expected and the pH was near 7. Fine chopping through a leaf shredder improved intake but not enough to maintain steer weights. The use of newspapers for forage in this manner is not advised until a better method of harvest and a method to obtain better fermentation is derived.

Title: Infrared for the Nutritional Evaluation of Crops and Miscellaneous Feedstuffs

Leaders: J. S. Shenk, B. R. Baumgardt, Pennsylvania, and R. F. Barnes, U.S. Pasture Research Laboratory

One of the important objectives in forage research has been the development of rapid, accurate, and inexpensive laboratory procedures to determine the quality or feeding value of forage. Currently laboratory procedures in use do a satisfactory job of describing forage quality; however, if progress is going to continue in this sector of agriculture, new and more rapid techniques will be needed.

The first breakthrough in new instrumentation was demonstrated April 28, 1975, at a meeting of the Hay Marketing Committee sponsored by the American Forage and Grassland Congress by its inventor, Karl H. Norris. Norris is chief engineer of the Instrumentation Laboratory, Beltsville. These initial studies of the near infrared spectra (1.4 to 2.4 μm) were conducted with 87 samples of dry ground forage. Temperate forage species analyzed were alfalfa, tall fescue, smooth

bromegrass and alfalfa bromegrass mixtures. These forages have been preserved as hay, silage, and fresh frozen forage. Tropical species included bermudagrass and Pangola digitgrass. Correlations for laboratory measurements of chemical composition were 0.99 for crude protein, 0.98 for neutral detergent fiber, 0.96 for acid detergent fiber, 0.96 for lignin, and 0.95 for in vitro rumen digestion. Animal response correlations were 0.88 for dry matter digestibility, 0.80 for dry matter intake, and 0.85 for digestible energy intake. Since one of the key components of the infrared analyses is a computer, data from the instrument can be used directly for ration formulation, forage management or plant breeding research.

We were so impressed with the potential of this device that Penn State has purchased this instrument with a Specific Cooperative Agreement from ARS-USDA. The instrument is currently housed at the U.S. Pasture Research Laboratory, USDA-ARS. Our first efforts will be to verify the initial discoveries followed by assessing the potential of the instrument to determine other chemical constituents and animal response factors. If these verification studies are successful, we will place the instrument into routine service on a research basis as part of our Cooperative Crop Quality Laboratory between the Pasture Laboratory and the College of Agriculture. Research will then be initiated into the basic aspects of the procedure as well as studies into new applications of the technology.

Title: Nutrient Changes of Alfalfa Forages Submitted to Protein Extraction

Leaders: H. Fenner and D. M. Vietor, Massachusetts

Feasibility of extracting protein from alfalfa for future use in human diets will avail the residues or pulp as possible cattle feed of a lower quality. It can be utilized fresh, dried or as low moisture silage. In its physical nature the roughage is reduced by maceration and hydrolic pressing to fibrous light green mats, which in the fresh form proved to represent an eagerly consumed supplement to a dairy ration based on corn silage as the only roughage. In the present experiments the amounts of roughage from each cutting used for extraction were insufficient for complete digestion trials with ruminants. Of the 11 cuttings taken from first and regrowth alfalfa, only the 5 harvested in August and later showed most uniform and desirable results. Of these the preprocessed forages ranged from 22-25% in crude protein, producing a pulp containing still 15-17%. The corresponding crude fiber values for the fresh forage and pulp were 24-28% and 34.5-39.5%, respectively. Six cuttings taken in June and July proved to be too mature, or too low in protein and too high in fiber for yielding after extraction still an acceptable feed for a productive ration.

In average the overall changes in relative proportions of original nutrients in the 11 alfalfa samples were for dry matter, crude protein, true protein, NPN, ether extracts, N-free extracts, crude fiber and ash: +77.36%, -25.75%, -28.13%, +13.91%, -20.23%, +1.63%, +22.89%, -20.47%. The relative increase of the NPN fraction (water soluble N) in the alfalfa pulp can be explained by the exposure of the cell-wall proteins to the released proteolytic enzymes of the cell content. The reduction in the proportion of mineral matter is caused mainly by the removal of the dissolved monovalent cation potassium found in the cell fluid which is pressed off with the liquid.

Aliquotes of the pre- and post-extraction forage have been ensiled in mason jars for a comparative study of possible changes in silage quality caused by the reduction in protein and mineral matters. The lowering of the buffer capacity in the forage pulp should result in a better fermentation of this product.

Title: Factors Affecting Nutritive Value of Alfalfa Hay

Leaders: B. R. Baumgardt and P.J. Wangsness, Pennsylvania

To optimize the use of forage-based diets for ruminants, it is necessary to know the influence of physical form of the forage and/or amount of concentrate in the diet on animal performance. The extent to which pelleting a portion of an all-alfalfa hay diet can substitute for grain (ground shelled corn plus soybean meal to make diets isonitrogenous) in lamb finishing diets was estimated. Dietary treatments were: (1) 100% chopped alfalfa hay (CAH); (2) 75% CAH, 25% grain; (3) 50% CAH, 50% grain; (4) 25% CAH, 75% pelleted alfalfa hay; (5) 100% chopped crownvetch hay. Crude protein (%), in vitro DDM (%), and average daily gains (g) were: (1) 19.4, 63.6, 136; (2) 20.2, 70.8, 166; (3) 20.2, 75.9, 247; (4) 19.1, 63.5, 180; (5) 18.4, 61.1, 83. Pelleting 75% of an all-alfalfa hay ration resulted in equal or slightly greater performance compared to the ration containing 25% concentrate.

Digestibility of forages has usually been determined at the maintenance level of intake. However, it would be useful to know if valid estimates of digestibility could be obtained at higher intakes. An experiment was designed to compare the digestibility of alfalfa hay when fed at 85% ad libitum or at maintenance. Because digestibilities of DM, NDF, and crude protein, at the two levels of intake, did not differ significantly, it was concluded that a valid estimate of alfalfa digestibility could be obtained at intakes above maintenance.

Title: Feeding Behavior of Ruminants Fed Forage-Based Complete Rations

Leader: P. J. Wangsness, Pennsylvania

Physical and chemical constituents of forage-based rations have been shown to be related to diurnal feeding behavior in ruminants. Studies continue on defining the dietary effects on spontaneous feeding behavior in 180 kg steers. An electronic system was developed to monitor number of meals, size of individual meals, time spent eating and eating rates. Diurnal feeding patterns were evident with most activity between 0600 and 1800 hours. Average meal size was 414.5 g but the range in meal size was large. With increasing meal size, both eating rate and time spent eating increased. Eating rate, however, plateaued while time spent eating continued to increase with the large meals. Results indicate that steers consume discrete meals and that both eating rate and total time spent eating influence size of individual meals. Studies are in progress to evaluate feeding behavior of sheep fed grass forages.

Title: Ultrafiltration of Alfalfa Juice for Human Protein Recovery

Leader: L. F. Whitney, Massachusetts

Ultrafiltration pilot studies have been conducted on alfalfa juice as affected by stage of maturity and processing parameters such as flow rate, pressure and flux. The membrane cutoff is approximately 15000 m.w. Fresh-cut alfalfa was commuted three times through an open hammer mill (Fritzmill T. M.), then subjected to pressures of 125 psi in a platen press. The press cake (50% m.c.), as well as the forage (80% m.c.) before pressing, were subjected to ensiling tests for suitability and palatability. Protein analyses of both fractions were determined with about 50% of the protein retained in the press cake forage fraction.

Approximately 50% of juice protein was recovered in the precipitant after ultrafiltration, not yet sufficient for commercial acceptance. Also, a membrane is not yet commercially available for the first-stage, upper-cutoff range which would remove chloroplasts while allowing protein fractions to pass through. This phase of the work has been completed and is in the process of final analysis. The search for proper membranes continues.

SECTION IX

SILAGE RESEARCH

Title: Corn Silage Yields of Several Corn Varieties Having Different Morphological Characteristics

Leaders: E. R. Jones and R. H. Swain, Delaware

Research is being conducted to determine if corn varieties having different morphological characteristics would have significantly different amounts of stem, leaf, and ear components in total dry matter production. In vitro digestibility is being measured to determine if total digestible material can be maximized by selection of silage corn hybrids having larger leaves or shorter smaller stalks.

Title: Wilted Haycrop Silage Versus Hay for Dairy Cows

Leader: J. B. Holter, New Hampshire

In a 4-year continuous trial (97 lactations), lactating cows were fed forage dry matter, 56% as urea-treated corn silage and 44% as either wilted haycrop silage (HCS), equal amounts of hay and HCS (HCS-H), or hay (H). A single concentrate mixture (18% CP, dry basis) was fed to production. Dry cows received limited forage plus about 2 kg concentrate daily. Intakes of forage and total diet dry matter were more for H than for HCS or HCS-H, but milk yield was not significantly more for H. Income-over-feed cost per year was similar among forage treatments, being slightly more for HCS-H. Reproductive performance and herd health were similar among groups. Decision about harvesting first-cutting haycrop as wilted silage or hay depends on earlier harvest (16 days) and quicker regrowth with HCS and on its adaptability to mechanized handling and blended complete rations. Cows which commenced gaining body weight < 56 days post partum exhibited higher reproductive efficiency than those remaining in negative energy balance > 56 days.

Findings have immediate application to dairy farmers in Northeast U.S. About 2000 cow-month records were incorporated with similar data at the Virginia Agricultural Experiment Station to form a data bank to predict maximum feed intake under various conditions.

Title: Silage Investigations

Leaders: M. A. Sprague, J. Zublena, and J. Adalla, New Jersey

Experiments were continued to determine hydrolyzable carbohydrate and protein contents of alfalfa forage while drying in the swath. Samplings in May, July, August and October indicated no losses up to 24 hr as a function of time after cutting. CHO contents were least on July 11, slightly greater on May 24, much greater on August 27 and highest on October 18. Protein analyses, now being completed, indicate much less variability between seasons than CHO.

Plots of Vernal alfalfa were cut at intervals of 3, 4, 6 and 7 weeks from April 4 to August 22, 1974. Yield, tillers, stand, and size of roots were determined. Four- and six-week intervals between harvests were superior in all criteria to either more or less frequent cuttings. Number of tillers per plant the following spring on 4- and 6-cut plots was double that on plots cut at 3- and 7-week intervals the previous season. More than half the plants were lost from plots cut every 3 weeks from April to September.

SECTION X

ENVIRONMENTAL RESEARCH

Title: Hatch 233 Movement of Heavy Metals in the Environment: Pollution and Recycling Schemes (Plus Water Research Institute Parallel Project)

Leaders: D. J. Horvath and R. Singh, West Virginia

Addition of sewage sludges to several West Virginia soils supporting several crops indicates that (1) sludges are variable among cities with respect to both plant nutrients and heavy metals, (2) plant growth and composition responses to a given sludge vary appreciably among soils, and (3) while only a few observations are available, it appears that the availability of nutrients in sludge may be severalfold greater than that of the same nutrients in chemical fertilizers and this could have important effects upon the economics of recycling, for example P.

The paper reporting the animal (vole) tissue responses to seasonally elevated fescue Pb will appear in the proceedings of the 1975 University of Missouri Annual Conference on Trace Substances and Environmental Health.

Title: Sewage Sludge Utilization in the New Jersey Pine Barrens

Leaders: R. W. Duell, R. B. Alderfer, D. K. Markus and D. W. Platt, New Jersey

After 3 years of applying secondary digested sludge to 3 low productivity soils, yields of Midland bermudagrass and overseeded rye are improving where rate of application is 10T dry matter/A/Y. The 20T rate often produces the highest yield. The 40T rate is potentially higher yielding, but harvestable grass is sometimes lost because of occasional applicator-induced lodging and spotty stands resulting from smothering. A yield of 4.7T dry matter/A obtained with sludge is far short of that obtained with proper management including commercial fertilizers in earlier trials. There has been no evidence of heavy metal toxicity although heavy metal content in tissues increased appreciably above base status with each increment of sludge. Available nutrients and heavy metals (North Carolina extractant) accumulate in the surface soils and reflect loading rates. Most elements decrease sharply with depth beyond 4 inches.

Nickel, however, appears to accumulate in the 12- to 24-inch depth. Increased organic matter extends at least to the 2-foot depth, and increased water retention extends to the 3-foot depth. The accumulated surface mulch of dried sludge may also contribute to improved moisture retention of these sandy soils.

Heavy midsummer inundation of a cool-season pasture grass mixture shortly after harvest did not cause appreciable loss of stand, but did stimulate regrowth. Rabbits, deer and cattle utilized sludge-treated grass even when residues were conspicuous on the foliage.

Title: Effects of Sewage Sludge on Soils and Yield of Corn and Soybeans

Leaders: A. M. Decker, R. L. Chaney, and D. C. Wolf, Maryland

Corn and soybeans were grown for the fourth season on field plots that had received 0, 25, 50 and 100 dry tons of digested sewage sludge in 1972. The pH dropped to an average of 5.5, so lime was added to bring the pH up to 6.5 prior to planting the 1975 crops. As in past years, 80 lb each of P_2O_5 and K_2O were applied to all fertilized plots; in addition all fertilized corn plots received 160 lb NIA.

Corn grain yields were significantly higher where sludge had been applied. Fertilizer application also increased grain yield regardless of the sludge rate. Fertilized plots without sludge produced 80 bushels of grain while yields at the 25-, 50-, and 100-ton rates were 103, 120 and 124 bu, respectively. Corn silage yields were similar but yield differences were much smaller. In contrast to past years, there was no soybean yield response to either sludge or fertilizer application.

Title: Disposal and Utilization of Dairy and Poultry Manure by Land Application

Leaders: H. D. Bartlett and L. F. Marriott, Pennsylvania

Liquid dairy manure was injected under orchardgrass sod in November 1974 (fall) or in April 1975 (spring) at rates to supply 300, 400 or 500 pounds N/acre for the second consecutive growing season. A check treatment of 100 pounds N/A as urea was also repeated.

Measurements recorded included NO_3-N and Cl in soil water samples collected periodically from 1 to 4-foot soil depths, and forage yields in 3 cuttings. Soil samples were taken in June and November for Kjeldahl N, NO_3-N and Cl analyses.

Nitrate N levels in water samples were generally much higher than in 1974, reflecting 2 years of manure application. The concentration was also higher in water from the fall-applied manure plots than from the spring-applied manure plots. At the 4-foot depth, NO_3-N values throughout the season for fall-applied manure were in the 10 to 20 mg/l range, while all values at that depth for the spring-applied manure were below 10 mg/l. Water samples from urea plots consistently contained less than 10 mg/l of NO_3-N at all sampling depths. Dry matter yields in 3 cuttings were 2.4 T/A for urea (insufficient N after the first cut), and 3.3 and 3.5 T/A for fall and spring manure, respectively. There was no significant difference for rate or time of application of the manure. The water and yield data would suggest that the lowest rate used (300 lb N/A) supplied adequate N for the orchardgrass and provided the least pollution potential.

No-till corn was grown a second year on orchardgrass plots which had received dairy manure injections to supply 700 to 3500 lb N/A/year during 1969 - 1971. Yields ranged from 93 to 114 bu/A of 15.5% moisture grain.

Title: Monitoring Effects of Land Disposal of Sewage Sludge on Crops Production and Minerals in Food Chain

Leaders: D. E. Baker, R. M. Leach and H. Cole, Pennsylvania

Biweekly sampling of six sewage treatment plants for one year was completed on July 1, 1975. All results have not been summarized, but the indications for several elements are that sludge composition varies much more among plants than over time within plants. Thus, it will be possible to predict sludge composition over time from relatively few samples. Experiments are continuing to determine the relationship of Cd within diets of chicks and meadow voles on Cd in body tissues. Small increases in dietary Cd cause substantial accumulation of Cd within liver and kidney over a relatively short time. Adding 3 ppm Cd to the diet of broiler chicks and laying hens caused an increase in Cd concentration of from 260 to 2250 percent of background levels. Activities of microorganisms and plant pathogens have not been affected significantly by sludge application causing excessive amounts of Cd within the food chain. While conclusions are not possible at this time, the importance of monitoring waste disposal with respect to water quality and animal and human health is evident.

Title: Using Cropland for Sewage Wastewater and Sludge Disposal

Leaders: L. T. Kardos, W. E. Sopper and W. R. De Tar, Pennsylvania

A sod, no-till management system was incorporated in the sewage effluent treated corn area. Six grasses and two legumes which were established in 1974 were suppressed by herbicide treatment. The latter varied in effectiveness from virtual elimination of the birdsfoot trefoil to nonsuppression of the tall fescue. The other grasses were Kentucky bluegrass, orchardgrass, perennial ryegrass, reed canarygrass and smoothbrome, the other legume, crownvetch. The crownvetch appears to show the best promise of adequate cover with least competition with the corn. The NO_3-N concentration in the soil water at 120 cm depth in the irrigated 5 cm per week area did not appear to be affected by the various sods during the June period, the period of maximum concentration. NO_3-N concentration in the fertilizer, unirrigated area was substantially higher than in the unfertilized, sewage effluent irrigated plots. A reed canarygrass area irrigated with 5 cm per week of sludge injected effluent received almost 900 kg N/ha. At this high nitrogen loading mean monthly NO_3-N concentration in the soil water at 120 cm peaked at 17.5 ppm in May but mean annual concentration was 11.5 ppm. Canarygrass dry matter yield was 10,900 kg/ha from three cuttings. At the end of the second year hybrid poplar planted in close spacing and irrigated with sewage effluent has attained a height of 8 feet compared to 4 feet on an unirrigated plot.

Title: Influence of Sprinkler Irrigation with Municipal Sewage Effluent and Cutting Management on Disease Incidence and Buildup on Reed Canarygrass Clones

Leaders: K. E. Zeiders and R. T. Sherwood, U.S. Pasture Research Laboratory

On May 1, 1974, a replicated field experiment was initiated to determine the impact of irrigation with municipal sewage effluent on disease development in 12 reed canarygrass clones which varied widely in palatability, and in reaction to *Stagonospora foliicola* and *Helminthosporium catenarium*. The plots were located within a 14-acre field that is planted each year in rows of corn, and irrigated weekly with 0 or 2 inches of sewage effluent. In 1975, the corn was planted without tillage; irrigation began May 22 and was terminated September 3, 1975. Half of the plants of each clone were clipped only once, on June 4; the other half were clipped 3 times, on June 4, July 31, and October 1. The severity of tawny blotch, which was the predominant disease, was rated on July 31 and September 30. A scale of 1 to 9 was used, where 1 = no disease, 9 = very severe, about 90 of leaf tissue killed.

Because the irrigated and nonirrigated clones were in separate locations of the field, the data were analyzed as separate experiments. A t-test of irrigated versus nonirrigated means indicated that tawny blotch (caused by S. foliicola) was significantly more severe (0.01 level of probability) on irrigated than on nonirrigated plants on both rating dates. A similar result was observed in September 1974 ratings.

For clones under irrigation, analysis of variance indicated there was no significant influence of cutting frequency for the July 31 reading; however, on September 30, disease severity was significantly greater (0.05 level) on plants under 1-cut than on those under 3-cut manatement. There was a significant difference in reaction of clones to tawny blotch for both rating dates.

For nonirrigated clones, there was no significant influence of cutting frequency for July 31, but for September 30, there was significantly more tawny blotch (0.01 level) on plants cut once than on plants cut 3 times. There was no significant difference in disease reaction of clones for July 31 because only trace amounts of disease were present; however, for the September 30 ratings, there was a highly significant difference in reaction of clones to tawny blotch. The interaction of cuts X clones was not significant for either the irrigated or nonirrigated treatments.

Results indicate that (1) irrigation was a primary contributing factor to the increased incidence of disease in both 1974 and 1975, (2) disease incidence will be greater on plants cut less frequently, and (3) there is considerable variability among the clones in their field reaction to tawny blotch. This latter conclusion agrees with results obtained in artificial inoculations. Clones which exhibit good resistance will be valuable as parents in breeding for resistance to tawny blotch.

LIST OF PUBLICATIONS

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RECIPIENTS OF GRADUATE DEGREES - 1975

M. S. Degree

Name/Institution/Advisor	Thesis Title
Adansi, Prosper Mawulom University of New Hampshire J. B. Holter	Conserving hay-crop as wilted silage with or without a commercial additive--possible applications to Ghana.
Bae, Dong Ho University of Vermont J. G. Welch	Effect of hay intake levels on rumination patterns in sheep.
Baker, Paul B Penn State University R. A. Byers	An adult preference test and a nutrient slant-board technique for rearing the clover root curculio, Sitona hispidulus (F.)
Craven, M. M. Cornell University R. P. Murphy	Reaction of several cultivars of alfalfa, Medicago sativa to Phytophthora megasperma.
Goodnow, R. E. University of Maine W. P. Apgar	Relationship of forage nitrogen fractions with in vivo forage utilization and in vitro fiber disappearance.
Karth, K. M. West Virginia University R. L. Reid	Comparative nutritive value of tall fescue, perennial ryegrass, smooth bromegrass and orchardgrass.
Lea. H. Z. University of New Hampshire G. M. Dunn	Stomatal diffusion resistance and stomatal behavior in tetraploid, hexaploid and octoploid plants of Bromus inermis Leyss.
Miller, G. A. University of Maryland J. H. Axley	Influence of poultry wastewater on drainage through Sassafras sandy loam and nutrient removal by forages from this soil.
Potvin, W. University of Connecticut D. W. Allinson	Nonstructural carbohydrate fluctuations, yield, and winter survival of ryegrass cultivars as affected by fall management treatments.

Name/Institution/Advisor	Thesis Title
Roemig, J. J. West Virginia University R. L. Reid	Mineral utilization in Lambs and guinea pigs fed magnesium fertilized forages.

RECIPIENTS OF GRADUATE DEGREES - 1975

Ph.D Degree

Bonde, M. R. Cornell University R. L. Millar	Induction, identification, and role of sativan and vestitol as phytoalexins in Lotus corniculatus L.
Kalmbacher, R. S. Penn State University J. B. Washko	Management factors affecting establishment and productivity of birdsfoot trefoil--tall fescue in woodland clearings.
Mason, Wesley N. Penn State University J. S. Shenk and R. F. Barnes	The inheritance of forage quality traits in orchardgrass (Dactylis glomerata L.)
Morrissey, R. University of Connecticut J. S. Koths	The influence of heavy metals on microbially mediated nitrogen transformations in soil: nutrification and ammonification.
Mueller, J. P. Penn State University J. B. Washko	Chemical preservation of high moisture hay.
Muslih, R. K. Cornell University D. L. Linscott	Lipid biosynthesis and the effects of 2,4-dichloro-3-nitro and 2,4-dichloro-3-amino benzoic acids.