REPORT OF THE TWENTY-THIRD ALFALFA IMPROVEMENT CONFERENCE

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Northeastern Region
Plant Genetics and Germplasm Institute
Agricultural Research Center
Beltsville, Maryland
TWENTY-THIRD ALFALFA IMPROVEMENT CONFERENCE

Program Chairman - D. H. Heinrichs

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INTRODUCTION

The 23rd Alfalfa Improvement Conference met concurrently with the 16th Forage Insect Conference at Carleton University, Ottawa, Ontario, Canada. One joint half-day session was held, devoted to new findings on harmful and beneficial insects. There was also joint participation in the field trip to the Animal Research Institute, Greenbelt Farm, and on some committees.

The conferences were opened at 8:30 a.m. on July 10 in Southam Hall by D. H. Heinrichs, Chairman of the Alfalfa Improvement Conference. F. K. Kristjansson, Director, Ottawa Research Station, welcomed the participants.

This report contains summaries of research studies reported, committee reports, business transacted, and a list of participants. Summary accounts from regional Alfalfa Improvement Conferences and from Canada are also included. From the entomological standpoint, this report covers only the session held jointly with the entomologists. A complete report of the Forage Insect Conference is being prepared by Arthur A. Hower, Jr., Department of Entomology, Pennsylvania State University, University Park, Pennsylvania 16802.

Speakers and their organizations are responsible for the information they have contributed to this report. They should be consulted by those who wish to reproduce the reports, wholly or in part.

Deep appreciation is expressed to the hosts of the conferences. Their kind hospitality and many courtesies contributed much to the personal enjoyment of the participants and to the success of the conferences. Special note is made of the banquet, when T. H. Anstey, Assistant Director-General (Western), Research Branch, Canada Department of Agriculture, described some of the research pursuits of the Canada Department of Agriculture.

Members of the Executive Committee of the 23rd Alfalfa Improvement Conference were as follows: D. H. Heinrichs, Chairman, Swift Current, Saskatchewan; R. R. Hill, Jr., University Park, Pennsylvania; M. D. Rumbaugh, Brookings, South Dakota; I. I. Kawaguchi, Bakersfield, California; E. H. Beyer, San Juan Bautista, California; W. R. Childers, Ottawa, Ontario; and C. H. Hanson, Secretary, Beltsville, Maryland.

This report was prepared in the Applied Plant Genetics Laboratory, Plant Genetics and Germplasm Institute, Agricultural Research Center, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, Maryland 20705. Copies are available on request. Mention of companies or commercial products does not imply recommendation or endorsement by the U.S. Department of Agriculture over others not mentioned.
The Status of Injurious Insects on Alfalfa in Canada

C. H. Craig
Research Station, Research Branch, Canada Agriculture,
University Campus, Saskatoon, Saskatchewan

A compilation of information from several sources and a search of pertinent literature reveal a wide diversity of insect problems in forage crops across Canada.

Grasshoppers pose the greatest threat to alfalfa in Western Canada, although not continually. Species including *Melanoplus sanguinipes*, *M. bivittatus*, *M. packardii* and *Carmnula pellucida* reach outbreak proportions every 10-12 years and take their toll for 3 or 4 years during the outbreaks.

The alfalfa weevil, *Hypera postica*, invaded the plains area in 1954 and quickly spread to cover an area of approximately 45,000 square miles in Saskatchewan and Alberta; populations have remained very low and no significant damage has occurred recently. After first recovery in Ontario and Quebec in 1967 the weevil now extends along a 500-mile front from the Ontario-Michigan border to the Quebec-New Hampshire border, and northward to Georgian Bay, Ottawa Valley and Montreal. Infestations and damage have been heaviest in counties bordering the Lakes; in 1970 hay losses to first-growth alfalfa in this area ranged from 25-60%. In Quebec damage in 1969 and 1970 was less than in 1968, although populations were about the same.

In the parkland areas of Manitoba, Saskatchewan and Alberta, the main alfalfa seed-producing region of Canada, plant bugs are a major deterrent to seed production. The species complex includes *Adelphocoris lineolatus*, *A. superbus*, *Plagiognathus medicagus*, *Liocoris borealis*, *L. lineolaris*, *L. rufidorsus*, *L. elisus* and *L. unctuosus*. Populations of from 4-60 bugs per sweep occur in most fields and seed yields are reduced 0-100%. Spring burning of alfalfa stubble and debris is a common practice to control egg-overwintering species, and insecticide treatment is relied upon for lygus control.

Pea aphid, *Acyrthosiphon pisum*, is always present and always fairly abundant in alfalfa. Each year damaging infestations develop in at least some locations across Canada; in south-central Alberta infestations are consistently higher on second-growth, irrigated alfalfa; thus this insect is of primary economic importance in that area. Reduced carotene and protein in hay and less winterhardiness of plants attributed to large aphid infestations.

In the Maritime Provinces, the clover root curculio, *Sitona hispidula*, is a limiting factor for forage production. There was an estimated 10% loss of alfalfa in 1970. Nematodes and fungi sometimes in association with the curculio aggravate deterioration of roots of legumes. The beetle occurs in other regions of southern Canada, except the plains region, but is of no
An insect being closely observed for abundance and spread in Ontario is the alfalfa snout beetle, *Brachyrhinus ligustici*, considered to be potentially a more damaging pest than the alfalfa weevil.

The alfalfa seed chalcid, *Bruchophagus gibbus*, is known to be widely distributed in Canada, reported to cause losses to second-growth seed yield in Ontario. Management practices in Western Canada have probably discouraged buildup of damaging infestations in alfalfa seed fields.

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**Breeding for Pea Aphid Resistance in Alfalfa**

G. R. Manglitz, W. R. Kehr, S. D. Kindler, and R. L. Ogden

Agricultural Research Service, USDA, and the University of Nebraska, Lincoln

Studies concerning pea aphid resistance in alfalfa were started nearly 40 years ago; however, progress on developing resistant varieties was quite slow during the early years. The outstanding breeding success achieved with spotted alfalfa aphid resistance during the early 1950's appeared to revive interest in pea aphid resistance. Presently pea aphid resistance is an integral part of many alfalfa breeding programs.

By following a few simple precautions it is possible to produce great numbers of pea aphids. This makes possible the mass infestation of seedling plants in the greenhouse, a technique which is the "backbone" of most pea aphid screening programs. Positive correlations exist between greenhouse screening and evaluation for resistance in the field.

The exact nature of resistance to the pea aphid is not known. Resistance reduces fecundity and survival and probably feeding of pea aphids. Resistance is fairly stable but can be modified by environmental factors, particularly low temperature. Genotype x temperature interactions occur. Biotypes of the pea aphid have been observed but have not, as yet, become a problem. Resistance is highly heritable but the mechanisms of inheritance are not fully understood.

Ladak was the first alfalfa variety observed with some resistance to the pea aphid. The first varieties in which the development of resistance was planned were: Washoe, Dawson, and Kanza. All three also have spotted alfalfa aphid resistance. Team which was developed for alfalfa weevil resistance also has pea aphid resistance. The development of multiple pest resistant varieties is the current trend.

Pea aphid resistant varieties, under aphid attack, will produce higher yields of better quality hay than will susceptible varieties.

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A new pest of alfalfa has appeared in the Northeast, the alfalfa blotch leaf miner, *Agromyza frontella* (Rondani). It was apparently first noticed in Hampshire County, Mass., by Gary Jensen and Dallas Miller in 1968. It was reported from surrounding States soon after. While confirmed from collections made in only three States, Massachusetts, New York, and New Jersey, it is now believed to be the species responsible from Maine through Delaware. There are no records of *Agromyza frontella* in Maryland, Ohio, Tennessee, or North Carolina, nor Ontario or Quebec in Canada. Much confusion remains as to what species of leaf miners are present in many other States of the Eastern U.S.

In 1971 Jensen and his coworkers found in June up to 50% of the leaflets infested on mature alfalfa plants. In Dutchess County, N.Y., some growers believe damage from the miner is greater than that of the alfalfa weevil. The miners disappear during the heat of late July and August so the impact is greatest on the first cutting.

For some time there was a great deal of confusion and delay as to the exact name of the species. K. A. Spencer and G. C. Steyskal, two of the foremost students of the Agromyzidae, after studying additional material, concluded in early 1972 that it was the same as the species described in 1875 by Camillo Rondani in Italy.

In Europe it is found in alfalfa from Italy to Russia and has been reported on alfalfa from England, France, Holland, Denmark, Sweden, and Germany. We are indebted to Bollow of Germany for details of its life history and habits. In Germany it has two generations a year. The first generation is in flight from April to May; the second from July to October. The eggs are laid under the lower epidermis in the parenchyma of the leaflets in special egg cavities and hatch in 3-8 days. The larvae pass through three instars in 3-4 weeks before pupating in the soil in 5-6 hours. The adults emerge in about 10 days or early July. Many pupae diapause until next spring when flights are particularly large following small, meaningless flights in late summer. In New York, Rogers noting the peaks of adult flights throughout the summer feels there may be three generations per year with the first one being about June 6th and with succeeding generations every 6 weeks coinciding with the 6-week cutting date for each succeeding hay harvest. It has been recorded as causing damage in Germany in alfalfa but in England it has never been recorded as causing any significant damage. Some workers in the U.S. feel it has the potential of becoming a serious problem here, greatly affecting quality and feeding value of alfalfa.

Most carbamate and phosphate insecticides now labeled and used for alfalfa weevil control were evaluated in 1971 and 1972 in New York at similar dosages as those used for weevil control with excellent success. Timing of the application seemed to be most critical to success with best results being
achieved at early "pinhole" or feeding stage. There was little difference in control of the miners with any of the insecticides used.

Early cutting, plus use of resistant varieties with parasites in the long run in an integrated control approach, may be the best answer to this problem. Resistance to insecticides has occurred in miners of other cultivated crops and at least five parasites have been recorded in the Northeast in the alfalfa blotch leaf miner to date.

Literature Cited


Recent Research Related to the Success of the Alfalfa Leafcutter Bee in Alfalfa Seed Production

G. A. Hobbs
Research Station, CDA
Lethbridge, Alberta

We first imported alfalfa leafcutter bees into Canada from the Northwestern U.S.A. in 1962. Since then we have tried to gain complete control over them in order to protect them from the weather and other enemies. We have also tried to make their management such a precise art that our growers could handle millions of them efficiently and cheaply.
In 1963 we started to use grooved boards to build hives that would be more attractive to the bees and more efficient for the bees and the beekeepers. We devised and experimented with many designs and colors. We knew that the bees prefer to live in narrow tunnels where they produce many more males than females. To encourage them to nest in tunnels wider than those they would normally choose and thus to produce more females, we tried to make the hives as attractive as possible.

**Color.**—We found that a hive painted in one color and stenciled with a pattern of another color was much more attractive to the bees than a hive painted in only one color. Of the color combinations tested, light blue on black, red, or green; red on black; and black on red were preferred. We also found that when hives with patterns of light blue painted on black, red, and green were placed side by side along the east-facing walls of the shelters, they were equally attractive to the bees. With the use of the colorful hives, we induced the bees to nest evenly throughout the hives, and thus prevented them from forming the congregations that produce the moist conditions favorable to the growth of mold in polystyrene nests.

**Tunnel length.**—In comparisons of various lengths of tunnels, we found that tunnels 7.3 cm or shorter were less efficient than tunnels 9.2 or 11.1 cm long. Also, we found that tunnels up to 21.6 cm long were almost as efficient as those half their length. The use of the longer tunnels would increase the efficiency of the alfalfa leafcutter bee beekeeping industry by reducing greatly the number of grooved boards that must be handled.

**Tunnel diameter.**—In various tests, we found that the bees preferred the narrowest (6.3 mm) tunnels and were least attracted to the widest (8.7 mm) tunnels. When they did nest in the 8.7-mm tunnels, they often placed two small cells side by side. When they nested in the 7.1- and 7.9-mm tunnels, they apparently did not increase the capacities of the cells but instead filled the extra space around each cell with leaf-cuttings. Although no increase in capacity in the cells in the 7.1-mm tunnels could be detected, we found that more females were produced in them than in the tunnels 6.3, 7.9, or 8.7 mm in diameter.

**Practical application.**—A newly designed grooved board of polystyrene with alternate 6.3- and 7.1-mm tunnels has been made and is being tested this season. Because the bees almost always choose to nest in the narrower tunnels, they can be expected to nest first in every second tunnel and therefore avoid the overcrowding that results in the production of mold. In addition, the bees that nest in the wider 7.1-mm tunnels should produce more females than those that nested in the 6.3-mm tunnels.

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Potential of Alfalfa Seed Production in Western Canada
with the Leafcutter Bee

D. A. Cooke
Research Station, CDA
Melfort, Saskatchewan

Alfalfa seed production in western Canada dates back to 1908 and coincides
with the development and introduction of the variety Grimm. For the next 50
years alfalfa seed production in western Canada was almost entirely confined
to the parkbelt region of the Prairie Provinces and was most successful along
the northern fringe of agricultural settlements. Rainfall was usually
adequate and an abundance of native bees (Bombus and Megachile) usually
provided satisfactory pollination. Seed production in the 1953-1962 period
averaged 4.5 million pounds per year. However, in the 1965-68 period it had
fallen to 2.8 million pounds and was even lower in 1969-1970. Extensive land
clearing destroyed the nesting sites of many native bees and their visitation
to alfalfa has been reduced by the attractive bloom of rapeseed (Brassica
napus and B. campestris).

The introduction of the leafcutter bee (M. rotundata) is beginning to revive
the alfalfa seed industry in western Canada. Bee management has been worked
out by Dr. G. A. Hobbs and we now have ample evidence of successful produc­
tion on both irrigated and dryland throughout western Canada. The potential
for contract multiplication of varieties recommended for use in eastern
Canada and the northeastern States is excellent. The potential for the
production of the hardy varieties recommended for western Canada and the
northwestern States is virtually unlimited.

Efficiency of Alfalfa Pollination by Different Species of Bees

W. P. Nye
Agricultural Research Service, USDA
Logan, Utah

A satisfactory alfalfa seed crop depends upon the strain, growing conditions,
insect control, and sufficient number of insects for cross-pollination. Few
insects other than bees trip alfalfa flowers, but the relative efficiency of
different species of bees, even those belonging to the same genera, differ
greatly and the efficiency of the same species differs in different locations.

The honey bee is an efficient alfalfa pollinator when it collects pollen, but
inefficient when it collects nectar, except during a brief learning period.
The percentage of pollen-collecting honey bees varies from time to time and
place to place. It tends to be greatest in Oklahoma, Arizona, and southern
California, intermediate in Kansas, Utah, and Nebraska, somewhat lower in
Idaho, Oregon, and Washington, and still lower in Alberta and Manitoba. The

1In cooperation with the Utah Agricultural Experiment Station.
tripping rate by nectar-collecting bees is seldom higher than 2% of the flowers visited except during brief periods when, perhaps, the number of learning bees is high. In general, the tripping rate by nectar-collecting honey bees follows the same regional trends as the percentage of pollen collectors.

Pollen-collecting honey bees are far more desirable on alfalfa seed fields than nectar-collecting ones. Pollen-collecting honey bees trip up to 80% of the flowers visited. The percentage of pollen-collecting honey bees on different seed fields varies from 0-100. It may vary from 1-50% or more on adjacent fields, depending upon the growing condition of the plants and insect control.

With the discovery that some colonies collect much greater percentages of alfalfa pollen than others and that the selection and breeding of these is heritable, it became possible to breed bees that collect unusually high and unusually low amounts of alfalfa pollen. The percentages of alfalfa pollen collected in the second, third, fourth, fifth, and sixth generations of the high preference line were 40, 50, 66, 85, and 86 and of the low preference line were 25, 15, 8, 18, and 8.

The relative importance of wild bees increases in areas where the honey bee fails to trip the flowers or collect pollen. Whereas the honey bee visits 7-17 flowers per minute, bumble bees (Bombus spp.) visit 10-30, leafcutter bees (Megachile spp.) visit 9-40, and the alkali bee (Nomia melanderi) visits 10-14. Bumble bees, leafcutter bees, and alkali bees trip 80-95% of the flowers visited. The alkali bee (N. melanderi) and the alfalfa leafcutter bee (M. rotundata) are highly gregarious and find alfalfa an attractive source of pollen. It has been demonstrated that increasing the population of both is practical and often correlated with high alfalfa seed yields.

Pollen consistency (purity of pollen) on the scopae of foraging honey bees, pollen collected in traps, foraging alkali bees, alfalfa leafcutter bees, and in the brood cells of the leafcutter bee varies considerably. Pollen collected by the honey bee in five alkali bee nest site locations contained only 1% or less mixed loads. Of the scopal loads of pollen collected by the alfalfa leafcutter bee, 59% were pure with 40% of these alfalfa, 27% had two types of pollen, 10% had three types, 3% had four types, and 0.2% had five types. Of the brood cells examined, 16% were pure, 48% had two types of pollen, 32% had three types, 4% had four types, 0.3% had five types, and 0.3% had six types. Of the scopal loads of pollen collected by the alkali bee, 40% were pure (all but 4% of these were alfalfa), 46% had two types of pollen, 11% had three types, 3% had four types, and 0.7% had five types.

The honey bee collected pollen from 23 species of plants in the alkali bee nest site locations. The alkali bee collected pollen from 15 species of plants and the leafcutter bee collected pollen from 13. In our surveys of the same localities, we noted 35 or more species of plants that were abundant and known to be attractive to at least several species of wild bees. At least an equal number of other plants, including grasses and many other wind-pollinated species, were also abundant but were unattractive to all bees, or to all except the honey bee. It would appear, then, that the honey bee
collected more than trace amounts of pollen from about two-thirds of the bee-attractive species of plants that were blooming, whereas the alkali bee and the alfalfa leafcutter bee collected pollen from about half of the bee-attractive species.

Pollen was collected chiefly from the major elements of the insect-pollinated flora. The largest amount of pollen collected came from the three main nectar sources, goatsrue (Galega officinalis), sweetclover (Melilotus spp.), and alfalfa (Medicago sativa).

From a distance, bees probably select flowers by color. At close range, they probably are guided by aroma of individual plants, nectar volume, sugar concentration, and the amount of pollen available per flower form. Different species are worked for pollen at different times of day, partly by proximity of crop, partly by times of presentation of pollen in the different species, and partly by competition between plant species.

The species from which mixed loads of pollen were collected seldom had floral features in common and were generally unrelated, except at the Greenville Farm in North Logan, where mixed loads, especially those of the alkali bee and the alfalfa leafcutter bee contained pollens collected from Galega officinalis, Melilotus spp., and Medicago sativa, and about 1% of the mixed loads of the honey bee in the same area contained pollen from G. officinalis and Trifolium repens, which are all legumes.

Status of Alfalfa Seed Production in Western U.S.A.

V. L. Marble
Agricultural Extension Service
University of California, Davis

Successful seed production involves insect control, pollination, and the integration of all management practices, particularly irrigation. In the last 20 years research on production problems has made alfalfa seed production a specialized industry. Successful growers have put research into practice, and regard seed production as their main objective rather than incidental to hay production.

In 1958, 1964, and 1971, the seven far-west States produced 67, 71, and 79% of the U.S. poundage, with California's share being 43, 34, and 37%, respectively. California's domination of U.S. alfalfa seed production peaked at 52% in 1957. Shifts to the Northwest and Nevada have occurred to a greater extent than simply transferring acres out of California. Seed production has nearly disappeared from Arizona and Utah. Reasons for increased western production include (1) higher yields made possible by utilization of honey bees and wild bees, (2) development of new public proprietary varieties requiring rapid seed increase with limited generations, (3) higher quality, (4) unmatched security of production from a limited quantity of stock seed, (5) acceptance of seed produced out of the area of adaptation, and (6) concentration of proprietary breeding programs in western States.
Over the last 15 years, certified seed acreage of public and proprietary varieties has fluctuated as noted in the following table.

### CERTIFIED ACREAGE AS PERCENT OF TOTAL

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<th>Proprietary</th>
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<td>California</td>
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<tr>
<td>Utah</td>
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</tbody>
</table>

Certified proprietary varieties are increasing in importance in the major seed States except Nevada and Oregon. In California they have increased to about one-third of the certified acreage. The percent of California's total production, certified and uncertified, as proprietary varieties for 1958, 1964, 1968, and 1971 was 4, 24, 46, and 47, respectively. Undoubtedly the Pacific Northwest will follow this trend, particularly in new lands where isolation problems with old public varieties don't exist.

The cost-price squeeze brought on by stable seed prices and spiraling operating costs in the past have to some degree been offset by increased yields in the P.N.W. but not in California. Production costs are $200-$250 in the P.N.W. and $275-$300 in California. Major costs include irrigation, weed and insect control, pollination, harvesting and processing, depreciation, interest on investment, and taxes. California studies show the break-even point on a 700-pound crop to be 42¢ per pound. One-third of the cost is depreciation and interest.

Production practices of superior western growers are increasing in similarity within the limits of climate. In the P.N.W., row plantings, direct combining after desiccation, larger fields, and increased planting of proprietary varieties are occurring. Important practices include control of harmful insects, adequate pollination, proper control of irrigation, weed control, and crop timing to minimize pesticide use, avoid seed loss due to weather and match pollinator activity.

The availability of other cash crops in the major alfalfa seed producing areas offers strong competition for land, financing, irrigation water, and management inputs. A healthy industry is dependent on future alfalfa use in North America and worldwide, the capacity of seed producers to solve economic and pollination problems, and willingness of consumers to pay a higher price for seed.
Nematodes and Root Rot of Alfalfa in the Maritimes

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Surveys of alfalfa crops in Nova Scotia and Prince Edward Island indicate that species of nine genera of plant-parasitic nematodes are associated with roots and rhizosphere soil. Species of root lesion (Pratylenchus), root knot (Meloidogyne), and pin (Paratylenchus) nematodes occur in larger numbers than cyst (Heterodera), stunt (Tylenchorhynchus), spiral (Helicotylenchus), and ring (Criconemoides) nematodes. Species of dagger (Xiphinema) and needle (Longidorus) nematodes are also encountered but in low numbers.

Greenhouse and field studies were conducted with Pratylenchus penetrans, the root lesion nematode occurring in the highest percentage of samples and in the greatest numbers. P. penetrans reduced alfalfa forage yield significantly in the greenhouse and yield reduction was influenced by nematode infestation level. In field plots infested with root lesion nematodes and fungi normally associated with forage legume root rots (Fusarium spp. and others), partial soil sterilization increased alfalfa forage yield significantly over two growing seasons, including the year of seeding. Since both nematodes and fungi were controlled, it was not possible to determine the effects of nematodes or root rotting fungi on forage yield. Subsequent field studies have shown that pre-plant nematicide treatments controlled root lesion nematodes and significantly increased alfalfa forage yield. When different nematicides and/or different rates of a nematicide resulted in differential control of root lesion nematodes, alfalfa forage yield was negatively correlated with nematode infestation. Fusarium spp. were recovered less frequently from roots growing in nematicide treated plots where nematode infestations were low, than from roots in control plots where nematode infestations were high. Laboratory studies showed that the nematicides used in the field had little effect on the fungi associated with alfalfa roots.

Fusarium Wilts and Root Rots of Alfalfa

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Root diseases have been a major concern of American and Canadian alfalfa growers for many years. Many fungi have been reported in association with diseased roots and have been held responsible for deterioration and poor persistence in stands. Fusarium oxysporum Schlecht. emend Snyd. & Hans. and F. solani (Mart.) App. & Wr. emend Snyd. & Hans. are two of the principal Fusaria involved in this disease complex in eastern Canada. The mechanism of
wilting incited by Fusarium spp. in alfalfa appears very similar to that of the wilting caused by F. oxysporum f. lycopersici (Sacc.) Snyd. & Hans. in tomato. Maceration tests and biochemical studies showed that pectin-splitting enzymes, especially pectic depolymerase, were involved. Cut stems placed in culture filtrates of Fusarium spp. wilted in less than 48 hours; and when the wilted stems were sectioned, the vascular elements were found plugged with a substance staining dark brown to red with ruthenium red. Movement of water was greatly impeded by the vascular plugs as indicated by uptake of dyes. Roots, stems, petioles, and leaves of naturally infected alfalfa plants collected from the field showed similar vascular plugging.

Results suggested that the fungal pectic enzymes in infected plants macerate host tissue, hydrolyze polymeric pectin into soluble pectic fragments and release into the vascular stream where in the presence of ions like Ca++ or possibly Mg++, they formed pectin gels which increase the viscosity to the point where mechanical plugging occurs. These plugs block the uptake of water or minerals and cause wilting of the plant.

Root extraction from resistant alfalfa varieties yields an inhibitory fraction which inhibits the growth of both Fusarium species. The inhibitory fraction has a molecular weight of between 1000 and 5000 and has a yellow pigment showing fluorescent under ultraviolet light.

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Root Rot of Alfalfa Related to Wet Soils

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It is often assumed that alfalfa (Medicago sativa L.) cannot tolerate wet feet. Reports like one by Benoit et al. (1967) have inferred that wet soil was the direct cause of stand depletion. The soil conditions that are often described in areas where stand establishment is a problem usually include an impervious subsoil which causes the surface soil to remain at or near saturation during extensive periods of excessive rainfall. Recent findings have indicated that in many instances it is not the water per se that causes stand losses, but it is due to a fungus that requires free water for infection.

Erwin (1965) discovered in 1952 that Phytophthora megasperma caused the alfalfa root rot that was responsible for stand depletion in excessively wet, irrigated soils in California. Since then Phytophthora root rot (PRR) has been reported from most of U.S. and parts of Canada. The pathogen appears to be endemic in most of our soils and infects and develops in alfalfa roots in poorly drained soils during extended periods of excessive rainfall or irrigation (Frosheiser, 1969).

P. megasperma is one of the water molds and its zoospores, which are motile in

1In cooperation with the Minnesota Agricultural Experiment Station.
water, cause the root infection. The rot continues while the soil is very wet. When the soil becomes drier the rot ceases and if enough taproot remains, the plants produce adventitious side roots and remain alive. Such plants have a shallow root system and often show severe drought stress when surface soil moisture is lacking. Initially, the rotted areas of the roots are yellowish brown in color and later turn black. When taproots of surviving plants in areas where the stand has been thinned by PRR are examined, they are usually rotted off at various depths. The tops are yellow or reddish, or may be wilted in advanced stages of the disease. When top symptoms are evident, the taproots are usually completely rotted and the plants cannot recover.

PRR is not a new disease in alfalfa. Wing (1912) described a condition in alfalfa in Ohio identical to what we have observed in field areas where the stand was destroyed by Phytophthora. He attributed it to wet soil due to clogged soil drains. Weimer (1927) described and illustrated typical PRR in alfalfa growing in the Missouri river bottom in Kansas.

Plants resistant to PRR can be found in very low percentages in most hardy alfalfa varieties. It appears that resistance may be due to Turkestan germplasm in these varieties. The varieties Lahontan and Washoe contain about 40% resistant plants. Evidently Phytophthora resistance was unconsciously selected under conditions favorable to PRR. The Flemish alfalfas appear the most susceptible.

Evaluations of reaction of alfalfa to PRR may be made in the greenhouse, growth chamber, or field. However, we feel that field evaluations are most valuable in a plant breeding program because one can simultaneously select for resistance to several root-rot pathogens, as well as for general growth and adaptation factors. Conditions necessary for field evaluations or screening are: P. megasperma-infested soil, a level seed bed, and an abundant water supply to keep the soil at or near saturation for 2-week periods or longer. To provide the initial inoculum in the soil, we have spread PRR-infested greenhouse soil and worked it in before seeding the first time. Soil from known Phytophthora-infested areas may be used. Once soil is infested, additional inoculum is unnecessary. We supplement rainfall with daily application of water to keep the soil as wet as possible without water standing. Irrigation is not used until the plants are at least 4 weeks old. Irrigation is then continued daily for a 2- to 3-week period. As many as three 2- to 3-week wet periods are applied during the growing season. Between wet periods, weeding, note taking, and clipping are accomplished. In the fall plants are dug and roots are scored for disease severity.

In the greenhouse, we have grown and evaluated plants in PRR-infested sand. In 1969, steamed sand 22 cm deep was infested with laboratory cultures of P. megasperma. During tests seed is planted in the sand and watered sparingly for 2-4 weeks; then additional water is added to raise the water level to the sand surface daily for 3-4 weeks. After this period, the plants are evaluated for root rot. Repeated tests have been made for more than 2 years without adding additional inoculum to the sand.
Recurrent selection for PRR resistance in four alfalfa populations was made in the field at St. Paul, Minn. The resistance in the MnP-A population, derived from Vernal and similar varieties, was increased from less than 5% in the original varieties to over 60% after two cycles of selection. Our MnP-B population, derived from resistant plants of 29 hardy and moderately hardy varieties and experimental lines, contained over 40% resistant plants after one cycle of selection. The MnP-D population, derived from resistant plants of 14 nonhardy alfalfa varieties, contained over 50% resistant plants after one cycle of selection. Seed of MnP-B and MnP-D populations have been released as sources of Phytophthora-resistant germplasm.

Genetic studies on Phytophthora resistance indicated that resistance is controlled by one tetrasomic gene (Pang, 1971). The nulliplex condition produces highly resistant plants, the simplex condition produces less resistant plants, and the duplex, triplex and quadriplex plants are highly susceptible. The same gene appeared to control the resistance in both Vernal and Lahontan.

**Literature Cited**


Phytophthora Root Rot, Rhizoctonia Root Canker, and Flooding Injury of Alfalfa in Southwestern United States

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Alfalfa root rots and flooding injury have always been the most important problems of alfalfa in Southwestern United States. These problems are associated with water and can be reduced through careful irrigation and good land leveling. No chemical control is possible. Resistance, combined with good management, seems to be the only effective way to solve the problem.

Three main diseases which are stimulated or caused by excessive soil moisture have been found in the Southwestern United States. They are Phytophthora root rot, Rhizoctonia root canker, and flooding injury, commonly called scald. The first two are caused by fungi. Symptoms are yellow, dead, and dying stems and lesions on the roots. Flooding injury is caused by prolonged soil saturation. It is more rapid under high temperatures and when the plants have been recently cut or damaged. Symptoms are dead stems following an irrigation or rain and xylem necrosis. Other diseases, such as Phymatotrichum or Texas root rot, Stagonospora root rot, and southern anthracnose, are also important in this crown and root rot complex, but are affected more by factors other than irrigation.

Germplasm resistant to Phytophthora root rot was first found by D. C. Erwin in the varieties Lahontan, Hilmar, and Arabian and is now being selected from other sources by many plant breeders. In 1967 the University of California released seed from crosses between Phytophthora root rot-resistant selections from Arabian and plants resistant to the spotted alfalfa aphid. This seed was also combined into germplasm pools for further selection in the field and greenhouse. Concurrently, broadbased germplasm pools with germplasm from African, Lahontan, Sirsa, and many other sources were being developed by making use of natural and planned selection in the extreme climate of the Imperial Valley. Usable resistance to Phytophthora root rot was found in the 5th generation and released as the variety UC Salton in 1972. UC Salton, as well as the Arabian germplasm pools, also seems to have resistance to Rhizoctonia root canker and flooding injury since they survived in field tests where these diseases were the main stand-depleting factors. However, work is needed on controlled tests using individual diseases and on the relationship between the three diseases.
Heritable Reaction in Some Alfalfa Populations in Field Nurseries to the Yellow Leafblotch Disease

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Yellow leafblotch of alfalfa induced by Leptotrichia medicaginis (Fckl.) Schuepp (Pyrenopeziza medicaginis Fckl., and Pseudopeziza Jonesii Nannf.) was severe in eastern South Dakota during the mid-1950's. In 1955 spaced plants in six breeding nurseries at Brookings were scored for the disease on an arithmetic scale of 1 to 10 corresponding to an estimated percentage of leaves diseased. Nurseries A to D and H2-BP54 were scored during first growth in late June or early July; CK was scored during first growth in late June and second growth in October.

Differences among parental germplasm sources in each of the nurseries were highly significant. In the CK nursery narrow sense heritability estimates derived by parent offspring regressions were $h^2 = .20$ in June, and $h^2 = .34$ in October. Both values were sufficiently large to permit genetic improvement in the population by mass selection. Both were of the same order of magnitude as previous estimates for resistance to Pseudopeziza medicaginis (Lib.) Sacc. in the same host population.

H2-BP54 nursery data were analyzed in accordance with bi-parental (Design II) expectations assuming trigenic and higher order interactions to be negligible. The analysis was of plot means with $k_0 = 4.5$. Our estimate of the additive genetic component of variance was 0.47 and that of the digenic component was 0.103. Mean level of dominance was $\bar{d} = .47$ and $h^2 = .64$. This high heritability coefficient was approximately equal to that previously reported for mean family reaction to P. medicaginis in the same nursery.

Reactions to the two pathogens were independent in the CK nursery ($r = 0.04$; n.s.) and not independent in the H2-BP54 nursery ($r = -.23$; $P < .05$).
Improving Persistence with Resistance to Anthracnose

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Four experimental populations with high resistance to anthracnose were tested for field performance in replicated broadcast plots. The resistant populations were developed by two cycles of recurrent phenotypic selection in the laboratory at Beltsville, Md. The contributions of anthracnose resistance to persistence and performance were assessed by comparison of the resistant populations with the susceptible cultivars from which they were selected or with closely related populations.

<table>
<thead>
<tr>
<th>Resistant population</th>
<th>Anthracnose mean score</th>
<th>Parent cultivar or closely related source</th>
<th>Anthracnose mean score</th>
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<tr>
<td>ARS-2</td>
<td>1.56</td>
<td>Team</td>
<td>3.79</td>
</tr>
<tr>
<td>MSHp6F-An3W3</td>
<td>1.67</td>
<td>Team</td>
<td>3.79</td>
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<tr>
<td>Beltsville 1-An3</td>
<td>1.79</td>
<td>Glacier</td>
<td>4.60</td>
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<tr>
<td>Beltsville 2-An3</td>
<td>2.11</td>
<td>Saranac</td>
<td>4.37</td>
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<td>LSD (.05)</td>
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</table>

Field tests were seeded in the spring of 1970 at Beltsville, Clarksville, and Wye Mills, Md. Two tests were established on adjacent sites at Beltsville; one of them was irrigated in 1971. All tests were attacked in late summer by naturally occurring epiphytotics of anthracnose. In each test, the anthracnose scores showed that the populations selected for resistance in the laboratory were highly resistant to anthracnose in the field.

At Wye Mills, anthracnose was first noted in the plots July 23, 1971. The disease had progressed sufficiently for scoring on September 29. The disease affected the fifth harvest forage yield on October 19, reducing the yield of Team significantly below the yield of MSHp6F-An2W2.

The test at Clarksville, Md., was attacked by anthracnose in the summer of 1970 and scored for the disease August 14. The resistant selections MSHp6F-An2W2 and ARS-2 were scored significantly more resistant than Team. This test was later damaged by bacterial wilt and abandoned.

Anthracnose developed in both Beltsville tests during the summer of 1971, and plots were scored for damage August 4 and September 10. When anthracnose became more severe, striking differences developed between the
Beltsville 1-An3 and Beltsville 2-An3 populations and the parental cultivars Glacier and Saranac for percent cover, percent weeds, and number of plants per unit area. The resistant selections were characterized by a higher percentage of cover, lower percentage of weeds, and higher number of plants per unit area.

In laboratory tests, Team had a higher level of anthracnose resistance than Glacier or Saranac. In both Beltsville field tests, Team was scored significantly more resistant than Glacier and Saranac and was not as severely debilitated as measured by percent cover, percent weeds, and plants per unit area.

Two conclusions were reached:

1. The anthracnose resistant populations developed by laboratory selection were highly resistant in the field.

2. The addition of anthracnose resistance to susceptible cultivars is an important contribution to their performance in the field in Maryland.

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Effects of Root Zone Temperature on the Growth of Alfalfa

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Evenson and Rumbaugh (2) recently reported that high soil temperatures which occur under fluctuating field temperature conditions retard alfalfa dry matter production. However, it was difficult to separate the effects of soil moisture and soil temperature in this experiment.

As a result, two growth chamber experiments were initiated to evaluate the effects of soil temperature on alfalfa grown under conditions of minimal moisture stress. In both experiments an alfalfa clone from a single plant was grown in metal cans (one propagule per can) which were placed in a water bath. The water bath was heated to a temperature of 39 °C during the lighted period and allowed to cool to chamber temperature during the dark period. Chamber temperatures were 26 °C during the 15-hour day and 12 °C during the night. Moisture stress on the plants was minimized by watering plants daily and maintaining the relative humidity near 100%.

Plants remained in the water bath for 0, 2, 4, 8, 16, and 32 days in the first experiment. Plants were removed from the water bath at the end of the designated period and were grown in another area of the chamber. All plants had a total growth period of 32 days.

Dry matter production was negatively and linearly correlated with time that the plants were in the water bath. Number of shoots per plant and the total of all shoot lengths per plant decreased in a curvilinear pattern with time. Average shoot length per plant reached a maximum somewhere around 4-8 days
Plants were placed in the water bath for 0, 26, and 52 days in the second experiment. Plants were harvested every 26 days for a period of 78 days from initiation of the experiment.

There appeared to be little or no residual effect of heat treatment on alfalfa production even though these treatments were quite severe. Barlow and Boersma (1) found that changes in corn (Zea mays L.) leaf elongation with changes in root temperature were essentially instantaneous in short-term experiments. If alfalfa reacts to root temperature in a manner similar to corn, high root temperatures would not be expected to have any residual effects on alfalfa production.

Literature Cited


SPECIAL QUALITIES AND LOWER BLOAT CAUSING PROPERTIES
Chairman - M. D. Rumbaugh

Evaluating Chemical Components Associated with Bloat in Ruminants

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Legume bloat in ruminants is caused by foam immobilizing the fermentation gases in the rumen. A foaming agent present in large quantities in alfalfa, Fraction I protein, is responsible for the foam. When cattle bloat the rumen pH range is 5 to 6 which coincides with the isoelectric range of the protein where it forms very viscous foams. The high foam viscosity is due to the fact that the foaming agent is a surface-denatured protein and forms insoluble monolayers on the liquid surfaces. The solid protein monolayers on the bubble surfaces are responsible for the foam's high resistance to flow and consequently the animal cannot belch up the gas in the normal way.

The bloat incidence increases rapidly with increasing Fraction I protein content of alfalfa. Below a threshold value of approximately 2% Fraction I protein content, cattle do not bloat.
Breeding for Low Soluble Fraction I (Nonbloating) Alfalfa

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A breeding program to develop a low Fraction I protein (nonbloating) alfalfa formally got underway with the seconding of Goplen to the CDA Research Station at Summerland, B.C., to work with McArthur and Miltimore on the bloat program. A large accession nursery was established in 1970 containing a diverse source of *Medicago* varieties, strains and species for Fraction I screening. Prior to formal screening procedures, however, it was necessary to undertake a number of experiments to determine the effects of many factors on Fraction I protein in alfalfa plants.

Analysis for percent Fraction I by acrylamide gel electrophoresis was carried out on approximately 100 varieties and strains of *Medicago sativa/media* from the 1970 accession nursery established at Summerland. A total of 4,106 individual plants were analyzed using samples (top 4 inches) from second-year mid-bud spring growth. The frequency distribution of this population covers a wide range from .49-11.56% and includes a fairly large number of plants with less than 2% Fraction I, the threshold guide for a nonbloating alfalfa. In addition to the above population of alfalfas, 43 accessions of *M. falcata* (2n and 4n) involving a total of 564 individual plants were analyzed for percent Fraction I. The frequency distribution of this population was near normal but with a much narrower range from 1.30-5.25% and included only a few plants with less than 2% Fraction I. All of the plants in these populations with less than 2% Fraction I have been sampled this spring (1972) and are now being analyzed for percent Fraction I. It is known that Fraction I protein is subject to considerable environmental influence and hence it is expected that a number of these low plants will appear with normal levels of Fraction I on rechecking. However, those plants found which again fall below the 2% level from the 1972 recheck will be selected for the initial cycle of breeding a low soluble Fraction I alfalfa. From our experience to date we do not expect to find the alfalfa "dream plant" with zero levels of soluble Fraction I. Rather, we expect to gradually lower levels of soluble Fraction I through successive cycles of recurrent selection.

The biochemical basis for this lowering of soluble Fraction I protein may well involve an increase in the tannin content of alfalfa. It is well documented that the nonbloating legumes such as sainfoin and crownsweat have precipitating agents (probably tannins) at such concentrations that practically no soluble protein is released from the leaves following cell rupture (Clark et al., 1970). It is encouraging to note that in spite of high tannin contents, such nonbloating legumes as crownsweat (Burns et al., 1972) and sainfoin (Holden, 1968) may be highly palatable.

**Literature Cited**

Variation of Fraction-1 protein content in five alfalfa populations varied from a low of 2.0-6.8% (Heinrichs and Miltmore, 1970). The component of variance due to population differences was 12% and that due to plants within populations, 36%. The *M. falcata* population contained the least Fraction-1 protein (2.1%), and the *M. sativa* population, the most (4.2%). Three populations of hybrid origin contained 3.3, 3.6, and 3.7% Fraction-1 protein. This study indicated that genetics plays a strong role in determining the amount of Fraction-1 protein in alfalfa.

In the present study eight "low" F-1 protein plants (less than 2.1%), and eight "high" F-1 protein plants (greater than 4.4%) were intercrossed according to a diallel system. The progenies, five plants per plot, were then grown in the greenhouse and field in a 4-replicate trial. The material was harvested on the per plot basis and analyzed for F-1 protein content at the Research Station, Summerland, British Columbia. Unfortunately, to date the F-1 protein data were available only for the test grown in the greenhouse. Other data, however, were available from the field test.

Plants differed in F-1 protein content for general combining ability at the 1% level of probability and for specific combining ability at the 5% level.

The general combining ability variance component was 33%; the specific combining ability variance component was 20%; the error component was 47%.

These heritability components compare favourably with those of crude protein content, yield, and root type. Actually, the specific combining ability for any of these was not statistically significant, although it was for F-1 protein content.

The data indicate that it should be possible to decrease F-1 protein content by breeding and selection. It may be worthwhile to follow a breeding program that will allow the best exploitation of specific combining ability.
### Table 1. Components of variance % of total

<table>
<thead>
<tr>
<th>Genetic implication</th>
<th>Character</th>
<th>F-1 protein greenhouse</th>
<th>Crude protein greenhouse</th>
<th>Yield, 1st cut field</th>
<th>Root type field</th>
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<tr>
<td>General combining ability</td>
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<td>33</td>
<td>27</td>
<td>52</td>
<td>28</td>
</tr>
<tr>
<td>Specific combining ability</td>
<td></td>
<td>20</td>
<td>7</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Error</td>
<td></td>
<td>47</td>
<td>66</td>
<td>42</td>
<td>62</td>
</tr>
</tbody>
</table>

### Table 2. Classification of 18 plants as to high, low and neutral combiners for the 5 characters

<table>
<thead>
<tr>
<th>Combining ability class</th>
<th>F-1 protein greenhouse</th>
<th>Crude protein greenhouse</th>
<th>Yield, 1st cut field</th>
<th>Root type field</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Low</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Neutral</td>
<td>13</td>
<td>12</td>
<td>10</td>
<td>11</td>
</tr>
</tbody>
</table>

Note: Two plants had good combining ability for high protein content in both tests, and one had good combining ability for low protein content in both tests.
Changes in Saponin Content and Leaf-Stem Ratio of Alfalfa
Resulting from Selection for Saponin Content

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Crops Research Laboratory, Logan, Utah

Up to five generations of recurrent phenotypic selection for low and high saponin concentration in alfalfa were practiced in each of six alfalfa cultivars. In the last cycle of selection, cultivars did not differ significantly and averaged 0.34% saponin index. The last cycle of the high series averaged 3.14% saponin index and ranged from 1.12% for Lahontan to 4.72% for Uinta. The saponin concentrations of leaves and stems were correlated \( P < .10 \). Concentrations of saponin in first and second crops were also correlated \( P < .10 \). There was a low correlation between saponin concentration index and leaf percentage \( P < .05 \). With the exception of high saponin Uinta, selection for saponin concentration did not significantly change the leaf percentage from the original cultivar. Changes in leaf percentage accounted for only a small part of the change in saponin concentrations. Yield and protein concentration were not affected by selection for low or high saponin concentration.

Chromatographic separations of the saponins in three of the cultivars indicate that in the high saponin selections there was a shift towards the saponins that contain carboxylic acid type aglycones and a shift towards the saponins that do not contain carboxylic type aglycones in the low saponin selections.

Developing Alfalfa with Improved Nutritional Value

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From the very beginning of alfalfa improvement in the U.S.A. and in Canada major emphasis was directed toward breeding for improvement in forage yield, either directly or indirectly through such components of yield as resistance to diseases and insects, response to photoperiod, greater tolerance to adverse temperatures, etc. Until recent times alfalfa improvement in respect to nutritive values largely was limited to such indirect effects as better leaf retention as a result of greater foliar disease and insect resistance, to greater leafiness (or stem fineness), and to improved management practices in respect to stage of growth or regrowth at harvest time. Deterrents to greater emphasis on breeding for improved nutritional values have been the general belief that management practices may be more important than genotype in determining final hay quality and the lack of procedures to measure accurately differences that might exist in heterogeneous populations for those positive (and negative) attributes that may affect growth and productivity in both monogastric and ruminant animals. With the development of improved mechanization in hay handling, greater utilization of haylage, greater emphasis on use of alfalfa pastures in beef cattle production, and expanded uses of alfalfa dehy and dehy products for poultry and other classes of
animals (including man), the time has come when alfalfa, like other crop plants, must be bred to meet the specific needs of the consumer as well as of the producer.

During the past decade a series of new techniques have been developed that make it possible to evaluate digestibility of single plants in alfalfa. These include the in vitro rumen procedures of Tilley and Terry, the detergent procedures of Van Soest and the stem structure relationships to digestibility proposed by Elliott. Research has shown that these attributes of nutritive values are interrelated and heritable, and population means can be altered by breeding and selection. Because—as expected—there may be negative relations between forage yield and digestibility values, the attainment of high digestibility may require adjustments in hay pricing and in hay quality standards to reflect product values to the livestock feeder.

Certain quality factors, and perhaps all negative or "antimetabolite" factors, may not necessarily be associated with yields. The carotenoid pigment complex, and especially the xanthophylls, have long been recognized for their values in poultry nutrition; the latter for their properties in producing desirable yolk color of eggs and skin color of broilers. Studies with many crop species show wide differences in carotene among plants. Carotenoid pigments, chlorophyll and nitrogen content all are positively associated—a desirable combination of characters. The 18S protein complex will be covered in other papers and omitted here.

Among several antimetabolites in alfalfa, the saponins have been most extensively studied, primarily because of their comparative ease in proximate analysis. From extensive studies by several States cooperating with the USDA Western Regional Research Laboratory it was shown that saponin values may reach levels as high as 3%. Research by Pedersen and colleagues at Utah, by Elliott and associates at Michigan and in our research laboratory all are in agreement that wide differences exist in saponin content among plants within populations and that saponin values may be modified by breeding and selection. Our studies have shown that the frequency of low saponin genotypes is greater among nonhardy than among winter-hardy populations, as shown below for samples analyzed in 1971.

<table>
<thead>
<tr>
<th>Groups</th>
<th>V. high</th>
<th>High</th>
<th>Med. hi.</th>
<th>Med.</th>
<th>Med. low</th>
<th>Low</th>
<th>V. low</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter hardy</td>
<td>100</td>
<td>170</td>
<td>24</td>
<td>7</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>305</td>
</tr>
<tr>
<td>Nonhardy</td>
<td>57</td>
<td>82</td>
<td>37</td>
<td>28</td>
<td>14</td>
<td>9</td>
<td>11</td>
<td>238</td>
</tr>
</tbody>
</table>

Our studies also have shown that there are no apparent adverse relationships between saponin content and leaf disease resistance, Phytophthora root rot resistance or resistance to such insects as spotted aphids, pea aphids, alfalfa weevil, or thrips. During the past year an evaluation also was made of stable foam, using the procedures suggested by Rumbaugh, and of protein content. Data from a selected population varying widely in saponin, weevil damage, thrips, common leafspot, stable foam, and protein content are shown below:
A study was conducted to determine the influence of various levels of ammonium nitrate applications on NO$_3$-N accumulations under alfalfa (Medicago sativa) and whether alfalfa has the ability to utilize excessive amounts of nitrate in the soil. Eight split applications of N totaling 0, 224, 448, and 672 kg/ha (0, 200, 400, and 600 pounds/acre) were studied at the Agronomy South Farm, Urbana, Illinois, at various depths on six sampling dates. Soil was sampled at depths of 0-15, 15-30, 30-60, 60-90, and 90-105 cm or to the water table which was never lower than 105 cm. Soil samples were dried, finely ground and analyzed for NO$_3$-N. NO$_3$-N concentrations were greatest in March 1970 at the 30- to 60-cm depth. No more than 1 ppm was found at the 90- to 105-cm depth (water table) for any N treatments on November 11, 1970. Highest concentrations of NO$_3$-N were found at the 15- to 30-cm depth for all N treatments at the end of the growing season, November 11. Although total amounts of NO$_3$-N were lower in March than in November, the highest accumulations were found at the 30- to 60-cm depth in March, but at the 15- to 30-cm depth in November. The only treatment on November 11 which did not show a significant difference when compared to the check was the 224 kg N/ha. Alfalfa would have some value in a rotation for reducing NO$_3$-N which may accumulate under continuous corn after excessive N applications.

Commercial Production of Leaf Protein for Animal and Human Use

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Although leaf protein has been known for many years to have nutritional value, until recently it has been more of a laboratory curiosity than an article of commerce. Initial commercialization has depended upon a process yielding high value dehydrated alfalfa as well as a leaf protein product for use in animal rations. The logistics for handling large amounts of bulky plant material had already been worked out and a market for dehydrated alfalfa already exists in many parts of the world. We feel that the development of leaf protein concentrate (LPC) for human food should also be developed initially within the framework of the existing commercial operation. Some companies produce as
much as 250,000 tons of dehydrated alfalfa meal per year. In the absence of governmental sponsorship by national or international agencies, only such large companies have the necessary capital to finance the research and development necessary to put the process for edible protein into commercial operation.

This has been our philosophy in developing the PRO-XAN process (the name derived from "protein xanthophyll concentrate"). Phase I (now commercialized) produces (a) standard grade dehydrated alfalfa meal; (b) a 50% protein, high-xanthophyll concentrate for poultry called X-PRO1; and (c) forage solubles concentrate for use as an unidentified growth factor (UGF) supplement for livestock. Phase II of the program is involved with the development of further economically sound steps to yield, pigment-free palatable LPC plus xanthophyll concentrate from the intermediate or end products.

Commercialization of Phase I has been carried out through the cooperative efforts of the Western Regional Research Laboratory and a large commercial dehydrator in the Imperial Valley of southern California (Batley-Janss Enterprises). This company normally harvests and processes about 300,000 tons of alfalfa per year to produce about 60,000 tons of dehydrated meal for poultry and cattle. By incorporating the Phase I process into their normal operation they are producing several thousand tons of a 50% protein-high xanthophyll leaf protein concentrate (LPC) which is sold as a feed supplement for poultry in addition to the dehydrated alfalfa.

Because the PRO-XAN process employs only a "scalping operation" to remove a small amount of the protein, the residual alfalfa meal still contains sufficient protein so that it can be sold in the normal commercial channels as a feed ingredient without discount from its normal price. This commercial operation is now in its third year and has proven to be sufficiently profitable that Batley-Janss Enterprises is contemplating a further expansion of their operation. The success of the operation can to a large extent be attributed to the employment of standard sugarcane rolls to both crush and express the juice very rapidly in one low maintenance operation, and to the employment of commercially available drying units already familiar to the dehydration industry. In addition, the process is set up as a continuous operation and completely automated.

1Trademark name for Protein-Xanthophyll concentrate prepared by Batley-Janss Enterprises, Brawley, California.
Alfalfa use has increased dramatically in the 12 Northeastern States during the past 3 years. At the same time, historic shifts have occurred in the way farmers grow, manage, harvest, and feed alfalfa. These trends have put alfalfa strongly into the profit picture on northeastern farms.

Since 1969, alfalfa seed use has risen from 2.9 million pounds to over 4.6 million pounds per year in the Northeast. At the same time farmers have shifted to high yielding new varieties, principally Saranac and Iroquois.

Seedings made with a herbicide instead of a companion crop are now the rule, rather than the exception. This practice has increased from near zero in 1966 to cover two-thirds of the acreage seeded in 1972. Resulting stands are excellent and promise high production for years to come.

Mixtures containing grass are becoming less common as farmers move to clear seedings. This is partially due to the common use of Eptam, a grass killer to control weeds. However, many farmers sow alfalfa alone despite using chemicals that will not harm grass.

Hay-crop silage has jumped in popularity. New York farmers put nearly one-half of their first cutting into silos of some sort this year. Farmer interest is strong in this practice, which eliminates the labor in handling bales, reduces risk of crop damage, and maximizes yields. Silo capacity is rapidly increasing as more silos are built. These include both sealed storage and concrete stave silos.

Contributing to this change has been the increase in capacity of field choppers. Once limiting factors in silage production, these are no longer bottlenecks. High horsepower tractors coupled with high capacity choppers make hay-crop silage making quick and easy compared with baling. Farmers say it's lots more fun to chop hay than to bale it.

Automated feeding equipment also has come into wide use in feeding hay-crop silage. This is common on the larger farms, reducing the labor needed to handle bales. Here again, it's more fun to push buttons than to heave bales.

Alfalfa weevil parasites are reasonably successful and have reduced farmers' fear of this pest. "Hot spots" have developed; however, farmers now believe that they can handle these through spraying and that ultimately parasites will provide control.

As a result of these factors, farmers are taking a new view of alfalfa. Now
it's up to us to find out what our farmers will need in alfalfa for the future.

Farmers tell us that foremost is higher yield. They have the equipment to handle it and the livestock to eat it. Improved lodging resistance is also a common request. Weevil resistance would also help. There is some demand for a variety earlier than any now on the market. And they'd like additional resistance to leaf and stem diseases, including anthracnose.

We must also keep a weather eye on the alfalfa blotch leaf miner, which hit alfalfa in the Hudson Valley this year and the alfalfa snout beetle, long isolated in north central New York, which has shown new movement during the past 2 years.

Farmer interest in alfalfa is increasing and will continue strong as long as alfalfa brings profits. Our goal must be to anticipate the problems of the next 10 years so that we can help farmers do well with alfalfa.

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Management and Alfalfa Persistence

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Persistence in alfalfa has become an increasingly important problem in Ontario, particularly under the more intensive management systems. Consequently, a number of management studies have been conducted with the objective of extending the stand life of our alfalfa meadows. An examination of these studies has disclosed the following:

1. The cyclic pattern of root reserves for Saranac, Vernal, and Beaver cultivars was very similar. Following a late August harvest, root-reserve storage occurred until about October 20. Saranac mobilized its reserves faster after cutting and stored larger quantities of reserves much later in the autumn than Vernal or Beaver.

2. Autumn harvests reduced November root reserves particularly when harvesting took place on the critical date. This critical autumn harvest date occurred when the post-harvest growing season was of sufficient length for reserve depletion but insufficient length for reserve replenishment.

3. The critical autumn harvest date occurred at the same time each year at each location studied within Ontario. This has enabled the production of a critical fall harvest map for the province.

4. Saranac and Iroquois alfalfa seeded in May and July stored reserves in identical patterns in the seeding year. Excess autumn top growth which accumulated should not be harvested from the May seedings on the critical date but browsing in late August or late
October had little effect on succeeding stand and yield. July seedings were severely affected by cutting or browsing at any time during the autumn.

5. Snow retention was important to insulate overwintering alfalfa plants. Where snow was removed during the winter, soil temperatures reached a low value of 12, 14, and 27 F at 2, 10, and 50 cm in the soil, respectively, and the alfalfa winterkilled. During a winter when ice accumulation was severe, alfalfa survived only where root reserves were high and the previous autumn top growth was 12 inches or greater. Top growth regimes of 2 and 6 inches under high reserves and 2, 6, or 12 inches or more under low reserves were completely winterkilled.

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Effect of a Third Cutting in Michigan on Yield, Carbohydrate Reserves, and Persistence of Alfalfa

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The present general recommendation regarding fall cutting in the north central and northeastern parts of the United States and eastern Canada is: Do not cut alfalfa from 4-6 weeks before the first killing frost (mid-September to mid-October). This has generally been interpreted not to cut in September and early October. This recommendation is based on data from various States but originally from data obtained in Michigan in 1934-38. Silkett, Harrison, and Rather recommended, as a result of their data, that "two cuttings (with the second cutting in mid-August) are safest in Michigan" since they got only a 1/3- to 1/2-ton increase when they took three rather than two cuttings. Their recommendation was sound for the 2-cut system.

Since about 1960, the North Central States and similar areas in Canada have recommended a 3-cutting system (June 1, July 15, and September 1) because of greater yields and quality than from two cuttings. Frequently the third cutting cannot be taken on time in late August or early September or the farmer may choose to green chop alfalfa daily throughout September. This research was designed to determine if September cutting was injurious with moderately winter-hardy or winter-hardy, wilt-resistant varieties under a 3-cutting system where the second cutting is taken in mid-July, rather than in mid-August as in the 2-cutting system. This system permits a longer interval between the second and third cuttings than in the research reported by Silkett et al. in 1934-38.

Third cuttings were made at East Lansing in the southern part of Michigan on September 1 (standard date of third cut) and 15, October 1 and 15, and November 1 and 15 in three separate experiments. Vernal alfalfa was used in 1965, 1966, and 1967; Vernal, DuPuits, and Cayuga in 1966, 1967, and 1968; and Vernal and Saranac in 1967, 1968, and 1969. The alfalfa was fertilized after each fall cutting treatment with 0 + 50 + 150, 0 + 0 + 150, or not
fertilized. Fall cutting treatments were made in each year in each of the three experiments.

Residual yields of the fall cuttings were measured in the following year for three successive years in each of the three experiments. Residual yields determined in the first (June 1) and second cuttings were similar for the September 1, September 15, and October 1 cutting treatments with the wilt-resistant varieties Vernal, Cayuga, and Saranac. The non-wilt-resistant DuPuits was injured by the September 15 cutting. Root numbers and size of roots of wilt-resistant varieties were the same under the September 1, September 15, or October 1 cutting treatments. Total available carbohydrates of roots on December 13 were similar in 1966 regardless of the previous cutting treatment, the level being slightly higher in Vernal than in DuPuits. Fertilizer did not affect fall cuttings differentially.

The results indicate that the strict "no-fall cutting in September" recommendation could well be liberalized in areas similar to the southern half of Michigan if wilt-resistant varieties are used. This would permit greater flexibility of management of alfalfa under modern dairying operations.

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Managing Alfalfa for Maximum Forage Production in Arizona

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University of Arizona, Mesa

There are many adapted and potentially high yielding alfalfa varieties available to growers in southern Arizona. Regardless of the inherent vigor of an alfalfa variety, the ultimate yield is determined by management, both before and after planting. Yields of 12.6-14.1 tons per acre, for the first 2 years of production were obtained at the University of Arizona's Mesa Experiment Station. Conditions contributing to these yields were an alkaline, well-drained, deep loam soil with good internal drainage and adequate leveling and seedbed preparation for uniform irrigation and harvest.

Although Arizona's desert soils are inherently rich in phosphorus, an additional application of this element insures its availability to the alfalfa plants for sustained, high-level production. Yield increases of 2 to 2-1/2 tons per acre were obtained from additional applications of phosphorus in 1970 and 1971. Four harvests in 1972 indicate even greater response.

Planting 20 pounds of certified seed in late September or early October for rapid establishment of healthy, strong plants insures early spring harvests and a long production year. Two-thirds of the average total annual production of Mesa-Sirsa alfalfa was from four harvests, April through July. Average total dry matter production reached its peak in June. This relates closely to the period of highest water-use efficiency. Cutting at one-third bloom allows synchronization of two irrigations with the harvest schedule, is favorable for root carbohydrate storage and crown bud development, and permits maximum sustained production, with minimal clipping and mangling of new crown
growth by harvesting operations.

Although the late summer growth period doesn't contribute significantly to total production, it is a critical time in management because of many adverse growing conditions. Plants are weakened by high temperatures and insects. Sporadic rainfall interferes with irrigation-harvest schedules, often causes saturated soil conditions, which in turn foster root rot, diseases, and invasion by summer annual grasses. The irrigation-harvest schedule must be adjusted to the season, rainfall, and harvest conditions, avoiding excessive soil moisture and compaction at harvest. One timely watering per cutting will usually match water use from August to February and maintain healthy, vigorous plants.

Strong, healthy plants can efficiently use water, nutrients, and stored carbohydrates to maximize yield as a new production year is started. We recognize an interrelationship between variety, stand life, harvest frequency, quality, irrigation efficiency, and yield. As new varieties are developed with greater resistance to soil pathogens and insects, management receives a challenge to produce 14 tons of alfalfa, not for 1 or 2 years, but for 3 and 4.

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Production of Alfalfa and Grass in a Dry Region as Affected by Seeding Patterns

M. R. Kilcher
Research Station, CDA
Swift Current, Saskatchewan

Within the continental northern Great Plains there is a semiarid region which includes the southwestern portion of Saskatchewan and the southeastern corner of Alberta. Average annual precipitation varies from 10-14 inches and is poorly distributed, temperatures are extreme, R.H. is low and evaporation high. The most important cultivated grasses include certain Agropyrons and a couple of the Elymus genus, while the most important legume is alfalfa of the media type.

For decades alfalfa has been seeded in mixture with grass. Earlier narrow spaced seedings usually resulted in fairly rapid elimination of the legume. Subsequently, increasing row spacings to 12 inches extended the time of alfalfa persistence as well as providing increased yields.

More recently it has been demonstrated that even wider spacings between rows give increasing productive longevity to the mixture stands. This work indicated the importance of plant populations.

In turn, and because the adapted cool-season grasses commence growth earlier than alfalfa, we started looking at crop component separation. In our first work in the late fifties the average seasonal crop yield of grass and alfalfa was increased by 20% when the grass and alfalfa were seeded in alternate rows.
spaced 12 inches apart.

Following this we have grown alfalfa and grass in alternate rows with even wider spacings with increasing yields. Cross seeding the two crops has also provided increased longevity and improved yields providing the spaces between rows are 2 feet or greater.

An additional advantage from component separation is the increased proportion of the legume compared to that grown in in-row mixture. In general, alfalfa comprised only 20-25% of yield when grown in mixture with grass, 30-40% when cross seeded and 40-50% when in alternate rows with grass.

Perhaps the most singular important phenomena is the very large yield advantage for the component separated stands in the extremely dry years. Whereas yield increases are only in the 10% area during favorable years they have been as high as fourfold in the driest seasons.

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Managing Alfalfa-Grass Pastures on Dryland in South Dakota

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Department of Plant Science
South Dakota State University, Brookings

Alfalfa varieties developed specifically for grazing have improved the productivity of many South Dakota pastures. Teton and Travois alfalfa were developed and released by the South Dakota Agricultural Experiment Station in 1958 and 1962, respectively. At present, approximately 100,000 acres of these varieties are being used in South Dakota. Other pasture alfalfas, primarily Rambler, are planted on an additional 8,000 acres.

Teton and Travois generally yield equal to or less than Vernal in South Dakota. However, they have persisted better than Vernal under intensive grazing by beef cattle and sheep. A mixture of between 30 and 50% Teton or Travois with a cool-season grass such as smooth bromegrass, intermediate wheatgrass, or crested wheatgrass is recommended. No documented cases of bloat have been reported when Teton or Travois has been grazed either in pure stands or in mixtures with grass. The prostrate growth habit, slow recovery after grazing, and early fall dormancy of these pasture alfalfas make them compatible with the seasonal distribution of growth of cool-season grasses. Rotational grazing is recommended. However, fall grazing in September and October does not appear to be as critical with Teton and Travois as with erect alfalfas, such as Vernal.

The technique of interseeding a pasture alfalfa into native sod offers considerable potential for increasing the quality and productivity of South Dakota grasslands. Alfalfa and/or a grass is planted in channels 2 inches deep and 4-6 inches wide and in rows approximately 20-40 inches apart depending on the availability of moisture in the area. No deferment of the area is required the seeding year, except when the seedlings become vulnerable to removal. In most cases, full-season grazing is possible the following year. This practice
is presently recommended statewide on favorable sites.

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REGIONAL REPORTS, COMMITTEE REPORTS, BUSINESS MEETING
Chairman - D. H. Heinrichs

Regional Reports (Regional chairmen were requested to prepare a list of research studies, research leaders, and locations of work.)

Alfalfa Research in Canada

D. H. Heinrichs
Research Station, CDA
Swift Current, Saskatchewan

Alfalfa research is conducted throughout Canada. At many locations it forms a part of a program concerned with many other crops, especially in the field of agronomy and pasture research. In this brief report I have attempted to identify the type of research conducted and the principal officers connected with it.

Ottawa Research Station, CDA, Central Experimental Farm, Ottawa, Ontario

Breeding (H. Baenziger). The major objective of the program is to develop wilt-resistant cultivars of the early Flemish and late standard type. Two synthetics have been evaluated in regional trials and will be released. Hybrid breeding, using male-steriles, is being investigated.

Genetics (L. Dessureaux). Studies on methods of utilizing hybrid vigor in breeding programs are being conducted along with methods of selecting favorable gene combinations and maintaining them.

Pathology (C. Chi). Research concerns host-pathogen relationships in diseases which attack roots and crowns of alfalfa and other legumes. Mode of action of pathogens, nutrient requirements and identification of disease resistance are being studied.

Entomology (J. C. Guppy and others). Ecological studies on the alfalfa weevil are emphasized.

Plant Science Department, N.S.A.C., Truro, Nova Scotia

Agronomy (J. S. Bubar). Variety trials and management systems as they are related to winter injury are conducted. Alfalfa survival is better when growing in mixture with grasses.

Research Station, CDA, Charlottetown, Prince Edward Island

Nematodes (C. B. Willis). Investigations include alfalfa and other forage crops.
Physiology (D. M. Suzuki). Studies are being conducted on the effect of various chemicals on winter injury.

Crop Science Department, University of Guelph, Guelph, Ontario

Agronomy (R. S. Fulkerson and others). Management studies related to yield and persistence are conducted. Time of cutting, height of cutting, and herbicide effects are some of the factors under investigation.

Breeding and Genetics (B. Twamley and others). Provincial strain trials aim to evaluate varieties and strains for yield, wilt resistance and winter-hardiness. Studies on the rate of photosynthesis variation among clones, digestibility studies of breeding stocks and the use of trisomics for determination of linkage groups are in progress. Screening methods are being developed whereby plants high in digestibility could be identified by morphological traits.

Research Station, CDA, Swift Current, Saskatchewan

Breeding and Genetics (D. H. Heinrichs). Breeding for winterhardiness and persistence under dry climatic conditions is the main objective of the program. Creeping-rootedness is considered to be an important criterion for selection. Genetic studies on the creeping-root character and winterhardiness are under way. Consideration is given to nutritive value of alfalfa and the usefulness of alfalfa as a pasture crop. The importance of leafiness and stemminess as a factor in quality and yield of alfalfa is being investigated. Varieties and strains are being evaluated for both hay and pasture use.

Management (M. R. Kilcher and J. D. McElgunn). Studies are under way on establishment of alfalfa, seedbed preparation, time of seeding, seed treatments, and others. Patterns of seeding alfalfa with grasses as a factor in production and persistence are being investigated. The role of alfalfa in maintaining nitrogen fertility of the soil and how this compares with fertilization practices without the use of a legume are under study. Time of irrigation and irrigation scheduling on alfalfa production and winter survival are receiving research attention.

Alfalfa for Pasture (D. H. Heinrichs and R. W. Lodge). Experiments are in progress with cattle aiming to assess the attributes of different varieties and types for pasture. The bloat hazard is given some consideration in respect to quantity of alfalfa, patterns of seeding, and varieties.

Research Station, CDA, Saskatoon, Saskatchewan

Breeding (B. P. Goplen). Major emphasis is being given to develop a non-bloating alfalfa. To this end, large and diverse alfalfa accessions are being screened to find plants low in soluble Fraction I protein using gel electrophoresis. This work is being carried out in close cooperation with the bloat research team in Summerland, B.C. A biochemist has just been added to the bloat research project. In late 1973, the basic bloat research and breeding will be centered in Saskatoon, Sask., and associated animal evaluation carried out at Kamloops, B.C. Limited research is being carried out on the effect of
herbicides and row spacing on alfalfa seed yields.

Pathology (H. Harding). Alfalfa lines are being screened for resistance to foliage diseases, primarily yellow leaf blotch and black stem. Further studies involve the investigation of toxin production by Leptotrochila medicaginis and Phoma medicaginis with the idea of using toxins in screening techniques.

Insect Pests (C. H. Craig). The major responsibility deals with the control of insect pests of alfalfa. Research includes: (1) Insecticidal control of plant bugs, including Adelphocoris spp., Plagiognathus sp. Lygus spp., in alfalfa seed fields, with particular emphasis on an insecticide treatment compatible with the pollination method utilizing the alfalfa leafcutter bee, M. rotundata. (2) Degradation of trichlorfon (Dylox) insecticide in alfalfa grown for seed and forage by analysis of green and cured foliage and chaff and seed for Dylox residue. (3) Insecticidal control of grasshoppers in alfalfa and alfalfa-grass mixtures as part of the continuing grasshopper control program.

A second area of research deals with the ecology of plant bugs infesting alfalfa seed fields: (1) Ecological study of the Lygus complex in the short-grass prairie area of Western Canada under dryland and irrigation farming.

Pollination (H. A. McMahon). The main research is concerned with management of crops and pollinators to increase alfalfa seed yields most efficiently, and includes (1) management studies regarding overwintering and incubation of bees; parasite, predator, inquiline and disease control; (2) effect of tripping intensity on seed yield and quality; (3) effect of commercial fertilizers on seed yield and intensity; and (4) selection of strain of Megachile rotundata that will work under less favorable weather conditions. This work has been under way for the past 7 years.

Research Station, CDA, Lethbridge, Alberta

Breeding (M. R. Hanna and E. J. Hawn). The general objective in the breeding program is to develop strains giving high forage and seed yield combined with adequate winterhardiness for the prairie region of Canada. Bacterial wilt resistance, stem nematode resistance and resistance to pea aphid are additional objectives.

Low Temperature Pathogens (J. B. Lebeau). Disease losses from low temperature pathogens are being assessed and research relative to these is in progress.

Bacterial Wilt (G. A. Nelson). Studies of factors that affect virulence and persistence of Corynebacterium insidiosum in soil and of its effect on yield of alfalfa are conducted.

Nematodes (E. J. Hawn). One objective is to determine the interactions of plant parasitic nematodes and other inciters of alfalfa diseases under irrigated agriculture. Special emphasis is now being placed into the role of the pin nematode (Paratylenchus projectus) in alfalfa sickness, a disease
prevalent on fields in central Alberta where alfalfa is being reestablished.

**Insect Pests** (A. M. Harper). Studies are in progress on the effects of parasites, predators, chemicals and management practices on populations of aphids on alfalfa.

**Pollination of Alfalfa** (G. A. Hobbs). Management procedures and equipment are being developed for propagation of *Megachile rotundata* for pollination of alfalfa. Special attention is being given to developing a hardy univoltine bee that will work at low temperatures. A study is also under way on the behaviour of the main enemy of bumblebee colonies in artificial domiciles.

**Evapotranspiration** (K. K. Krogman). Studies are being conducted on the effects and interactions of plant spacings and soil moisture supply on quantity and quality of alfalfa seed crops.

**Research Station, CDA, Beaverlodge, Alberta**

**Seed Production** (P. Pankiw). Purity of alfalfa seed, as affected by distances and various pollinators, is under investigation. White-flowered, white-seeded markers are used. As Beaverlodge (Lat 55°N) is outside of the area of adaptation of *Megachile rotundata* various management techniques to increase activity of the insect are being attempted.

**Nitrogen Fixation** (W. A. Rice). The effects of physical and chemical soil conditions on nitrogen fixation by *Rhizobium meliloti* are being checked. Resistant strains to soil acidity are being selected.

**Management** (P. B. Hoyt). Liming and other factors related to growing alfalfa on acid soils (pH 4.5-6.1) are being studied. Experiments are being conducted on the effects of alfalfa on succeeding grain crops. In one experiment conducted on 10 soil types with subsoils ranging from sandy loam to solonetz, measurements are taken to determine to what extent alfalfa roots open the soil and make nutrients available.

**Crop Science Department, University of Alberta, Edmonton, Alberta**

**Alfalfa Sickness** (J. L. Bolton, G. R. Webster, and F. D. Cook). Investigations are concerned with pinpointing the cause of this strange condition in alfalfa.

**Cytotaxonomic Studies** (K. Lesins).

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A list of alfalfa research projects and contact men as reported to me is given below. Some of the projects have cooperating scientists other than those listed as contact men.

Department of Plant and Soil Science, University of Tennessee, Knoxville (W. D. Barber). Search for better resistance to the alfalfa weevil in irradiated diploid alfalfas.

USDA and Crop Science Department, North Carolina State University, Raleigh (T. H. Busbice). Breeding multiple pest-resistant experimental alfalfa varieties with emphasis on stem nematode, anthracnose, Phytophthora root rot, and alfalfa weevil resistance.


Department of Agronomy, University of Maryland, College Park (J. A. Schillinger). Recurrent selection for resistance to Sclerotinia trifoliorum. Selection for increased protein production through selection for tolerance to Simazine. Contribution of new disease- and insect-resistant strains to better field performance (cooperative with USDA, Beltsville).

Department of Agronomy, Pennsylvania State University, University Park (R. W. Cleveland, J. B. Washko, and F. L. Lukezic (Plant Pathology)). Selection for resistance to anthracnose (C. trifolii and C. destructivum) and
bacterial wilt. Selection in creeping-rooted populations for increased vigor, upright stems, rapid creeping, and resistance to bacterial wilt and other
diseases. Testing of privately and publicly developed varieties in coopera­
tion with Regional Project NE-74. Improvement of alfalfa forage quality and
yield for dehydration. Alfalfa management and the incidence and severity of
disease.

USDA, U.S. Regional Pasture Research Laboratory, University Park, Pennsylvania
(R. R. Hill, Jr., K. T. Leath, R. A. Byers, R. F. Barnes, K. E. Zeiders, and
others). Quantitative genetics of disease and insect resistance, some quality
components, mineral composition, and yield. Inbreeding in alfalfa. Effects
of the number of parents on the performance of alfalfa synthetics. Selection
for disease resistance (Ascochyta leafspot, Leptosphaerulina leafspot, and
common leafspot). Nature of disease resistance. Selection for resistance to
the meadow spittlebug and the blotch leaf miner. Evaluation of damage caused
by the potato leafhopper. Effects of methods of harvest and storage of forage
on intake.

Department of Plant Breeding and Biometry, Cornell University, Ithaca, New York
(R. P. Murphy and C. C. Lowe). Breeding for increased yield, and resistance
to the alfalfa weevil and potato leafhopper. Evaluation of experimental
synthetics, several of which trace to "exotic" germplasm from Plant Introduc­
tion collections. Selection for resistance to southern anthracnose. Evalua­
tion of a large number of lines for reaction to the alfalfa blotch leaf miner.
Testing of privately and publicly developed varieties in cooperation with
Regional Project NE-74.

Department of Agronomy, Cornell University, Ithaca, New York (G. W. Fick).
Effect of alfalfa weevil on physiology, production, and quality. Development
of preliminary computer models of alfalfa growth.

USDA Regional Plant Introduction, New York State Agricultural Experiment
Station, Geneva (D. D. Dolan and S. W. Braverman). Evaluation of a large
number of alfalfa introductions for numerous traits. A catalog giving descrip­
tions of the introductions is published in alternate years.

CDA, Ottawa Research Station, Ottawa, Ontario (H. Baenziger, L. Dessureaux,
C. C. Chi, and J. C. Guppy). Breeding of persistent, wilt-resistant cultivars
of early (Flemish) and late (Standard) alfalfa adapted to eastern Canada.
Investigations of hybrid breeding using male sterility, including studies on
yield potential and seed production methods. Genetic studies on selection
methods to maximize and maintain favorable gene combinations in synthetics.
Studies on host-pathogen relationships with a group of pathogens which attack
roots and crowns of alfalfa and other legumes. Ecological and population
dynamics studies on the alfalfa weevil in eastern Ontario.

Ste. Foy Research Station, Ste. Foy, Quebec (H. Gasser, R. Paquin, C. Willemot,
and H. Hope). A comprehensive breeding program with the Atlantic Provinces
which includes breeding for yield, winterhardiness, tolerance to frequent
cutting, and resistance to bacterial wilt, common leafspot, and root-knot
nematodes. Studies on the mechanism of hardening which includes chemical
induction of hardiness, metabolism of amino acids during hardening, changes in
lipids during hardening, and protein synthesis during induction of frost resistance. An inventory of nematode populations in alfalfa fields is being kept. Study of common leafspot with respect to crop disease loss assessment.

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Report from the Central Alfalfa Improvement Conference

M. D. Rumbaugh
Plant Science Department
South Dakota State University, Brookings

The 12th meeting of the Central Alfalfa Improvement Conference was held in St. Louis, Missouri, March 3-4, 1971. Research personnel from commercial companies and public agencies participated in a joint meeting the first day. Summaries of research results, reports of regional committees and the Variety Review Board, and listings of new CAIC check varieties and insect- and disease-resistant checks were compiled in a report which was widely distributed. Personnel of public and private agencies met separately the second day. Officers elected for 1972-73 were: M. D. Rumbaugh (S.D.), Chairman; J. D. Axtell (Ind.), Vice-Chairman; and D. A. Miller (Ill.), Secretary. Subsequent information in this report was based primarily on information obtained from a questionnaire sent to public workers in the Central Alfalfa Conference.

Research activities directly related to alfalfa improvement are as follows:

Breeding and Genetics: Breeding for multiple pest resistance; yield and quality in relation to insects and diseases; possible shifts in insect and disease resistance in relation to certified seed class; inheritance of AMV and Rhizoctonia resistance; development of pasture-type alfalfas; inheritance of leafiness, number of tillers per crown, stem size, and persistence; selection for high quality protein; bidirectional selection for saponin level; graft transferability of cytoplasmic male sterility; locating and identifying types and sources of male-sterile and maintainer systems; determining factors that influence gametic behavior in alfalfa; temperature effects upon pollen incompatibility; developing new and useful gene marker systems; chromosome engineering and cell culture.

Entomology: Biology, ecology, distribution, damage, and control of eastern and western strains of alfalfa weevil; integrated control of insects through management, varieties, and insecticides; development of control, bioassay, and screening techniques for potato leafhopper; plant bug level of infestation in relation to yield and quality; evaluation of insecticides on non-target pests and associated natural enemies; effects of fungicide foliar sprays on insect populations; foraging behavior of honeybees, bumblebees, and leafcutter bees on alfalfa; management of leafcutter bees for seed production.

Management: Seeding rates in mixture with high yielding grasses when seeded in the spring without a companion crop; establishment with and without companion crop under dryland and irrigation; first-year production from spring-established stands; cutting management in the integrated control of alfalfa weevil; harvest schedules to produce highest yields of protein and TDN;
potential of utilizing September and October harvests; fertilizer responses; stage of growth in relation to level of resistance to potato leafhopper, yield, and quality; performance of alfalfa in alfalfa-brome grass pastures in relation to management system; grass varieties or species that will persist under a three-cutting schedule annually; potential of utilizing alfalfa as compared to grasses as filter crops for sewage effluent; range interseeding.

**Bacteriology:** Basic research on Rhizobium.

**Pathology:** Surveys of economic importance and/or selection for resistance to Phytophthora, anthracnose, Rhizoctonia, bacterial wilt, downy mildew, bacterial and Leptosphaerulina leafspots, yellow leaf blotch, and other foliage diseases; complete studies of AMV in alfalfa; forage crop range of Xiphenema americanum; evaluation of anthracnose-resistant populations vs. their parental varieties; pathogenicity of Pseudopeziza jonesii; determining organisms in the crown rot complex and how to breed for resistance; evaluating the effect of fungicides on alfalfa forage and seed yields.

**Physiology and Biochemical:** Relationships between leaf-stem ratios and crude protein and fiber; the protein and carbohydrate composition of materials expressed from alfalfa; C14 studies of the effect of plant genotype on amount of stored root reserves and utilization of these reserves in regrowth; effect of photoperiod, temperature, and time of day on quantity and quality of alfalfa nectar; effects of root zone temperature on growth and development; influence of temperature on growth and composition; root reserves in relation to management in the integrated control of insects; factors that affect seed size within a plant.

**Fertilization:** Lime, phosphate, sulfur, potassium, copper, and zinc requirements; fertility requirements under irrigation; timing of annual topdressing; response to rates and fineness of grind of limestone; soil test and pH change as correlated with yield; yield and persistence at different rates of Cl and SO4 carriers of K; absorption of minerals as influenced by temperature; influence of N rates on yield and composition.

**Seed Production:** Relation of nectar characteristics to pollinator attractiveness; development of types of domiciles for leafcutter bees; year and area of seed production in relation to o.p. progeny performance; percentage of crossing in relation to marker population, plant spacing, bee species, and forage yield; evaluation of clones and synthetics in California and Idaho; selection for seed yield in populations.

**Forage Quality:** Forage quality in relation to management, insect and disease resistance; harvest on degree day basis and evaluation of forage quality by in vitro analysis; diurnal variation in forage quality and quantity; effect of microwave drying on quality; saponin levels; high and low nutritionally efficient lines in poultry rations; selection for low stable foam production; comparison of various methods of measuring digestibility; comparison of preservatives for silage.

**Animal Nutrition:** Bloat studies; haylage in feeding trials; influence of alfalfa maturity on intake and milk production; alfalfa vs. grass for milk and
beef production; pasture management systems; fineness of grind, pellet size, quality and percentage of dehydrated alfalfa in rations; feeding trials; determination of blood metabolite levels to check their role as chemostatic intake regulators.

**Agricultural Engineering:** Efficient seeding and drying methods; theoretical consideration in hay handling systems; harvest equipment; evaluation of high moisture, loose hay harvesting systems; cost analysis of feeding field-baled hay and low- to medium-moisture silage; handling chopped hay with minimum labor; extracting juice for protein.

**Agricultural Economics:** Linear programming of all forages and managements in building feed supply systems; cost of production under various systems of handling, alfalfa in least-cost rations.

**Other:** Remote sensing of stage of growth, disease and insect damage from April 27 to October 30.

Areas of research by public personnel and the approximate FTE in each area were: breeding (5), testing (4), genetics (4), management (9), nutrition (6), utilization (5), pathology (5), entomology (7), and physiology (4).

Research subjects most frequently cited as being needed to improve the value of alfalfa for the north central farmer included: (a) development of high yielding varieties with multiple pest resistance and high quality, (b) mechanization of harvesting and feeding, and (c) fertilization and management.

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**Report from the Western Alfalfa Improvement Conference**

Ike I. Kawaguchi  
Waterman-Loomis Company  
Bakersfield, California

The 14th Western Alfalfa Improvement Conference was held June 17, 1971, at Laramie, Wyoming, in conjunction with the Western Society of Crop Science meetings. Several excellent papers on alfalfa were presented as a part of the WSCS program. Officers elected for 1972-73 were: Chairman, Ike I. Kawaguchi; Vice-Chairman, Bill Melton; and Secretary, I. J. Johnson.

During the business meeting a resolution was proposed by Dr. M. W. Pedersen for consideration by the chairman of the national Alfalfa Improvement Conference. The resolution reads as follows: "Be it resolved that the Western Alfalfa Improvement Conference go on record as being opposed to the regulation requiring the registration of alfalfa varieties by the Food and Drug Administration."

A questionnaire was mailed to public and private alfalfa workers in the 12 Western States and the following summary was compiled from information supplied by 21 respondents.
Southwestern U.S. The most frequently mentioned varieties for hay production were Moapa, Lahontan, Mesa-Sirsa, and El-Unico with several proprietary alfalfas being listed from third to fifth in the order of economic importance. New Mexico listed Mesilla, Zia, New Mexico Common, and several proprietary varieties.

Phytophthora root rot, root-knot nematodes, crown rot, downy mildew, stem nematode, southern anthracnose, Fusarium wilt, and bacterial wilt were the most frequently mentioned disease pests. The Egyptian alfalfa weevil, spotted alfalfa aphid, pea aphid, alfalfa caterpillar, Western yellow-striped armyworm, leafhoppers, thrips, and grasshoppers were devastating to alfalfa hay production. Phosphorus, potassium, sulphur, and zinc were named as elemental deficiencies.

Alfalfa workers report 153 evaluation trials at 63 locations in California; 28 trials at 6 locations in Arizona; and 19 trials at 8 locations in New Mexico. M. H. Schonhorst is also testing in Texas and Sonora, Mexico.

Central and Northern Areas. The varieties Ranger, Vernal, Lahontan, and several proprietary alfalfas were of primary importance in this region. Other varieties listed were Washoe, Kanza, Dawson, Buffalo, Rhizoma, and Travois. Ladak is utilized for dryland hay production.

The diseases most frequently mentioned in the area within and surrounding the Great Basin and the Columbia Basin of Washington were bacterial wilt, stem nematode, root-knot nematode, crown and root rot complex, Phytophthora root rot, and some foliage diseases. The balance of the northern and central region also listed diseases such as yellow leaf blotch, downy mildew, Sclerotinia, Fusarium wilt, black stem, and common leafspot.

Insect pests of economic importance in hay production are the alfalfa weevil, pea aphid, spotted alfalfa aphid, grasshoppers, alfalfa caterpillar, leafhoppers, and the clover root curculio. The spotted alfalfa aphid was not reported north of the 42nd parallel.

There are 69 varietal evaluation trials reported in the northern and central areas at 34 locations. Oregon and Utah have plans to increase work in alfalfa.

Roscoe Taylor reported three trials in the Matanuska Valley of Alaska where testing is being conducted for black stem and winter survival. Some of the plant materials used include Medicago sativa x M. falcata.

Of 279 total evaluation trials reported in the western region, private industry accounted for about 39%.

Insects in Seed Production. The lygus bug, clover seed chalcid, pea aphid, spider mites, and stink bugs were reported economically important over much of the western region. The spotted alfalfa aphid is listed in the central area and particularly important in the Southwest. The northern and central area also listed the alfalfa weevil and grasshoppers as pests in seed production.

Breeding and Studies on Alfalfa Pathogens. A percentage value will be given
to indicate the magnitude of involvement of the 21 respondents for each specific organism.

Stem nematode, 62%; Phytophthora root rot, 57%; southern anthracnose and bacterial wilt, 48%; Rhizoctonia root and crown rot and common leafspot, 24%; alfalfa mosaic, southern root-knot nematode and Fusarium wilt, 19%; Cercospora, black stem, northern root-knot nematode and seedling disease, 12%; cotton root-knot nematode, scald, alfalfa rust, and Stemphylium, 9%. Sclerotinia, Stagonospora, Leptosphaerulina, Texas root rot, and alfalfa dwarf were listed on 5% of the reports.

Of special interest, Nevada is engaged in developing several non-dormant and dormant populations with multiple pest resistance of several different combinations of disease and insect pests. They have also achieved complete resistance to Meloidogyne hapla and are working on a uniform screening technique for Rhizoctonia solani.

Entomology. The spotted alfalfa aphid, pea aphid, Egyptian alfalfa weevil, alfalfa weevil, lygus bug, clover seed chalcid, and stink bug are receiving much attention in breeding and/or biological and chemical control. Much interest is also shown in the pollinators (honey bee, leafcutters, and alkali bee). Spider mites and thrips also are being studied.

Arizona reports testing and selections for eight biotypes of the spotted alfalfa aphid. California is involved in intensive studies on the biological control of the spotted alfalfa aphid, pea aphid, lygus bug, and the Egyptian alfalfa weevil.

Other Areas of Breeding and Study. Many organizations are working on alfalfa persistence, seed production, soil fertility, forage quality, weed control, and irrigation. Alfalfa genetics, inbreeding, heterosis, hybrid production, and combining ability also are being actively studied. Pasturing and alfalfa-grass mixtures are of interest at high altitudes and in the northern areas.

Of special interest in California is the study of trisomic transmission, heat stress, and the effect of traffic on alfalfa roots. Quality and nutritional evaluations are being conducted in Colorado, and alfalfa digestibility in Washington.

A New Regional Project. "Physiological criteria for forage, range, and pasture breeding" has been prepared and submitted to the Western Experiment Station Directors.

Suggested Areas of New or Greater Research Emphasis. The inheritance and identification of bloat-causing compounds and the development of non-bloat alfalfas were of greatest interest. Breeding for greater digestibility and nutritional quality was equally important in requests. Other areas of new research were: studies on yield decline in late summer; day length sensitivity; water-use efficiency; root reserves as related to dormancy types and cutting management; development of more varieties with multiple pest resistance, especially in alfalfa weevil, lygus bugs, and common leafspot. Other requests were studies on intervarietal responses to various plant nutrients,
investigate potential for human consumption, evaluation of breeding material for xanthophyll as related to egg yolk and skin pigmentation in layers and broilers, the relationship of 18S proteins between individual clones and other nutritional attributes, the inheritance of male-fertility restorers and self- and cross-incompatibility, and the establishment of four gene pools for male-sterile lines, maintainers, and restorers.

Committee Reports and Business Meeting

Report of the Committee on Standard Tests for Characterizing Disease and Insect Resistance of Alfalfa Varieties

I. Duties Assigned to Committee:

A. Review situation and point out gaps that exist in pest resistance evaluation on presently used and obsolete varieties.

B. Suggest standard tests that should be used or that need to be developed so that they can be readily used.

C. Determine whether or not it would be possible to evaluate varieties at certain centers that have facilities and know-how to carry out tests that would characterize varieties for disease and insect resistance.

D. On a priority basis, list which insect and disease resistance tests should be carried out.

E. Prepare a report for inclusion in the 23rd Alfalfa Improvement Conference report.

II. Present Situation

The importance of pest resistance in alfalfa has been recognized since the introduction of bacterial wilt resistant varieties. Spotted alfalfa aphid resistant and pea aphid resistant varieties were next. Resistance to nematodes, anthracnose, Phytophthora, plus common leafspot, blackstem, Cercospora, Leptosphaerulina, and Rhizoctonia are becoming additional traits for which a breeder must screen. The increase in emphasis on breeding for pest resistance comes at a time when pathological and entomological support on alfalfa is being reduced in many States. The need for standardized testing procedures and check varieties was discussed at all three regional alfalfa conferences in 1971. The Plant Variety Protection Act gives additional emphasis to the need for standardizing the characterization of disease and insect resistance.

This committee has been handicapped by lack of time. Nevertheless, we have attempted to (1) determine the important alfalfa diseases, insects, and nematodes in the United States, (2) draw distribution and severity maps for each pest, (3) list scientist and locations with greatest expertise for each
pest, (4) determine the availability of critical evaluation and screening procedures for each pest, and (5) describe standard evaluation methods for those pests where adequate information is available.

III. Recommendations of the Committee on: Standard Tests for Characterizing Disease and Insect Resistance of Alfalfa Varieties.

1. That the 23rd Alfalfa Improvement Conference recommend the establishment of uniform evaluation procedures for describing the level of pest resistance in alfalfa varieties.

2. That the 23rd Alfalfa Improvement Conference recommend the continuation of this committee for the purpose of finalizing and publishing the information contained in this report.

3. That the 23rd Alfalfa Improvement Conference recommend that in connection with evaluation of pest resistance, the Variety Protection Office consider using only data obtained from tests where standard procedures are utilized (whenever standardized procedures are available).

4. That the 23rd Alfalfa Improvement Conference commend the many agronomists, entomologists, nematologists, pathologists, and extension personnel that have contributed to the information assembled in this report.

Respectfully submitted by:

R. J. Buker
M. W. Nielson
E. L. Sorensen, Chm.
Subcommittee on insect resistance

F. I. Frosheiser, Chm.
K. T. Leath
W. F. Lehman
Subcommittee on disease resistance

J. H. Elgin, Jr., Chm.
Subcommittee on nematode resistance
D. K. Barnes, Committee Chm.

N.B. All available copies of the 58-page report of this committee were distributed at the conference. Only parts of it are reproduced here. The committee is updating that report and preparing it for publication. C.H.H.

Report and recommendations as modified above were accepted. The committee was complimented for its diligence and accomplishments. There was a consensus of opinion at the conference that the recommendations of this committee should be implemented.
A. Purpose and functions of the Data Retrieval Committee.

The purpose of the Data Retrieval Committee is to develop a code for a uniform system of alfalfa data recording and retrieval. It is intended to be used as a guide by anyone who performs alfalfa studies. To paraphrase the secretary's note at the end of the 1970 Committee Report (Twenty-Second Alfalfa Improvement Conference Report, p. 47), this code gives guidance to recording data in variety tests and research studies and is expected to become a standard system for recording most alfalfa data. It is not meant only for plant introductions. If you disagree with the report or have suggestions, please so inform the Data Retrieval Committee.

Each alfalfa worker who uses the system may select only those traits in which he is interested. If variety tests in several locations are made, the traits to be evaluated may be selected from the system and the ratings recorded according to the established descriptions.

B. Duties performed.

The Data Retrieval Committee performed two duties prior to this meeting. One was to review the 1970 report and code system and the other was to conduct a survey to determine how many alfalfa workers are using the data recording and retrieval system. A discussion of these duties is presented.

1. Review of the 1970 report and code system. It was noted that the nomenclature of at least four diseases listed on the "D" or disease cards needs revision. Since the ASA alfalfa monograph, which will be published in the near future, will contain the names of diseases affecting alfalfa, it was decided to defer revision of the nomenclature until after publication of the monograph. In this way, the revision can be made to agree with the monograph.

Nomenclatural changes for two of the diseases being considered:
(1) change Phytophthora cryptogea to P. megasperma Drechs., and
(2) add anthracnose, Colletotrichum trifolii Bain.

2. Survey of use made of data recording and retrieval system. A questionnaire was distributed to alfalfa breeders and others working with the crop. In this questionnaire, they were asked: (1) are they using the system in whole or in part; if so, what parts; (2) are they using a system of their own; and (3) do they have suggestions for improvements or any comments they wish to make about the system.

A total of 74 forms were distributed and 38 were returned, which makes a response of 53%. A tabulation of responses to questions follows:
Number using the system (all or partial) 12
Number who expect to use it 2
TOTAL 14
Number who developed their own system 3
Number not using any system 19
Number who had not seen the code before 2

The number who are using the system or plan to use it (14) represent 36% of those who responded. Thirteen commented that the system is adequate and should be continued. One said that the system is too cumbersome. One said that he has added air pollution damage; and one suggested corrections to the names of certain diseases listed on the disease card. The traits for which the system is being used include many from three of the trait cards, i.e., "C" or plant characteristic cards, "D" or disease cards, and "I" or insect cards.

The results of the survey were valuable and helpful and I wish to extend thanks for the committee to all who responded. However, we hope that the number who adopt the unified system, or component parts, will increase in the future so as to develop greater uniformity of recording data by alfalfa workers.

C. Recommendations.

The Data Retrieval Committee recommends:

1. That this committee be continued for another 2 years.

2. That the new committee make nomenclatural changes to the disease cards to correspond to nomenclature used for alfalfa diseases in the ASA alfalfa monograph and that these changes be made after the monograph is published.

3. That the new committee consider adding to the disease card damage to alfalfa as a result of air and/or soil pollution, fertilizer deficiency or toxicity, toxicity from other chemicals, and other physiological imbalances.

Submitted by:

W. R. Kehr  K. J. Larson
J. H. Elgin  D. D. Dolan
J. D. Axtell  J. W. Miller

W. H. Skrdla, Chairman

Report accepted.
Report of the Committee on Cultivar Descriptions

This report attempts to list and briefly describe alfalfa cultivars which have been developed and released since the last report submitted to this conference in 1970.

If additional information on individual cultivars is desired, the breeder or applicant of the cultivar should be contacted.

Voluntary registration of all new cultivars with the Crop Science Society is strongly encouraged. This provides readily accessible information which describes the cultivar's principal characteristics, thus enhancing the matching of specific cultivars or genotypes with potential areas of use and specific problems found in that area.

Information summarized in Tables 1, 2, and 3 was collected and respectfully submitted by the following members of this committee:

- D. E. Brown
- C. H. Hanson
- D. H. Heinrichs (Replacing M. R. Hanna)
- D. A. Miller
- Dale Smith
- J. R. Thomas
- M. H. Schonhorst, Chairman

Report accepted.
<table>
<thead>
<tr>
<th>Name of cultivar and year of certification</th>
<th>Experimental designation</th>
<th>Certification Applicant</th>
<th>Developers</th>
<th>Origin and/or breeding procedure</th>
<th>Probable area of adaptation</th>
<th>First year of commercial distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anchor 1971</td>
<td>RP 38</td>
<td>Rudy-Patrick Seed Co. D. E. Brown</td>
<td>R. R. Kalton, M. K. Miller</td>
<td>Bred for early growth, resistance to bacterial wilt, downy mildew, and pea aphids.</td>
<td>Same areas in U.S. where Flemish varieties perform well and where more winter-hardness and bacterial wilt resistance are required.</td>
<td>1972</td>
</tr>
<tr>
<td>Bonus 1971</td>
<td>Syn. 66-7</td>
<td>Cal/West Seeds P.O. Box 1428 Woodland, Calif. 95695</td>
<td>I. J. Johnson</td>
<td>Eight parent clones selected from Vernal for less response to short daylengths and desirable forage and disease reaction.</td>
<td>Corn Belt States south of line from St. Paul, Minn., and Madison, Wis.</td>
<td>1972</td>
</tr>
<tr>
<td>El-Unico 1968</td>
<td>Arizona DC-1, SW-30, and UNICO</td>
<td>Arizona Agr. Exp. Sta. and ARS, USDA Tucson, Ariz. 85721</td>
<td>M. H. Schonhorst, R. K. Thompson, M. W. Nielson, P. D. Keener</td>
<td>Two 2-clone synthetics from diverse sources (African and P.I. 235736) were intercrossed. The four parent clones were highly resistant to SAA and high in GCA for forage production using PX progeny tests.</td>
<td>Irrigated Southwest alfalfa region in the U.S. and other arid to semiarid desert areas.</td>
<td>1968</td>
</tr>
<tr>
<td>Hayden 1970</td>
<td>Arizona DC-2 and SW-</td>
<td>Arizona Agr. Exp. Sta. and ARS, USDA Tucson, Ariz. 85721</td>
<td>M. H. Schonhorst, R. K. Thompson, M. W. Nielson</td>
<td>Two 2-clone synthetics from diverse sources (Sonora-70 and Mesa-Sirsa) were intercrossed. The four parent clones were resistant to SAA and high in GCA for forage production using PX progeny tests.</td>
<td>Irrigated Southwest alfalfa region in the U.S. and other arid to semiarid desert areas.</td>
<td>1971</td>
</tr>
<tr>
<td>Sonora-70 1970</td>
<td>Reselect Sonora SW-37</td>
<td>Arizona Agr. Exp. Sta. and ARS, USDA Tucson, Ariz. 85721</td>
<td>M. H. Schonhorst, R. K. Thompson, M. W. Nielson, P. D. Keener</td>
<td>Nine parent clones, originally selected from Sonora field in 1963, were free of foliage diseases and high in GCA for forage production using PX progeny tests.</td>
<td>Irrigated Southwest alfalfa region in the U.S. and other arid to semiarid desert areas.</td>
<td>1971</td>
</tr>
<tr>
<td>Name of cultivar and year of certification</td>
<td>Experimental designation</td>
<td>Certification Applicant</td>
<td>Developers</td>
<td>Origin and/or breeding procedure</td>
<td>Probable area of adaptation</td>
<td>First year of commercial distribution</td>
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<tr>
<td>Thor 1970</td>
<td>N5-150</td>
<td>Northrup, King &amp; Co. 1500 Jackson St. N.E. Minneapolis, Minn. 55413</td>
<td>J. L. Mings</td>
<td>Thirty parent clones tracing to Saranac, Cardinal, and Glacier, resistant to bacterial wilt, high in forage production and rate of recovery.</td>
<td>Areas where Flemish alfalfas are adapted and where bacterial wilt is the limiting factor.</td>
<td>1971</td>
</tr>
<tr>
<td>UC Salton 1971</td>
<td>UC 52</td>
<td>California Agr. Exp. Sta. El Centro, Calif. 92243</td>
<td>W. F. Lehman E. H. Stanford</td>
<td>Broad-based germplasm pool, including adapted and non-adapted sources, was grown under conditions of severe natural selection for resistance to root rots and SAA Ent-F for five generations.</td>
<td>Low desert valley areas of southern California.</td>
<td>1973</td>
</tr>
<tr>
<td>Warrior 1970</td>
<td>NO-507</td>
<td>Northrup, King &amp; Co. 1500 Jackson St. N.E. Minneapolis, Minn. 55413</td>
<td>Dale Grissom</td>
<td>Two large synthetic populations, one Flemish, the other a diverse winter-hardy U.S. germplasm, were planted in alternate rows and interpollinated.</td>
<td>Northern and mid-western U.S. and southern Canada.</td>
<td>1962</td>
</tr>
<tr>
<td>WL 308 1971</td>
<td>303A</td>
<td>Waterman-Loomis Co. Bakersfield, Calif. 93309</td>
<td>D. F. Beard I. I. Kawaguchi D. N. Clary</td>
<td>Selections were made from WL 303 for resistance to bacterial wilt, 335 plants were interpollinated to produce breeder seed.</td>
<td>Same as WL 303 where greater resistance to bacterial wilt is needed.</td>
<td>1972</td>
</tr>
<tr>
<td>Name of cultivar and year of certification</td>
<td>Experimental designation</td>
<td>Certification Applicant</td>
<td>Certification Developers</td>
<td>Origin and/or breeding procedure</td>
<td>Probable area of adaptation</td>
<td>First year of commercial distribution</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>--------------------------</td>
<td>-------------------------</td>
<td>-------------------------</td>
<td>----------------------------------</td>
<td>-----------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>WL 504 1970</td>
<td>CX 54</td>
<td>Waterman-Loomis Co.</td>
<td>D. F. Beard, I. I. Kawaguchi, Calif. 93309</td>
<td>Five cycles of phenotypic recurrent selection were conducted for resistance to SAA, pea aphids, and apparent diseases. The final selections of 92 individuals form the parentage of WL 504.</td>
<td>Southwestern U.S. where Moapa has been well adapted.</td>
<td>1971</td>
</tr>
<tr>
<td>WL 508 1970</td>
<td>CX 58</td>
<td>Waterman-Loomis Co.</td>
<td>I. I. Kawaguchi, D. F. Beard, Calif. 93309</td>
<td>Three cycles of phenotypic recurrent selection for resistance to both SAA and pea aphid were applied to WL 504. In addition, selection was based on freedom of downy mildew and other foliar leaf disease symptoms.</td>
<td>Southwestern U.S.</td>
<td>1971</td>
</tr>
<tr>
<td>183 1970</td>
<td>Syn 67-4</td>
<td>DeKalb Agresearch</td>
<td>I. J. Johnson, DeKalb, Ill. 60115</td>
<td>Plants were selected from Moapa and Sonora for resistance to downy mildew, foliage color and recovery under 28- to 30-day harvest cycle. Progeny from these plants were screened for resistance to EM-B SAA. Superior clones were selected and used as parents of 183.</td>
<td>Sacramento and San Joaquin valleys in California, also Mexico.</td>
<td>1971</td>
</tr>
<tr>
<td>Cultivar and year licensed</td>
<td>Experimental designation</td>
<td>Licensing Applicant</td>
<td>Licensing Developers</td>
<td>Origin and/or breeding procedure</td>
<td>Probable area of adaptation</td>
<td>First year of commercial distribution</td>
</tr>
<tr>
<td>---------------------------</td>
<td>--------------------------</td>
<td>--------------------</td>
<td>---------------------</td>
<td>----------------------------------</td>
<td>-----------------------------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td>Kane 1971</td>
<td>LC-B</td>
<td>Research Station, Canada Dep. Agriculture</td>
<td>M. R. Hana, E. J. Hahn</td>
<td>Bred for drought tolerance and resistance to bacterial wilt. Has creeping-root habit and variegated flower color.</td>
<td>Alberta, Saskatchewan, and Montana.</td>
<td>1971 (seed growers only)</td>
</tr>
<tr>
<td>Name of cultivar</td>
<td>Experimental designation</td>
<td>Applicant</td>
<td>Developer</td>
<td>Origin and/or breeding procedure</td>
<td>Probable area of adaptation</td>
<td></td>
</tr>
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<td></td>
</tr>
<tr>
<td>Americana</td>
<td>AA 61 x 95</td>
<td>L. Teweles Seed Co. R.R. 1 Clinton, Wis. 53201</td>
<td>Paul Sun</td>
<td>Bred for tolerance to bacterial wilt, leaf-spotting diseases, potato leafhopper yellowing.</td>
<td>Midwest U.S.</td>
<td></td>
</tr>
<tr>
<td>Klondike</td>
<td>AA 116 x 120</td>
<td>L. Teweles Seed Co. R.R. 1 Clinton, Wis. 53201</td>
<td>Paul Sun</td>
<td>Bred for branched root system, wide, deep-set crowns, and some resistance to diseases.</td>
<td>Midwest U.S.</td>
<td></td>
</tr>
</tbody>
</table>
Report of Committee on Available Breeding Lines of Alfalfa

The committee canvassed the experiment stations and industry representatives with alfalfa breeding programs for additions to the lists included in previous reports. The new entries are as follows:

<table>
<thead>
<tr>
<th>State/Province</th>
<th>Contact</th>
<th>Official release</th>
<th>Stock</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iowa</td>
<td>I. W. Carlson</td>
<td>Iowa 3018</td>
<td>Seed</td>
<td>Syn 3 of a yellow-flowered synthetic. It had 11 parent clones. Its main</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>value probably would be as a genetic marker.</td>
</tr>
<tr>
<td>Minnesota</td>
<td>D. K. Barnes</td>
<td>MnP-B1</td>
<td>Seed</td>
<td>Interpollinated seed produced on 160 plants selected in 1969 for Phytoph-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>thora resistance. Plants were selected from winter-hardy and moderately</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>winter-hardy varieties and experimental strains.</td>
</tr>
<tr>
<td>Minnesota</td>
<td>D. K. Barnes</td>
<td>MnP-D1</td>
<td>Seed</td>
<td>Interpollinated seed produced on about 90 plants selected in 1969 for Phyto-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>phthora resistance. Plants were selected from 14 varieties and experimental</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>synthetics adapted to the Southwestern United States.</td>
</tr>
<tr>
<td>USDA</td>
<td>C. H. Hanson</td>
<td>Beltsville 1-An4</td>
<td>Seed</td>
<td>Populations highly resistant to anthracnose - selected from Glacier,</td>
</tr>
<tr>
<td>&quot;</td>
<td></td>
<td>2-An4</td>
<td>&quot;</td>
<td>Saranac, and Vernal, respectively.</td>
</tr>
<tr>
<td>&quot;</td>
<td></td>
<td>3-An4</td>
<td>&quot;</td>
<td></td>
</tr>
<tr>
<td>USDA</td>
<td>C. H. Hanson</td>
<td>Beltsville 4-An2</td>
<td>Seed</td>
<td>Population moderately resistant to anthracnose from Mexican introduc-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>tions.</td>
</tr>
<tr>
<td>State/Province</td>
<td>Contact</td>
<td>Official release</td>
<td>Stock</td>
<td>Description</td>
</tr>
<tr>
<td>---------------</td>
<td>---------------</td>
<td>------------------</td>
<td>-------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>USDA</td>
<td>C. H. Hanson</td>
<td>Beltsville 5-An2</td>
<td>Seed</td>
<td>Population moderately resistant to anthracnose from Peruvian and Spanish introductions.</td>
</tr>
<tr>
<td>USDA</td>
<td>C. H. Hanson</td>
<td>MSA-CW3An3</td>
<td>Seed</td>
<td>Population resistant to anthracnose, bacterial wilt, common leafspot, potato leafhopper yellowing and rust.</td>
</tr>
<tr>
<td>USDA</td>
<td>C. H. Hanson</td>
<td>MSB-CW5An3</td>
<td>Seed</td>
<td>Population resistant to anthracnose, bacterial wilt, common leafspot, potato leafhopper yellowing and rust.</td>
</tr>
<tr>
<td>USDA</td>
<td>C. H. Hanson</td>
<td>MSB-CW5</td>
<td>Seed</td>
<td>Population resistant to rust, potato leafhopper yellowing, common leafspot and a moderate level of resistance to bacterial wilt. Also more persistent than commercial varieties in Eastern test.</td>
</tr>
<tr>
<td>USDA</td>
<td>C. H. Hanson</td>
<td>2-1-2H</td>
<td>Clone</td>
<td>Ozone resistant - from MSB-CW5An2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2-4-1H</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2-1-3H</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>2-3-2H</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2-2-3H</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USDA</td>
<td>C. H. Hanson</td>
<td>10-1-3H</td>
<td>Clone</td>
<td>Ozone resistant - from Team</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10-4-4H</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>10-3-4H</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>10-3-2H</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USDA</td>
<td>C. H. Hanson</td>
<td>11-3-2L</td>
<td>Clone</td>
<td>Ozone susceptible - from Williamsburg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11-1-2L</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>11-1-1L</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>11-4-3L</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
This list does not include official variety releases and plant introductions since they are widely publicized by other means.

All respondents were also asked to indicate (1) how many requests they had released, (2) how many listed materials they had requested, and (3) what uses had been made of the materials they had received. At least 40 persons in the U.S. and Canada were contacted and 33 replies were received. Of these, 21 indicated that they had either supplied or requested any listed materials. A few replies were very specific but many were very general, so the data reported here are largely estimates.

The estimated number of requests filled was around 1000 while the estimated number of materials requested by respondents was around 400. The lack of agreement between these two numbers is probably due largely to inaccurate estimates but other possible factors are: (1) not all participants responded, and (2) some requests were from foreign countries so would be included in the first estimate but not in the second. The important point, however, is that fairly extensive use of the listed releases is being made.
Uses for these materials were varied, but the primary use appeared to be in practical breeding programs. The use listed most frequently was as a source of pest resistance, especially disease resistance. The released materials were either used as a source of selection directly or combined with the breeder's own materials. Clonal releases, especially male steriles, were used mainly in crossing with other selected clones and in hybrid breeding programs.

Other uses listed were: observation, development of germplasm pools, genetic studies, and cytoplasmic sterility studies.

From this survey it appears that alfalfa breeders are using the listings fairly extensively and this committee recommends continuation of the service.

Respectfully submitted,

Hans Baenziger
O. J. Hunt
M. K. Miller
J. L. Mings
G. R. Buss, Chairman

Report accepted.

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Report of Committee on Preservation of Germplasm

In the 1970 report of this committee it was proposed "that alfalfa breeders assist the NC-7 Regional Plant Introduction Program by making controlled-pollination increases from original seed of alfalfa introductions." These increases were to be made in the greenhouse or under cages with 2,000 to 10,000 seeds required. Such a program has been initiated.

Eighty-five questionnaires were mailed to alfalfa researchers in the United States asking whether or not the recipient would assist in an increase program. Of 30 respondents, 22 were positive with 59 accessions accepted for increase during 1971-72.

It is now proposed that another committee on the preservation of germplasm be appointed to serve until the 24th Alfalfa Improvement Conference to be held in 1974. This committee would continue to coordinate the germplasm increase program now initiated. It would also make recommendations on other matters which may arise and which relate to the preservation of alfalfa germplasm.

Submitted by:

D. F. Beard A. J. Oakes
T. H. Busbice W. H. Skrdla
R. R. Kalton M. D. Rumbaugh, Chairman

Report accepted.

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57
Committee on Nomenclature of Biotypes and/or Physiologic Races of Insect Pests and Diseases

This committee considers the following list of recommendations as an addition to the recommendations made to the Twenty-second Alfalfa Improvement Conference, July 1970, page 65 of the Report.

RECOMMENDATIONS:

1. Work of this committee should be restricted to biotypes of the spotted alfalfa aphid because the published information and economic damage by biotypes or physiologic races of other insects or diseases of alfalfa seem insufficient to warrant action.

2. Guidelines for differentiating biotypes or physiologic races of each insect and disease of alfalfa are expected to be different. It is suggested that existing guidelines be used as much as possible as sources of ideas for biotypes or physiologic races of other organisms.

3. Insect response to the plant is the primary basis for designating biotypes. However, host response may be used as a secondary criterion for differentiating biotypes. Critical, meaningful criteria such as yellowing, streaking, and foliage deformation could be used but criteria still difficult to classify or vague, such as general loss of turgor pressure or yield, should be avoided. If the host response and pest response show a differential reaction, a dual designation of a letter followed by a number shall be used. No additional designation will be given if the host response augments or compliments the pest response.

4. Clones shall be the test material used to differentiate biotypes of the spotted alfalfa aphid. However, research on the possible future use of varieties as differentials is encouraged since varieties are easy to maintain in a relatively unchanged condition.

5. The clones used as differentials should be in a healthy condition. Some means of restoring old clones to a disease-free condition, such as bud or meristem culture, should be used when clones become unthrifty and affected with viruses, bacterial wilt, etc.

6. The minimum number of differential clones or varieties necessary to classify biotypes of the spotted alfalfa aphid should be five.

7. The following is a list of clones and varieties which might be tried as differentials when new biotypes are tested. This point is presented as a suggestion, not as a recommendation, because the problem needs more research.

   Clones: C 904, C 905, C 908, C 911, C 947, and C Al

   Varieties: Mesa-Sirsa, Caliverde, Caliverde 65, Moapa, and Cody

8. The responsibility for maintaining alfalfa clones used as differentials
for the spotted alfalfa aphid shall be determined by the regional Alfalfa Improvement Conference(s) where biotypes are a problem. Two individuals should be assigned to maintain each clone.

9. Since temperature can affect host plant resistance, extremes of temperature (below 70 and above 95 F) should be avoided. Temperatures between 75 and 90 F are suggested. It is also suggested that test conditions, such as fertility, irrigation, etc., be maintained at levels favorable for good host plant growth.

Respectfully submitted,

J. J. Cartier  R. T. Sherwood
O. J. Hunt    E. L. Sorensen
G. D. Moore   M. C. Wilson
M. W. Nielson  W. F. Lehman, Chairman

Report accepted.

Report of the Committee on Chromosome Numbering in Alfalfa

The report of this committee to the 22nd Alfalfa Improvement Conference, 1970, proposed a numbering system and identification key for the pachytene chromosomes of diploid Medicago sativa L. which was adopted by that conference. Following the distribution of the conference report no suggestions or criticisms of the proposal were received. However, there is one small error in Fig. 1 of that report. On the line G, referring to Gillies 1968 publication, the order of the numbers 7 and 5 should be reversed to read--5, 7, 8 as correctly reported in the publication of Gillies and Bingham, Can. J. Genet. Cytol. 13:397-403, 1971.

Since our 1970 proposal, publications and manuscripts prepared on pachytene chromosomes in diploid M. sativa, M. falcata, hybrids of M. sativa and M. falcata, and M. glomerata have followed the proposed numbering system without exception. It is apparent that the adopted chromosome numbering system for diploid M. sativa can and should be followed for diploid species in the sativa-falcata complex and we so recommend. While pachytene information on the tetraploids in this complex is too meager to draw conclusions it is very probable that the same numbering system could also be followed.

Other than to follow up our intention to publish these proposals in a widely distributed appropriate journal, there is no apparent need for the appointment of another committee on Chromosome Numbering in Alfalfa.

On the other hand, we would strongly recommend that a committee be established to review gene nomenclature and symbolization and that a designated chairman serve as the coordinator with authority for the assignment of gene symbols in alfalfa. The revision should consider computer suitability of symbolization.

K. C. Armstrong  E. H. Stanford
Report of the Variety Certification Committee (As amended)

This committee's assignment was to: (1) review the report of the 22nd Alfalfa Improvement Conference, (2) make recommendations to AOSCA on certification standards for hybrids, and (3) make recommendations concerning size and shape of field, and further define parameters on seed contamination.

I am pleased to report activity in all assignments. Work in Canada on isolation when leafcutter bees are used should be helpful and study of contamination in farmers' fields in California has been suggested.

Most of the committee's effort has been devoted to hybrids. To this end two manuscripts (Intra-plant Variation for Pollen Production in Male-sterile Alfalfa and Pollen Production in Relation to Crossing in Alfalfa Hybrids) were prepared and reviewed by each member of the committee. In addition, a study on the effect of locations, technicians, and male steriles was completed, but has not been completely analyzed. The committee's suggested recommendations for certification standards for alfalfa hybrids follow:

RECOMMENDED HYBRID ALFALFA CERTIFICATION STANDARDS

(Applies to hybrids made with cytoplasmic sterility where marker genes are not available.)

I. Application of Genetic Certification Standards

A. The Genetic Certification Standards, pages 1 through 17, are basic.

B. The Genetic Standards are modified as follows:

1. Section II. Eligibility Requirements for Varieties

   Standards applicable to specific crop varieties shall apply to the production of male parent (C) lines.

2. Section III. Designation of Classes of Seed

   a. A commercial hybrid is one to be planted for any use except seed production.
   b. Only the class "certified" is recognized in commercial hybrid seed.
   c. A commercial hybrid to be certified must be produced from certified foundation seed that has been field inspected.
   d. Definition of parental types: A - The male sterile, B - a line which when crossed with an A type maintains...
sterility for the production of foundation seed. C - any male-fertile line used as the male parent in the production of a certified commercial hybrid.

3. Section VI. Production of Seed - Unit of Certification

The entire crossing field grown by and/or belonging to an applicant and used for seed must be eligible and must be inspected.

4. Section VI. Production of Seed - Field Inspection

Certified seed fields of commercial hybrids or foundation seed stocks shall be given at least three field inspections as follows:

a. Before planting to determine adequacy of isolation and freedom from volunteers.

b. After planting, but before flowering, to check for volunteers.

c. Each year during full bloom (at least 75% of the plants in bloom) but before appreciable seed set to determine pollen production in the male-sterile line.

Two hundred plants shall be sampled to determine the pollen production index (PPI). If the index is near the 95 or 75% limits another 100 plants shall be sampled and included in the calculation. Samples shall be taken in such a manner that they are representative of the entire field. See III B.

(After the first year inspection will be limited to 4 b and 4 c above.)

II. Land Requirements

Land used for hybrids or foundation seed stocks must be free of volunteers.

III. Field Standards

A. Isolation

1. Seed stocks

Minimum isolation distance for the production of foundation seed stocks (A x B) shall be at least 1,320 feet. A B-parent border is desirable.

2. Commercial hybrids and male parent (C) lines

General standards shall apply to the male parent (C) line used
for the commercial hybrid, and to the commercial hybrid. The C parent used in the production of the commercial hybrid can be certified if the male-sterile line meets the requirements of the 95% hybrid.

3. Inter-planted blocks - between the seed and male-fertile pollinator

There shall be at least 6 feet between the pollinator lines in a crossing block or between the seed and male-sterile pollinator line in a hybrid production field, and they shall be managed and harvested to prevent mixing. (There was not complete accord on this point. C.H.H.)

4. Ratio of male-sterile and pollinator lines shall not be more than 2:1.

B. Pollen production in seed lines

1. **Maximum pollen production index (PPI) permitted**

<table>
<thead>
<tr>
<th>Crop</th>
<th>Seed stocks</th>
<th>Allowable index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation</td>
<td>A line</td>
<td>14</td>
</tr>
<tr>
<td>Certified production fields (A x B) x C</td>
<td>A x B line</td>
<td>6</td>
</tr>
<tr>
<td>95% hybrid</td>
<td></td>
<td>42</td>
</tr>
<tr>
<td>75% hybrid</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Flowers examined by tripping on a red pot label and viewing with a headband magnifier rating from 1, 2, 3, and 4 and weighted 0, .1, .6, and 1.0, respectively. 1 = no pollen. Multiply the number of plants/class by the factor indicated. Total the values. Divide by the number of plants and multiply by 100.

2. The seed parent and pollinator shall meet the following:

<table>
<thead>
<tr>
<th>Factor</th>
<th>Foundation</th>
<th>Certified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other varieties</td>
<td>1:1,000</td>
<td>1:100</td>
</tr>
</tbody>
</table>

IV. Seed Standards

General standards apply.
Availability of printed copies of *Alfalfa Science and Technology* is anticipated in October 1972. It is published by the American Society of Agronomy, Inc., 677 South Segoe Road, Madison, Wisconsin 53711.

The monograph represents the specialties and efforts of more than 70 authors who are experts in alfalfa improvement. The title reflects dual emphasis on basic information (chapters 1-17) and practical application (chapters 18-33). I wish to extend my sincere appreciation to the authors, the editorial committee, and more than 80 persons who assisted with chapter reviews.

Following is information on contents of the monograph for those of you who are not familiar with its coverage.

*Alfalfa Science and Technology* opens with a detailed discussion of the world distribution and historical developments surrounding this important forage crop, from its Old World origins to its spread through the Americas. Subsequent chapters deal with crop morphology, anatomy, physiology, ecology, chemical composition, genetics, and breeding, with an extensive discussion of the taxonomy and cytogenetics of *Medicago*. Also included are discussions of alfalfa varieties, culture management, and fertilizer use for forage production.

Four chapters are devoted to disease and pest control. Among the sections dealing with modern usage and production practices are "Equipment for Harvesting, Storing, and Feeding," "Pasture Production and Utilization," and "Processed Alfalfa Products for Food and Food Industries." Also covered are such topics as alfalfa in feedlot feeding, weeds and weed control, the alfalfa seed industry, and seed characteristics.

Alfalfa from an international viewpoint is considered by the authors in the final chapters, with discussions of the outlook, potential, and future research needs and aims.

C. H. Hanson, Editor
Resolutions Committee Report

Whereas all those in attendance at the 23rd Alfalfa Improvement Conference have thoroughly enjoyed the educational and congenial atmosphere of the meetings in Ottawa, we do hereby extend our most sincere thanks to Dr. W. R. Childers and his colleagues, to the Canada Department of Agriculture, Research Branch, to the Animal Research Institute and its staff, and to Carleton University for their efforts in providing local accommodations, meeting arrangements, kind hospitality, and the interesting tour of the Greenbelt Farm.

Whereas everyone appreciated the Monday noon luncheon, we would like to extend a grateful vote of thanks to those members of the American Seed Trade Association and the Canadian Seed Trade Association who kindly sponsored this affair. We are also appreciative of the interesting presentation of research pursuits of the Canada Department of Agriculture, Research Branch, by Dr. T. H. Anstey after the banquet.

Whereas the meetings truly have provided a wealth of information, discussions, and exchange of ideas for alfalfa researchers, we heartily commend Dr. D. H. Heinrichs and his Executive Committee of the 23rd Alfalfa Improvement Conference and Dr. B. C. Pass and his Executive Committee of the 16th Forage Insect Conference for all their diligent efforts in organizing and conducting the individual and joint programs of the respective conferences.

The Resolutions Committee respectfully submits these resolutions and moves that they become a part of the minutes of the conference reports. Furthermore, it is suggested that the Secretary prepare and send letters of appreciation to those institutions, firms, and key individuals whose efforts contributed to the success of the conferences.

E. H. Stanford  
J. L. Bolton  
R. R. Kalton, Chairman

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Report of Nominations Committee

The Nominations Committee presented the name of Dale Smith, Professor of Agronomy, Department of Agronomy, University of Wisconsin, Madison, who was unanimously elected as the new chairman. The Nominations Committee consisted of R. R. Hill, Jr., B. P. Goplen, and I. J. Johnson, chairman.

Paul Sun was nominated by industry to serve as its representative on the Executive Committee of the Alfalfa Improvement Conference during the next biennium.

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Plans for the 1974 National Alfalfa Improvement Conference

An invitation was received to hold the 1974 conference on the University of Arizona campus at Tucson. The invitation was accepted. The date has been set for October 8-10, 1974. The date chosen was a compromise to avoid conflicting meetings of agronomists and entomologists.

The Secretary received the following program suggestion for the joint session usually held during the first half day: "Agronomic practices which affect insect damage."

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Attendance

E. J. ARMBRUST, Nat. Hist. Survey, Univ. of Illinois, Urbana
K. ARMSTRONG, CDA, Ottawa Research Station, Ottawa, Ontario
Lloyd E. ARNOLD, Arnold-Thomas Seed Service, Fresno, Calif.
R. E. ASHER, S&A Seed Farms Ltd., Brooks, Alberta

H. BAENZIGER, ORS, Central Experimental Farm, Ottawa, Ontario
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