Barnes

# MINUTES

of the

Fourteenth Central Alfalfa Improvement Conference

Madison, Wisconsin

July 15-16, 1975

Reported by

E. T. Bingham
Secretary
Agronomy Department
University of Wisconsin
Madison, Wisconsin 53706

14th Central Alfalfa Improvement Conference
Madison, Wisconsin
July 15-16, 1975

Agenda:

July 14, 1975 - Arrive, Madison Inn, 601 Langdon St., Madison, Wisconsin

July 15, 1975

8:00 A. M. - Tour

| | |
|---|---|
| 1. Biotron - Madison Campus | (45 min.) |
| 2. Juice extraction - Madison Campus | (20 min.) |
| 3. Travel to Arlington | (60 min.) |
| 4. Rest stop, Registration (Bus, refreshment, and lunch charges) | (25 min.) |
| 5. Complete juice utilization - Arlington | (30 min.) |
| 6. Variety testing, Weed control, Equipment for Alfalfa utilization | (45 min.) |

12:00 noon - Catered Lunch

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|---|---|
| 7. Breeding | (60 min.) |
| 8. Management and Physiology | (60 min.) |
| 9. Refreshments | (30 min.) |
| 10. Demonstration and discussion by Nitrogen Company Inc., Milwaukee | (45 min.) |

4:15 P. M. - Return to Campus

July 16, 1975 - Meet in Lowell Hall - Rec Room (across street from motel)

8:30 A. M. - Business
A. Approval of agenda
B. Appointment of nomination and location committees

Paper presentations
1. Status of Hybrid Alfalfa - Paul Sun, Teweles Seed Co.
2. Comparative measures of mirid damage on alfalfa forage - Kugler, Kehr, and Ogden, University of Nebraska and Agricultural Research Service, USDA
3. Selecting for high nitrogen fixing genotypes in alfalfa - M. W. Seetin and D. K. Barnes, University of Minnesota and Agricultural Research Service, USDA
4. Potential of low altitude remote sensing imagery for identifying pest injury, stage of plant growth, and yield in alfalfa - D. K. Barnes and M. P. Meyer, Agricultural Research Service and University of Minnesota

Discussion

12:00 noon - Catered Lunch

1:15 P. M. Minutes
New Business
State Reports
Plans for Regional Tests

CAIC
July 15, 1975

| Participants | | Addresses |
|---|---|---|
| Darrell A. Miller | University of Illinois | Urbana, IL 61801 |
| Jonas Miller | Arnold Thomas Seeds | Des Moines, IA |
| Carleton Ruenger | " " " | Markesan, WI |
| Mark A. Brick | Cal-West Seeds | West Salem, WI |
| Don W. Graffis | University of Illinois | Urbana, IL |
| J. M. Scholl | University of Wisconsin | Madison, WI |
| Wayne S. Hautman | WL Co., 3400 Colverton Blvd #12 | Beltsville, Md. 20705 |
| Irving T. Carlson | Iowa State University | Ames, IA |
| Glenn A. Page | Northrup King | Stanton, MN |
| Robert R. Kalton | Land O'Lakes | Webster City, IA |
| Keith Gelder | Land O'Lakes | Fort Dodge, IA |
| Ike Kowaguchi | Waterman-Loomis Co. 601 Oswell St. | Bakersfield, CA 93307 |
| W. R. Kehr | USDA-ARS, Univ. of Neb. | Lincoln, NE |
| Dwain W. Myer | North Dakota State U. | Fargo, ND |
| Donald L. Smith | Cal/West Seeds | Woodland, CA |
| Robert E. Cowell | Teweles Seed Co. | Muscatine, IA |
| Lenat Hofmann | ARS-USDA, Box 459 | Mandan, N.D. |
| Gordon C. Marten | ARS-USDA, Univ. Minn. | St. Paul, MN |
| Jack L. Mings | Northrup, King | Washington, IA |
| Edgar L. Sorensen | ARS-USDA, Kansas State U. | Manhattan, KS |
| Glenn D. Moore | Northrup, King & Co. | Eden Prairie, MN |
| Jim Phillips | Northrup, King & Co. | Stanton, MN |
| Mark Seetin | University of Minnesota | St. Paul, MN |
| Mohammad Reza Azizi | University of Minnesota | St. Paul, MN |
| Ted R. Knous | University of Minnesota | St. Paul, MN |
| Duane Smith | University of Minnesota | St. Paul, MN |
| J. J. Johnson | Cal/West Seeds | Woodland, CA |
| Katie Kugler | University of Nebraska | Lincoln, NE |
| John Kugler | University of Nebraska | Lincoln, NE |
| J. Charles Walters | North American Plant Breeders | R. 3, Ames, IA |
| Don Viands | University of Minnesota | St. Paul, MN |
| Larry R. Teuber | University of Minnesota | St. Paul, MN |
| Melvin D. Rumbaugh | S.D. State University | Brookings, S.D. |
| Richard R. Smith | ARS-USDA, Univ. Wisconsin | Madison, Wi |
| Ernst Harlser | Kansas State University | Manhattan, KS |
| Norman L. Taylor | University of Kentucky | Lexington, KY |
| R. W. Van Keuren | OARDC | Wooster, OH |
| Fred Frosheiser | ARS-USDA, Minnesota | St. Paul, MN |
| Ted Bingham | University of Wisconsin | Madison, Wi |
| Donald E. Brown | Land O'Lakes | Caldwell, IDA |
| Bob Ogden | University of Nebraska | Lincoln, NE |
| D. F. Beard | Waterman-Loomis Co. | Adelphi, MD. |
| Don Stuteville | Kansas State University | Manhattan, KS |
| M. B. Tesar | Michigan State University | E. Lansing, MI |
| R. Leavett | Michigan State University | E. Lansing, MI |
| H. W. Ream | University of Wisconsin | Madison, WI |
| Dale Smith | University of Wisconsin | Madison, Wi. |
| James D. Ford | Wilstar Seeds, PO Box 1393 | Des Moines, IA 50303 |

Abstracts of Tour Information
University of Wisconsin - July 15,1975

# Development of a Direct Forage Harvesting, Preservation, and Plant Juice Protein Production System[1/]

Howard W. Ream

Eleven departments in the College of Agricultural and Life Sciences and in Mechanical Engineering, University of Wisconsin-Madison are cooperating in the development of a system for the direct harvesting of alfalfa and other forages and the extraction of a protein concentrate that can be used in animal feeds, or when further refined, in human foods.

The objectives of this system are to harvest alfalfa or other forages at a stage when they produce the optimum yield of nutrients per acre regardless of weather conditions, to make more efficient use of the protein in the crop, and to recycle some of the elements in the plant tissue back to the land or otherwise utilize them as a media for single-cell organism to produce more protein. Field losses of leaves and nutrients, harvesting time, energy costs, and fertilizer requirements may also be reduced. More efficient use is made of the protein contained in forages such as alfalfa (20 to 22%) because a high protein concentrate (40-45%) is extracted with enough protein left in the pressed forage (16-18%) to satisfy the nutrition of ruminant animals.

The system makes it possible to harvest forage with one trip of the machinery through the field after which the freshly cut material is macerated and squeezed to express juice. The liquid thus removed is treated to extract protein which can be dried, treated, or further processed as an excellent protein and vitamin source for animal feeds or human food. The pressed forage, which has a favorable moisture content for making silage, is ensiled. The deproteinized juice which remains has possibilities as a media for the growth of yeasts or other organisms to produce additional protein or it can be returned to the land as a fertilizer.

Basic research has shown that the most efficient method of plant juice extraction is to fracture the cell walls by maceration and then press the plant material. Equipment has been designed, constructed and tested which has farm scale capacity and which can process material with less than half the energy requirements of any of the previous processing methods.

More efficient methods of coagulating the protein from the extracted whole plant juice are being investigated. An alternate to coagulation by heat or acid, that of an acid-forming anaerobic fermentation appears very promising.

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1/ A summary of interdisciplinary research supported by the College of Agricultural and Life Sciences, University of Wisconsin-Madison 53706 and by Hatch Project No. 5026, by the Research Committee of the Graduate School with funds supplied by the Wisconsin Alumni Research Foundation and by the National Science Foundation Grant AEN-13078 with participation by the departments of Agricultural and Mechanical Engineering, Agricultural Economics, Agronomy, Biochemistry, Dairy, Food, Meat and Animal, Nutritional and Poultry Sciences.

Pressed alfalfa silage produced under this system was found to be equally as good a forage as conventional low moisture alfalfa silage when fed to average producing dairy cows. However, with high producing dairy cows intake was insufficient and milk production declined. A drier pressed forage must therefore be produced. This will be possible with improved processing equipment.

Alfalfa juice protein concentrate, when properly processed, has been found to be a satisfactory substitute for at least part of the soybean meal, or other protein concentrate, in feed rations for hogs and poultry. With laying hens alfalfa juice protein concentrate is an excellent source of Xanthophyll, being about 2.5 to 3 times as active as alfalfa meal.

The deproteinized juice, which contains very large amounts of K and considerable N, has proved to be valuable as a fertilizer when applied to alfalfa, bromegrass, or corn. Green weight of silage corn was increased from 16.1 to 21.4 tons/acre and bromegrass yields were doubled when one-half acre inch of the residue juice was applied. A similar application on an alfalfa-bromegrass mixture resulted in an increased proportion of alfalfa in the mixture.

# Effects of Potassium Topdressing a Low Fertility Silt Loam Soil on Alfalfa Herbage Yields and Composition and on Soil K Values

Dale Smith

Alfalfa (Medicago sativa L.) uses large amounts of soil K. The purpose of this study was to determine the amount of topdressed K needed to obtain maximum herbage yields from alfalfa under presently recommended harvest schedules. 'Ranger' alfalfa was established on a low K Typic Argiudoll (Plano silt loam) and topdressed the first two of three harvest years with zero, 56, 112, 224, 448, 672, 896, and 1120 kg/ha K as KCl. Two annual harvest schedules were used; (a) three cuts at first flower, and (b) same as (a) plus an early October cut (4 cuts). Yield responses were similar for the two harvest schedules, but 3-year average yields were highest with three cuts annually. Residual yields and stands showed that the detrimental effect of an early October cut (4 cuts) was partially alleviated by high K topdressing rates. The 3-year average yields were highest with 672 kg/ha of topdressed K, and then decreased at higher K rates. Herbage K percentage at 672 kg/ha K averaged 2.8% for the 3 harvest years, and 56% of the fertilizer K was recovered in the herbage. Analysis of total herbage from the third harvest year showed that Mn concentration, as well as K, increased as K topdressing rate increased, whereas concentrations of N, P, S, Ca, Mg, Na, Cu, Zn, and B decreased. There was no effect on IVDDM, Fe, and Al concentrations. It is concluded that higher rates of applied K are needed than presently are being used in order to obtain and maintain high herbage yields and persistence from alfalfa stands. See Agron. Jour. 67:60-64, 1975, for further data.

# Alfalfa Breeding Research

E. T. Bingham and T. J. McCoy

## Maximum Heterozygosity

The theory of maximum heterozygosity was tested in alfalfa (Thesis by M. W. Dunbier). Autotetraploid parents (HD4x) which could be only mono-allelic or di-allelic duplex were produced by chromosome doubling 2x haploids of cultivated alfalfa and their diploid derivatives from crosses with wild diploid relatives. HD4x parents were mated to produce single crosses (SC) which were in turn used to produce double crosses (DC). Gene frequencies should be the same in HD4x, SC and DC populations, although their genotypic structures were expected to differ with the DC population having the highest frequency of tetra-allelic loci. Thus, any performance differences among the populations should reflect differences due to different genotypic structures. SC and DC populations were evaluated for forage yields in the greenhouse and field; self- and cross-fertility and seed weight of HD4x, SC, and DC groups were tested in the greenhouse. Performance was consistently DC>SC for forage yield although it was significant at P=5% level in only one of four harvests. Performance for fertility and seed weight were DC>SC>HD4x, and differences were much larger and significant at P=1% level. The consistent ranking of DC>SC>HD4x when compared with the theoretical genotypic structures of these populations provides evidence for both the existence of multiple allelic series and the importance of tri- and tetra-allelic loci in conditioning maximum performance. Methods of maximizing heterozygosity were discussed, whereby component lines or strains could be increased separately and then synthesized in two final steps, analogous to single and double crosses.

## Gametes with the Unreduced Chromosome Number (2n gametes).

The frequency of 2n (unreduced) gametes in a population of Cultivated Alfalfa at the Diploid Level (CADL) was studied utilizing tetraploid Saranac Male steriles as the female parent and crossing with 750 CADL plants as male parents. The number of seeds produced er pollination is an indication of the frequency of 2n male gametes because union of a n(2x) female gamete with a 2n(2x) male gamete results in tetraploid progeny. Average seed set was less than 1 seed per 25 pollinations but seven CADL plants produced greater than 2 seeds per pollination. The general low frequency of 2n gametes indicates that CADL is reproductively stable, producing almost entirely diploid progeny from CADL X CADL matings. Preliminary observation of the seven exceptional plants indicates all seven produce a relatively high frequency of 2n pollen. Future research will determine the mechanism of 2n gamete formation and genetic control of the mechanism. If simple genetic control of a mechanism producing 2n gametes which are genetically equivalent to first meiotic division restitution is found the mechanism may possibly become a tool in breeding alfalfa. 2n gametes genetically equivalent to first division restitution (FDR) transfer a large amount of intra- and inter-allelic interactions from parent to offspring. The union of a 2n (FDR) female gamete from one diploid with a 2n (FDR) male gamete from an unrelated diploid could theoretically result in superior highly heterozygous tetraploid progeny.

# Alfalfa Significant Contributor to No. 1 Hay Status

Dwayne A. Rohweder

Alfalfa is grown on 75% of Wisconsin's hay and silage acres and contributes significantly to Wisconsin's No. 1 standing in hay production. This alfalfa production is valued at more than $475 million. Over 7% of the hay is marketed as cash hay with Wisconsin ranking 11th in annual hay sales.

Alfalfa as hay, silage and pasture is the backbone of feeding programs for Wisconsin dairy and beef cattle and has been a major factor in reaching the average milk production of 10,700 pounds per cow. With recent high costs for energy and protein, alfalfa and other legumes have been placed in the spotlight.

Consequently, Wisconsin places major emphasis on the evaluation of alfalfa varieties. Varieties are evaluated for winterhardiness and wilt resistance to give the persistence needed under Wisconsin's climate and yield under the early cutting system. More recently varieties are being evaluated for leaf disease resistance and for persistence on a wide range of soil conditions.

The end result of this work will be a more effective system of recommendations that will provide varieties to meet farmer specific soil resource and livestock enterprise needs.

A forage evaluation and computerized ration balancing program has been adopted. Emphasis is being placed on improving hay marketing procedures.

## Birdsfoot Trefoil in Wisconsin

J. M. Scholl

Birdsfoot trefoil, Lotus corniculatus, is now being recommended in Wisconsin for use on areas which are marginal for alfalfa. The acreage of birdsfoot trefoil is increasing.

This legume is performing well on the heavy clay soils in northern Wisconsin where poor internal drainage may limit the use of alfalfa. It also performs relatively better than alfalfa on some soils with pH below 6.5. It is now being used in pasture renovation programs on sloping land in the unglaciated area of southwestern Wisconsin where it is expected to remain for long periods of time.

Birdsfoot trefoil recovers, after grazing, from axillary buds on the lower stems. Therefore grazing should be controlled so that some stems remain. The grazing types are prostrate and some stems can be expected to remain under moderate continuous grazing.

Varieties which are performing best in central and southern Wisconsin are Carroll, Leo, and Mackinaw. Maitland may be added to the list in northern Wisconsin where a snow cover is more dependable. The three varieties and Empire were at least as hardy as Vernal alfalfa as indicated by survival during the severe winter of 1974-75 at Arlington, Wis.

## Breeding Bromegrass for Alfalfa-Grass Mixtures

Paul N. Drolsom

The recommended three-cut system for highest yield of total digestible dry matter per acre with alfalfa has led to problems for smooth bromegrass grown with alfalfa. The crucial stage for brome appears to be just after jointing, as it is beginning to head. This stage often occurs when alfalfa is at late bud, or very first flower, the recommended time for first harvest. This apparently is at a time when basal tiller buds in brome are not very active. The alfalfa recovers more rapidly, and if there is a moisture shortage, the bromegrass is at an even greater disadvantage.

Recently bromegrass breeding lines were screened for growth responses when grown with alfalfa and harvested three times each year over a three-year period. Differences occurred among the 60 brome lines and the best eight lines have interpollinated. Progenies from these are now being evaluated in a solid stand of alfalfa, using the recommended 3-harvest system.

Business Meeting; July 16, 1975
Lowell Hall, U.W. Campus

It was moved by Rumbaugh and seconded by Jonas Miller to accept the minutes of the 13th CAIC held at Kansas City, Kansas. It was moved by Rumbaugh and seconded by Sorensen to appoint Irving Carlson as incoming secretary of the CAIC.

I. J. Johnson presented a report of the "Working Conference on Research to Meet U.S. and World Food Needs."

Gordon Martin reported that the North Central Regional Task Force has recommended the establishment of a North Central Regional Dairy Management-Forage Research Center with 13 SMY's and a dairy herd of 500 milk cows at the Wisconsin Agricultural Experiment Station. An additional 11 SMY's should be added to the North Central effort to be located at other State Agricultural Experiment Stations. Thus, a total of 24 SMY's is recommended for the region. The research programs of these scientists should be complementary to the research recommended for the Regional Center. Additional details can be found in the Dairy-Forage Task Force Report of the North Central Region.

# Report of the Status of Hybrid Alfalfa

Paul Sun
L. Teweles Seed Company

Inheritance in alfalfa is complex. The breeding behavior of forage yield is profoundly compounded by its quantitative nature of inheritance. However, the cytoplasmic male sterile system does provide a genetic tool to learn the inheritance pattern of forage yield.

In the present study, crosses were made to obtain information about additive and non-additive gene effects for forage yield. The degree of heterosis in different crosses was also investigated.

$F_1$ progeny consistently exceeds male parents in most single crosses, ranging from 3-16% in 1972-74 tests and 6-35% in 1973-74 tests. The mean forage yield of 3-way hybrids was higher than single crosses in most cases. It seems that the expression of heterotic effect reaches a higher level in crosses with four different parental lines.

# Comparative measures of mirid damage on alfalfa forage[1]

J. L. Kugler, W. R. Kehr and R. L. Ogden[2]

During the 1973 and 1974 growing seasons, alfalfa (Medicago sativa L. and M. falcata L.) clones, foreign plant introductions, experimental and adapted cultivars and progenies of hand crosses were examined for their reaction to feeding by two mirid species, the tarnished plant bug [Lygus lineolaris (Palisot de Beauvois)] and the alfalfa plant bug [Adelphororis lineolatus (Goeze)]. Leaf malformation, vegetative stunting, forage yield, recovery rate, dry matter, protein and carotene contents were measured in the field under natural and caged infestations.

Visual damage scores among adapted and experimental cultivars caused by natural infestations were not consistent between yield nurseries examined on the same date. Visual scores for adapted germplasm manually infested under large cages, were not significantly correlated with other traits or with visual scores between dates. Protein and carotene contents of infested forage were not significantly different from noninfested forage.

In small cages (approx. 1 ft.$^2$), 15 and 27% decreases in forage yield and plant height, respectively, occurred in direct-seeded open-pollinated progenies of selected clones subjected to alfalfa plant bugs at a rate of 2 bugs per cage. Differences among progenies in stunting apparent at an infestation rate of 2 bugs per cage were not observed at a rate of 6 bugs per cage. Dry matter content of the forage tended to increase as the number of bugs per cage increased.

Six clones were chosen as parents for diallel crosses based on visual scores of mirid leaf malformation of their open-pollinated progenies in 1973. Two clones each were classified as resistant, intermediate and susceptible to mirids. The clones also differed in resistance to pea aphid [Acrythosiphon pisum (Harris)], spotted alfalfa aphid [Therioaphis maculata (Buckton)] and potato leafhopper [Empoasca fabae (Harris)]. The rankings of clones and their respective $S_1$ progenies were not in complete agreement, however, diallel cross progenies tended to react to mirids as expected in 1974. Estimates of heritability of resistance in these clones to the two mirids and other insects await 1975 experimental data.

1/ Contribution from cooperative investigations by the Nebraska Agricultural Experment Station and the Agricultural Research Service, U. S. Department of Agriculture. Published as Abstract Series No. 75-474, Abstract Series, Neb. AES. Research reported was conducted under Project Numbers 12-005 and 15-005.

This publication was supported in part by the National Science Foundation and the Environmental Protection Agency, through a grant (NSF GB-34718) to the University of California. The findings, opinions and recommendations expressed herein are those of the authors and not necessarily those of the University of California, the National Science Foundation or the Environmental Protection Agency.

2/ Graduate Research Assistant, Department of Agronomy; Research Agronomist ARS, USDA, and Professor of Agronomy, Department of Agronomy; Assistant Professor, Laboratory of Agricultural Biochemistry, University of Nebraska, Lincoln, Nebraska 68503.

# Selecting High-Nitrogen-Fixing Genotypes in Alfalfa

M. W. Seetin and D. K. Barnes
University of Minnesota and Agricultural Research Service,
U.S. Department of Agriculture

Nitrogen is an essential element for plant growth. Supplies of petroleum based nitrogen are becoming depleted and more expensive. This has caused more attention to be given to symbiotic nitrogen fixation in leguminous plants. Alfalfa has been reported to fix from 100 to 600 kg/ha of nitrogen annually. Much of the symbiotically fixed nitrogen is removed with harvest of the legume species. However, some legumes may also excrete nitrogenous compounds that can be used by other plants (1). This is in addition to the contribution of nitrogen from decaying roots and nodules. Nitrogen fixation research on alfalfa began in Minnesota in 1974. We have had two major objectives: 1) to determine if genetic variation exists for nodulation and nitrogen fixation in alfalfa, and 2) to develop a procedure that could be used in a plant breeding program for screening large numbers of plants for nitrogen fixation potential.

The acetylene reduction technique (2) is the method presently used in most legume research programs to estimate nitrogen fixation potentials. The method involves using gas chromatography to measure the reduction of $C_2H_2$ (acetylene) to $C_2H_4$ (ethylene) by the nodule enzyme nitrogenase. Plant material for our research was initially selected in April 1974 from about 2,000 plants of 8 alfalfa varieties. Seventy-seven plants were selected as being either high or low nodulators. Cuttings were made and inoculated with a commercial mixture of inoculum, containing Rhizobium meliloti. Three replications of each clone were visually scored for nodulation and root type. The objective of the study was to determine if plants could be visually classified for nodulation and root habit. The scoring system used was a 5 class system with 1 having the most nodules or best root system and 5 having no nodules or the poorest root system. Clones differed significantly in both nodulation and root type. A significant correlation ($r = 0.36$) existed between nodulation and fibrous root score. No other significant correlations existed. Thirty-seven of the extreme clones were selected for use in an acetylene reduction study to determine if a correlation existed between nodule scores and nitrogen fixation as estimated from the acetylene reduction assay. Inoculated cuttings were transplanted into autoclaved washed sand in 4 replications of 2 plants/pot. Nilnitrate Hoagland's solution was flushed through each pot three times per week. Plants were clipped at first flower and allowed to regrow. At first flower of the regrowth, nodule activity was measured via acetylene reductions. No significant correlation was found between acetylene reduction values and the root or nodule scores.

Ten clones selected as high and low nitrogen fixers (5 of each) were used in studies to determine the effect of nutrient levels on nitrogen fixation as measured by acetylene reduction.

One study involved differing levels of potassium in the nutrient solution. Acetylene reduction values were increased with increasing levels of K. The differences were small but significant. Top weights were not significantly affected. However, a significant correlation of $r = 0.75$ occurred between acetylene reduction values and top weight ($n = 50$).

In another study the same ten clones were used to determine if nitrogen level in the nutrient solution affected acetylene reduction. Five rates of $NH_4NO_3$ (0,10, 20,40, and 80 ppm) in nil-nitrate Hoagland's solution were used. Significant differences in acetylene reduction occurred at 20 ppm. This appeared to be near the level where soil nitrogen level suppressed nitrogen fixation by the plant. J. H. Hoglund (3) notes a similar "bimodal" response in some alfalfa seedlings. A significant correlation of $r = 0.76$ was obtained between acetylene reduction values and top weights. A significant clone x nitrogen level interaction indicated that not all

clones respond in the same manner to combined nitrogen levels. Clones were significantly different for acetylene reduction in both the potassium and nitrogen studies. Clonal reactions between the two tests were highly correlated, $r = 0.95$.

Based on data obtained over the past year, we conclude that alfalfa genotypes differ in degree of nodulation. However, visual nodulation scores do not appear to be correlated with acetylene reduction values. Variation also appears to exist among alfalfa clones for nitrogen fixation potential. N and K levels in the soil and soil moisture level affected acetylene reduction values. Increased acetylene reduction values were associated with increased top weight. Therefore, plants with increased nitrogen fixation rates have a more than random chance of being productive types. Based on our data to date we believe that it should be possible to breed for increased nitrogen fixation potential in alfalfa. Improved screening methods are being developed.

## LITERATURE CITED

1. Agboola, A. A. and A. A. A. Fayemi. 1972. Fixation and excretion of nitrogen by tropical legumes. Agron. J. 64(4):409-412.

2. Hardy, R. W. F., R. C. Burns, and R. D. Holsten. 1973. Applications of the acetylene-ethylene assay for measurement of nitrogen fixation. Soil Biol. Biochem. 5:47-81.

3. Hoglund, H. J. 1973. Bimodal response by nodulated legumes to combined nitrogen. Plant Soil 39:533-545.

# Potential Value of Low Altitude Remote Sensing for Identifying Pest Injury, Stage of Plant Growth and Yield in Alfalfa

D. K. Barnes and M. P. Meyer

Agricultural Research Service, U.S. Department of Agriculture
and
University of Minnesota, St. Paul, Minnesota 55108

Sequential ERTS-compatible multispectral, multiscale 70 mm aerial photography was conducted on a 9-acre alfalfa ecosystem study at Rosemount, Minn. The objective was to determine if aerial remote sensing techniques could differentiate varieties, stage of plant growth, and disease or insect injury.

Four replications of 5 alfalfa varieties were planted in 100' x 120' plots. Each plot was sub-divided by weekly applications of fungicides on a 40' strip running north and south and a 40' strip of insecticides running east and west. Ground-truth data were collected weekly throughout the growing season by Agronomists, Entomologists, and Plant Pathologists. This included plant height, yield, incidence, and level of leaf and stem diseases, and population numbers of more than 40 species of insects. In 1973 overflights using Aerochrome Infrared/Wratten 15 at a scale of 1:6336 were made about every two weeks between May 8 and August 27. A VP-8 image analyzer was used to monitor film density of each plot area. Three estimates of density were made per plot area. These measurements were averaged, statistically analyzed and then related to ground truth information from the same plot area.

Alfalfa varieties differed significantly in their relative reflectance patterns. The relative reflectance was 99.0, 97.6, 96.9, 95.6 and 92.3 (LSD .05 = 2.5) for Ranger, Kanza, Team, Weevlchek and MSB-11, respectively. The lower value probably indicated darker green foliage. Fungicide and insecticide treatments and stage of plant growth caused significant differences in reflectance patterns. For nearly two weeks after clipping the treated areas had relatively less reflectance (97) than the non-treated areas (100). However, during the following weeks until harvest, the untreated areas had less reflectance (94) than the treated areas (100). Between two and nine significant correlation coefficients occurred between reflectance patterns and yield, plant growth traits, and pest populations for each of the 8 dates of imagery. Another significant source of variation for reflectance was terrain (replications). Differences in plant growth associated with soil moisture caused greater differences in relative reflectance patterns than those caused by pests.

We concluded that differences in infrared reflectance of alfalfa measured with infrared photography were influenced by varieties, stage of plant growth, pest populations, pest injury, and field areas. Differences in reflectance due to varieties and field areas appeared to preclude the use of remote sensing imagery to survey and identify pest problems and yield potential. However, low altitude and satellite imagery may be useful for identifying alfalfa acreages and stand densities in very early spring. It may also be possible to determine time of harvest patterns over large geographic areas. Remote sensing could have some potential for use in alfalfa research programs, but more studies are needed.

STATE REPORTS - July 16, 1975
Lowell Hall, U.W., Campus

# ILLINOIS

D. A. Miller

Area of research and principal investigators.

1. Forage yield tests of commercial cultivars and experimental strains are being continued on a fee testing program. Public released cultivars and progenies of University of Illinois selected clones are being tested on state project funds. D. W. Graffis and D. A. Miller.

2. Introduction of Legumes into Grass Sods. D. W. Graffis.

3. Nutritive Value of Alfalfa and Nitrogen-fertilized Grasses at Different Maturities. D. W. Graffis and F. C. Hinds (An Sci).

4. Effect of Boron on Alfalfa Weevil Populations. D. A. Miller and D. W. Graffis.

5. Alfalfa Fertility -- Phosphorus and Potash Interaction. J. A. Jackobs and D. W. Graffis.

6. Protein Production and Inheritance. D. A. Miller.

7. Resistance to Alfalfa Weevil. D. A. Miller.

8. Physiological Genetics -- Mitochondrial Activity and Nitrate Reductase. D. A. Miller.

9. Resistance to Heaving and Fibrous Rooting Characteristics. D. A. Miller.

10. Annual Alfalfa Production. D. A. Miller.

11. Allelopathic Interactions with Alfalfa. D. A. Miller.

12. Nitrogen Fixation Study and Effect of " N-Serve." D. A. Miller.

# IOWA

I. T. Carlson

## Current Status and Problems of Alfalfa in Iowa

According to the Iowa Crop and Livestock Reporting Service, alfalfa is grown for hay on 1.77 million acres in Iowa. The acreage is up 3% from 1974.

Insects have been more serious on alfalfa this year than in recent years. The variegated cutworm and alfalfa weevil caused considerable damage in western and southern Iowa, respectively. Entomologists are mapping the distribution of the weevil and its parasites. They have introduced two new parasites. Field demonstrations on alfalfa weevil control are being conducted.

The potato leafhopper became a serious pest earlier than usual this year. It caused severe yellowing and stunting of alfalfa in late June. It was a factor in low second-cutting yields in variety trials at Ames.

Bob Nyvall, Extension Plant Pathologist, reports a large increase in incidence of Phytophthora root rot. He is receiving samples of alfalfa infected with the disease from all sections of Iowa. Spring and summer blackstem and crown rot were frequently observed this year also.

## Areas of Research and Principal Investigators

1. Forage yield tests of privately and publicly developed varieties and experimental strains. We are currently testing 103 varieties and experimental strains. Results from commercial varieties are published annually. -- I. T. Carlson, Agronomy.

2. Legume-grass management with supplemental nitrogen application. At the Shelby-Grundy Experimental Farm in southern Iowa, alfalfa and red clover were seeded singly with each of four grasses (orchardgrass, reed canarygrass, smooth bromegrass, and switchgrass) in May 1974. Four nitrogen (N) treatments are as follows: (1) 0 N, (2) 90 lbs./A of N in early spring, (3) 90 lbs./A of N after the first cutting, and (4) 90 lbs./A of N after the third cutting. Plots will be harvested four times each year. Total yield, seasonal distribution of yield, contribution of legume, contribution of grass, and persistency of each will be evaluated. -- W. F. Wedin, Agronomy.

3. Sod-seeding alfalfa, birdsfoot trefoil, and crown vetch into predominantly bluegrass sod. Paraquat was used to control existing vegetation. Results show that alfalfa was successfully established and it is producing good yields of forage. -- W. F. Wedin, Agronomy.

4. Frost seeding legumes in cool-season grasses. Alfalfa, birdsfoot trefoil, red clover, white clover, and crownvetch will be frost seeded in orchardgrass, bromegrass, and Kentucky bluegrass. -- J.R. George, Agronomy.

5. Effects of ensiling and different silage additives on protein solubility and ensiling losses of alfalfa. -- R. L. Vetter, Animal Science.

# MICHIGAN

M. B. Tesar

Area of alfalfa research and principal investigators:

1. Perennial grasses with nitrogen and Vernal alfalfa in northern Michigan.-- M. B. Tesar.

Bromegrass, orchardgrass, tall fescue, and reed canary grass were planted alone or with Vernal alfalfa in 1967. Grasses above have been fertilized annually with 0, 50, 100, or 200 lb N per acre. Yields for 1974 and for the 7-year average ( ) for an average of 50, 100 and 200 lb N per acre are: BG-3.54 (3.89), RC-3.54 (3.82), OG-3.46 (3.73) and TF-3.22 (3.90). Yields with alfalfa are: BG-3.54 (4.30), RC-4.31 (3.87), OG-4.16 (3.72) and TF-4.41 (3.54). Seven-year average increases in tons per acre per 100 lbs N of all grasses were as follows for different rates of N: 50-lb rate - 2.08; 100-lb rate - 1.79; and 200-lb rate-1.28. Alfalfa comprised 30 to 60% of the stands of alfalfa-grass mixtures in the first cutting of 1975. Alfalfa-grass mixtures yielded an average of 4.30 tons hay per year for the 7-year period with little variation attributable to grasses. This was equivalent to about 150 lbs N added to the grasses (average of 100-lb (3.84 tons hay) and 200-lb (4.59 tons) rates of N per acre.

2. Rates of spring- and summer-seeded Vernal and Saranac alfalfa maintained at high and low fertility. -- M. B. Tesar.

Vernal and Saranac alfalfa were spring seeded with oats or summer seeded alone in 1968 at rates of 2 to 24 lb/acre and fertilized annually with P and K or not fertilized. Yields were greater in the first harvest year (1969) from spring seedings because of more vigorous plants. Summer seedings had more seedlings per square foot than spring seedings. Summer seedings outyielded spring seedings starting in the third harvest year (1971). Plots fertilized annually started to outyield unfertilized plots in the third year. In the sixth year (1974), fertilized plots were yielding 45% more than non-fertilized plots.

Yields increased as seeding rates increased to the 8-lb rate during the first four harvest years. The 12-lb rate was higher yielding than the 8-lb rate starting the fifth and especially in the sixth year.

Total yield for the 6-year period indicates a slightly higher yield at the 12- than at the 8-lb rate. The experiment will continue for 10 years to determine if the 24-lb rate will produce the highest yield in the tenth year as hypothesized.

3. Phytophthora root rot in alfalfa under stress. Seppo K. Pulli and M. B. Tesar.

Incidence of Phytophthora megasperma Drechs root rot on alfalfa in the seeding year was studied on a tiled well-drained loam soil in October at East Lansing, Michigan. Samples were obtained in all combinations of the following: early (April 27) and late (May 19) seeding, irrigation (two 2-inch applications) and no irrigation, Vernal and Saranac cultivars, two and three cuttings in the seeding year and seven seeding rates -- 2,4,8,12,16,20, and 32 lbs/A.

Irrigation treatment of 2 inches each on July 29 and August 15 increased Phytophthora root rot in alfalfa roots when the natural precipitation between April 1 and October 31 was 22 inches, 1.8 inches above normal. Vernal and Saranac were equally susceptible to root rot under irrigated or non-irrigated conditions. Alfalfa seeded at below normal seeding rates of 2 and 4 lb/A was significantly less diseased than at normal (9 or 12 lb/A) or higher seeding rates.

Maximum Phytophthora root rot was induced by a combination of stress factors including high soil moisture levels, frequent cutting, high seeding rates, and late spring seeding. (To be published in Sept.-Oct. Crop Science, 1975).

4. Varietal trials of alfalfa. M. B. Tesar.

Seventeen of 36 varieties produced an average yield of over 7 tons of hay (12% moisture) per year at East Lansing in the 5-year period 1970-1974. Six varieties produced over 7.5 tons. One variety, Pioneer 520, yielded over 8 tons of hay per acre per year for the 5-year period. The excellent yields were due partly to the excellent class I Brookston soil and four cuttings per year (late May, July 10-12, Aug. 22-26, Oct. 15-30) rather than three. Four cuttings per year increased the yield about one ton per acre per year (based on other MSU research). In the first year of a new alfalfa test, one variety produced 8.99 tons per year with several varieties over 8 1/2 tons.

5. Anthracnose disease in USDA selections of alfalfa. M. B. Tesar and T. Elgin, USDA, Beltsville.

USDA selections of anthracnose-resistant Vernal, Saranac, Team, and Glacier alfalfa were clear seeded in 1974 and compared to the above varieties. There were no significant differences attributable to anthracnose at yield levels of 3 1/2 tons forage of 12% moisture. (Note: anthracnose symptoms were observed in July in Michigan in 1975 in farmers fields under conditions of high rainfall and high temperatures.)

6. Municipal sewage effluent for the production of forage crops for livestock. M. B. Tesar and B. D. Knezek.

Three plots each of perennial grass species, six alfalfa varieties, and two birdsfoot trefoil varieties, were established on an untiled Miami loam soil in August, 1973, in three replicates. In mid-May of 1974, two varieties of corn, and one each of forage sorghum, pearl millet, and sorghum sudangrass were sod-seeded on a cover crop of rye treated with a weed killer. The pearl millet stand was a failure. Sewage effluent containing 10 ppm of N, 1.3 ppm of P, and 10 ppm of K was applied in 1974 at weekly rates of 1, 2 and 3 inches starting in mid-July. Three cuttings of perennials and one of annuals were made in 1974.

Alfalfa yielded about 20% more than perennial grasses but 50% less than corn for silage. Maximum yields of perennial grasses were at the 2-inch effluent level. Alfalfa yielded equally well at all three effluent levels. Maximum yields of corn was at the 1-inch level. The sorghum or sorghum sudan was highest yielding at the 3-inch levels.

Percentages of nitrogen, P, and K in all grasses and P and K in alfalfa increased as rates of applied effluent increased.

Alfalfa and most perennial grasses tolerated all three effluent levels particularly well. Bromegrass, however, was injured at the highest water level.

7. Effect of irrigation, variety, seeding date, and frequency of cutting and seeding rate in clear seeded alfalfa. S. Pulli and M. B. Tesar.

Yields of clear-seeded alfalfa in the seeding year increased up to a rate of 8 pounds per acre in 1971 seedings with good 2,4-DB weed control and up to 12 lb/A in 1972 seedings with poorer weed control. Root and top growth increased up to the 12-lb rate but % root increase was much less than increase in top growth. Both plateaued beyond the 12-lb rate. Seedling numbers increased almost linearly as rates increased; weight per root decreased almost linearly up to the 12-lb rate and then decreased only slightly. Three cuttings in the seeding year did not reduce next year's yields or fall TNC reserves compared to two cuttings in the 1971 seedings, but seedings cut twice in 1972-seeded alfalfa yielded about 10% more in 1973 than when cut three times in 1972. Dates of spring seeding and irrigation in the seeding year had no differential effect on next year's yields which were similar to those of summer-seeded alfalfa. Percent IVDMD was not influenced by seeding rate in any cutting in the 3- or 2-cut systems. Averages for all cuttings over all seed rates were: 73.8% - 3 cuts, early seeding; 74.5% - 3 cuts, late seeding; 68.3% - 2 cuts, early seeding; and 71.6% - 2 cuts, late seeding.

8. Establishment of alfalfa on a quackgrass sod in northern Michigan. M. B. Tesar.

Deep plowing of quackgrass in early May, followed by immediate seedbed preparation band seeding, and cultipacking resulted in excellent alfalfa stands. Rapid growth of the alfalfa seeded with the most modern seeding method (banding the legume seed over phosphorous fertilizer for rapid root growth, then cultipacking) gave the alfalfa enough vigor to compete successfully against recovering quackgrass.

9. Sod seeding of alfalfa in five grasses under conditions of high and low (5.5) pH. M. B. Tesar and S. Powles.

10. Utilization of 3- and 4-cut alfalfa utilizing linear programming of dairy feeding systems in a corn silage-alfalfa feeding system. R. Black, G. Schwab and M. B. Tesar.

11. Influence of 3- and 4-cut systems on the productivity and longevity of Vernal and Saranac alfalfa. M. B. Tesar.

12. Fall cutting of Vernal and Saranac alfalfa in northern Michigan. M. B. Tesar.

13. Establishment of alfalfa on quackgrass treated with glyphosate and plowed under. M. B. Tesar.

# NEBRASKA

W. R. Kehr

This is a cooperative program involving the state and federal governments. It is cooperative among the Agronomy, Biochemistry, Entomology, and Food Science and Technology, and Plant Pathology Departments of the University of Nebraska. Regional cooperation includes planning and summarizing regional yield tests, participating in the NC-83 regional seed production project as the primary station, and the preliminary evaluation of plant introductions under the NC-7 regional project.

Objectives:

1. To develop breeding methods.
2. To develop disease and insect resistant varieties with high hay and seed yield, persistence, hay quality, and other traits for hay, pasture, and range.

Publications in process on recent work:

Alfalfa pest management to control damage from potato leafhopper.
Registration of alfalfa germplasm pools NC-83-1 and NC-83-2.
Influence of TIBA on the yield and quality of alfalfa.
Cross-fertilization in seed production in relation to forage yield of alfalfa.
Registration of dryland germplasm pool C-3.

Work completed, ready for manuscript work:

Cross-fertilization in relation to inbreeding in white and yellow-flowered materials.

Windrow drying of alfalfa prior to dehydration.

Cross-fertilization in relation to seed size.

Pea and spotted alfalfa aphid resistance in crosses of susceptible x resistant parents and reciprocals.

Alfalfa protein concentrate of varieties.

Dawson seed lots.

Performance of polycross seed from several sources.

Quality of alfalfa clones, $S_1$ and OP progeny, and derived synthetics.

Work in progress:

Anthracnose seed lots.

NC-83 regional project "Seed production of insect-pollinated legumes."

BIC germplasm pool development (in cooperation with Minnesota).

Mirid resistance.

Stand density in relation to forage yield of varieties resistant or susceptible to pea and spotted alfalfa aphids.

Summer migration of the alfalfa weevil.

Alfalfa weevil control experiments.

Survey for alfalfa weevil resistance in pubescent alfalfas.

Initial germination and germination 10 years after rf seed treatment.

Yield trials of varieties and experimental synthetics.

Breeding work
- recurrent selection for combined resistance to insects and diseases, forage yield and quality, seed yield and adaptation.

Performance of alfalfa varieties in competition with bromegrass.

Alfalfa pest management
- 4 varieties, 3 insecticides
- 4 varieties, foliar and soil fungicides and insecticides

Effectiveness of selection for forage yield at three field spacings in three populations.

Field selection for resistance to the alfalfa weevil.

Evaluation of varieties for field resistance to the alfalfa weevil.

The effect of selection for seed yield on seed and forage yield, insect and disease resistance.

Forage yield of OP progenies of $S_0$ and $S_1$ clones and derived synthetics in relation to cross-fertilization in seed production.

Forage yield of reciprocal "crosses" and comparable crosses produced from seed mixtures of the two parental synthetics.

Personnel:

Agronomy - W. R. Kehr, USDA-ARS
Biochemistry Lab. - R. L. Ogden
Entomology - G. R. Manglitz, USDA-ARS
Food Science and Technology - L. D. Satterlee
Plant Pathology - J. Riesselman

# OHIO

R. W. Van Keuren
OARDC
Wooster, Ohio 44691

Interest in alfalfa continues high. Because of excessive rain early in the season Phytophthora was evident in new seedings where soil drainage was not good and some stands were lost. The excessive moisture also resulted in some new seedings becoming weedy. The wet conditions reduced the vigor of the alfalfa and conversely was favorable for weed invasion. Potato leafhopper continues to be the most serious alfalfa insect and appeared earlier than usual in 1975. Anthracnose was noted in second growth of 'Saranac' at Wooster.

Studies involving alfalfa continue to be a major part of the forage research. New alfalfa variety trials were established in 1975 at Wooster and at the Northwestern Branch in Wood County, with a fall seeding planned for August at the Jackson Branch in Jackson County. August seedings are being used in southern Ohio because of the problem of heavy crabgrass infestations in spring seedings.

Management studies at Wooster include a P and K study, weed control in alfalfa, a time/frequency of harvest study, and interseeding of alfalfa into established grass swards. Utilization studies, including alfalfa for grazing, are being continued with dairy cattle, beef cows, and sheep.

The current alfalfa and grass variety studies and miscellaneous studies are reported in Agronomy Department Series 195, Ohio Forage Report - 1973/1974, available from Wooster.

Report on NC-83, "Seed Production of Breeding Lines of Insect-Pollinated Legumes"

I. T. Carlson, 1975 Chairman

The project was revised in 1972-73. The current objectives are as follows:

1. To evaluate the seed production potential of parental materials and experimental populations and to select for seed yield within populations.

2. To produce seed of experimental combinations from selected parental materials and to use the seed for forage yield and other cooperative tests.

3. To produce seed lots of recurrent selection populations supporting systematic cooperative regional research.

4. To produce seed of gene pools for the preservation of germplasm.

Principal accomplishments of the project during the past two years were as follows:

1. It has continued to facilitate seed increase and seed yield evaluation of breeding material for alfalfa breeders in the North Central Region.

2. NC-83-1 and NC-83-2, broad-based germplasm sources of alfalfa adapted respectively to northern and southern growing areas, were released to alfalfa breeders.

3. Seed was increased of Beltsville International Composites BIC-5 and BIC-6. Plans were made for the registration of these alfalfa populations and for the release and distribution of seed.

4. Approximately 4 to 6 pounds of seed were produced of each of nine Beltsville International Composite (BIC) sub-populations each selected for seed yield or resistance to stem nematode, potato leafhopper yellowing, pea aphid, spotted alfalfa aphid, bacterial wilt, Phytophthora root rot, common leaf spot, or anthracnose.

5. Seed was increased of a birdsfoot trefoil germplasm pool. Plans were made for registration of this germplasm and for release and distribution of seed.

6. A study of effects of inbreeding and selection for seed yield on crossing between alfalfa populations was completed.

7. A manuscript entitled "Predicting Seed Yields of Birdsfoot Trefoil Clones" was prepared for publication.

8. Open-pollination progeny tests for seed and forage production of 24 birdsfoot trefoil clones were completed.

Work in progress on the project includes: (1) seed yield evaluation of alfalfa synthetics in California and Idaho, (2) seed yield evaluation of 20 alfalfa clones in California, (3) the growing of 19 alfalfa populations of 1000 plants each in Idaho for seed yield selection, (4) seed increase of 44 experimental combinations and recurrent selection populations of alfalfa in California or Idaho, and (5) production of seed of an experimental synthetic variety of birdsfoot trefoil.

# SOUTH DAKOTA

M. D. Rumbaugh

## I. Breeding:

The objectives of the variety development program remain the same as the past two years. We are seeking a variety with the vegetative morphology of Travois but with increased seed yield potential and possibly lower stable foam volume. Syn.-1 and Syn.-2 seed of one promising experimental synthetic will be produced in Idaho and South Dakota this year. We are initiating a study with alfalfa mosaic virus this year.

## II. Pasture Research:

The research program at Norbeck is being continued under the supervision of Jim Green. He is also doing some research and demonstration work with interseeding. Jim Johnson is also conducting interseeding research in the western part of the state.

## III. Agricultural Engineering:

The efficiency of large hay packaging systems is being determined. Hay quality is being considered over an extended storage period. Some irrigation research with alfalfa rotations is also in progress.

## IV. Entomology:

Bob Walstrom is investigating integrated techniques for the control of alfalfa weevil. Bathyplectes anurus has been introduced in Lawrence County to complement B. curculionis which has been established in South Dakota since 1934. The use of leafcutter bees for seed production is being evaluated.

## V. Physiology:

Paul Evenson's research has demonstrated maximum growth of alfalfa when root zone temperature is approximately 70°F and crown zone temperature is approximately 95°F.

WISCONSIN REPORT - SEE ABST. OF TOUR