Spring 1963

South Dakota Farm and Home Research

Agricultural Experiment Station

South Dakota
Farm and Home Research

VOLUME XIV NO. 2 SPRING 1963

A New Soil Test for Nitrogen

MESSAGE FROM THE DEAN AND DIRECTOR

TODAY WE HEAR MUCH more of the term "team efforts in research." And people ask if the individual is still as important today as in the time of Pasteur or the Curries.

Irrespective of the size of a research team or group, individual initiative is still the secret in a successful research effort. I would like to illustrate by referring to a scientist who is engaged in developing a new wheat variety.

He himself must be a trained geneticist, statistician, and plant breeder. He must call on the plant pathologist for a disease evaluation, the miller for market possibilities and trade acceptance, and the entomologist to determine insect resistance. But the final success or failure of his plant breeding program will still depend mainly on his own dedication and ability.

Another place where "team" efforts by researchers are made is with a counterpart in another state agency or a private industry. For example, we work with the Soil Conservation Service and Bureau of Indian Affairs on soil survey programs in South Dakota.

Our Division of Agriculture and substation staffs work with their farmer-businessmen advisory groups, whose intimate knowledge of crop and livestock problems makes them specialists. They can be of great assistance to the research worker in pinpointing his efforts toward the solution of pressing problems.

We work with research scientists from other experiment stations in the North Central region and in the northern great plains area. If a group of animal nutritionists meet they discuss their research programs and the type of problems in their respective areas.

Then, too, as a "team" effort scientists gather at national scientific society meetings, seminars and symposiums, and work together during leaves of absence for study.

From all these discussions may emerge a general research plan, but it is still up to the individual worker to mobilize the resources available to him in the most effective manner possible in carrying out his own research ideas.

In short, as important as teamwork is, the real key to progress is still the type of individuals making up the "team."

in this issue

SOUTH DAKOTA FARM AND HOME RESEARCH

A Report of Progress

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To simplify terminology, trade names of products or equipment are sometimes used. No endorsement of specific products named is intended, nor is criticism implied of products not mentioned.

by Vernyl D. Pederson

Assistant professor of Plant Pathology

FLAX SEEDLING BLIGHT

Seedling blight, a common disease of flax, has plagued the flax growing areas of South Dakota for many years. The disease strikes down flax seedlings suddenly and without warning. Young plants may topple over and die within a few hours after attack. In a few days, seedlings dry up and are blown away or covered by soil so that little evidence remains to suggest what may have caused the reduction in stand.

Failure to obtain good stands of flax is often blamed on poor seed or improper seed bed preparation. These two factors may be involved in the seedling blight complex, but frequently the primary cause is fungi that live in the soil and rot the seed or kill the seedling either before or after emergence. *No section of South Dakota is free from potential hazard of this disease for all soils contain these fungi.*

Previous cropping history of the land does not appear to influence the occurrence of the disease for seedling blight may occur in flax following alfalfa and other field crops. Several outbreaks of the disease occur when soil moisture and temperature conditions are suitable. Other unknown factors, however, influence severity, for the disease may drastically reduce stands in one field, while a nearby field may completely escape seedling blight. (Continued on next page)

Figure 1. Seedling blight caused by the fungus *Rhizoctonia solani*. The fungus was placed at X when the seed was planted. The seed closest to the fungus rotted and failed to germinate. Seed farther away germinated, but in a few days the seedlings rotted below the soil surface, withered and died. The five seedlings on the right are healthy because when the picture was taken, the fungus had not grown sufficiently from X to reach them.

Recognize by Symptoms

First symptoms of fungi infection on flax seedlings are water soaked areas on young, succulent stems just below the soil surface. These areas rapidly become reddish-tan and may enlarge until the tissues are weakened and the seedlings fall over, wither, and die (figure 1).

Seedling blight tends to occur in patches. These patches often contain only dead plants bordered abruptly by healthy ones. The patches may appear suddenly and spread rapidly, and in a few days stand destruction may be extensive (figure 2).

Occasionally, new roots sprout above the rotted region of a flap seedling. These plants may recover and survive, but their growth is retarded and yield from such stunted plants is reduced (figure 3).

Plants may also die before they appear above ground. As young seedlings grow up through the soil, they are highly susceptible to attack by the soil borne disease organisms. In heavy soils that crust after a rain, pre-emergence kill is sometimes unusually severe and 50% or more of the stand may be lost.

Another cause of stand failure is seed rot. Flax seed is invaded by soil-borne fungi during early stages of germination and the embryo is killed before it sprouts. Although damaged, cracked seed is particularly liable, even the best seed may fail to germinate because of seed rot by soil-borne fungi.

Control

No practical means of control is known that will prevent seedlings from being killed by soil-borne fungi. Seed rot, however, may be controlled partially with seed treatments, such as Ceresan M, Panogen, or Captan. These fungicides prevent fungi from invading seed by disinfecting the soil surrounding the seed.

Table 1. Percent Emergence of Flax Seedling from Cracked and Uncracked Seed in Steamed and Unsteamed Field Soil*

Treatment	Unsteamed field soil		Steamed field soil	
	Cracked	Uncracked	Cracked	Uncracked
No seed treatment	4	46	87	95
Panogen	48	57	50	92
Orthocide 75	42	63	72	87

*Steaming soil kills soil-borne disease organisms that cause seedling blight.

Cracked and damaged seed is particularly benefited by seed treatment. Emergence of healthy seedlings is improved when cracked seed is treated and planted in soil that harbors the seedling blight fungi. In steamed soil, however, percent emergence from cracked seed is almost as high as emergence from sound seed (table 1). This indicates that cracked seed is not inherently low viability seed, but rather that fungi in field soil invade the damaged seed and kills it. Since most seed lots contain some damaged seed, treat them with fungicides to improve germination and emergence.

Many Problems Remain Unsolved

Several questions remain unanswered about the seedling blight problem in South Dakota. Why does it occur sporadically? Why is it unusually severe some years while in other years, practically non-existent? Why are some fields severely affected while neighboring ones remain unscathed? What factors or combination of factors such as soil temperature, moisture, fertility, seed bed preparation or crop rotation sequences influence severe outbreaks of the disease? Answers to these questions are being sought under Experiment Station research projects in the Plant Pathology Department. Eventually, these answers will support logical recommendations for practices that will lead to effective control of seedling blight.

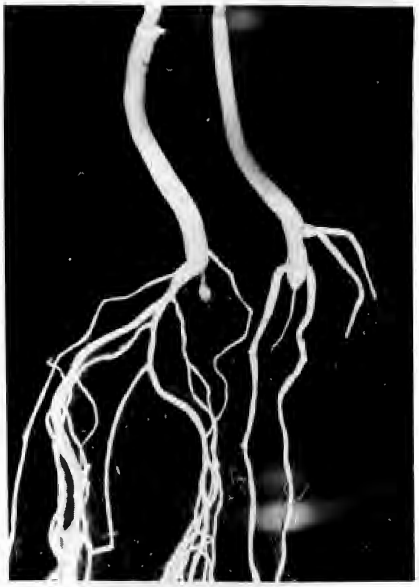
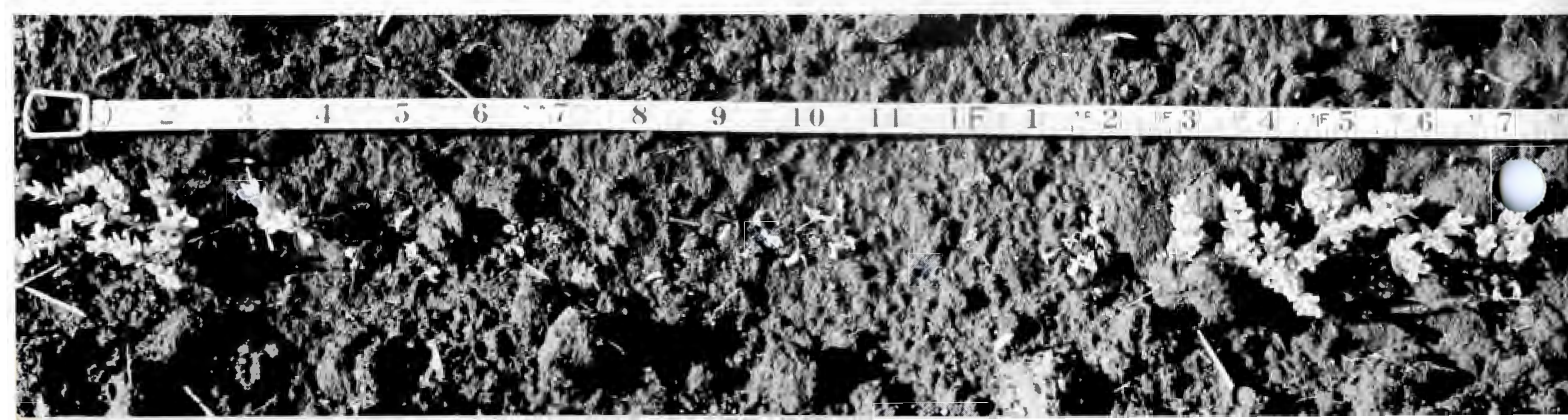


Figure 3. Roots growing from the zone above the portion of flax seedlings rotted off by the seedling blight fungus. Such flax plants manage to survive, but they remain stunted throughout life.

Figure 2. A 10-inch section of a row of flax destroyed by Seedling Blight. These seedlings were all killed within a 24-hour period. When many such sections are killed in adjacent rows of flax, reduction in stand may be extensive.



Improve Alfalfa Yields

— with optimum plant populations

by M. D. Rumbaugh, *Associate Professor of Agronomy*

Population density is one of the major variables affecting the yield of any crop species.

Maximum production can be attained only when the number of plants per acre is optimum for the environmental conditions under which the crop is grown. This concept is well recognized in the management of the large seeded grains, such as corn and sorghum. With the small seeded legumes, however, little attention is directed toward number of plants per acre except immediately following seeding or when the stand has diminished to where hay production is obviously not profitable.

Population density studies in conjunction with experiments relating yield to various aspects of the vegetative growth of alfalfa were initiated at Brookings in 1960. Plants of Ranger and Teton varieties were started in the greenhouse and transplanted in the spring. The seedlings were planted in cross-checked rows, using four spacings on different plots. These were 42, 21, 10.5, and 5.25 inches. Two replicates contained only alfalfa. The remaining two replicates were over seeded with Nordan crested wheatgrass. Because of inadequate grass stands, the latter two replicates were reseeded with grass in 1961 and not harvested in that year. Those plots containing only alfalfa were harvested in both 1961 and 1962.

Careful and repeated hand cultivation held competition from weed species to a minimum. All plants were cut at the soil surface and forage yield was determined as oven dry tons per acre.

Forage Yields

Average yields of hay for 1961 and 1962 for alfalfa alone and for a mixture of alfalfa and crested wheatgrass at different spacings of the alfalfa are shown in tables 1 and 2. Yields were satisfactory in both years, though higher in 1962 because of the favorable moisture and temperature conditions. In both years the population density of the alfalfa plants exhibited a marked influence upon total dry matter per acre. Table 1 shows that the closest spacing treatment resulted in an average of 4.80 tons per acre more hay than the widest spacing. The difference between the two varieties is not significant.

It is also apparent from the data in table 1 that higher yields would

Table 1. Average Hay Yields for Alfalfa Alone Planted at Four Population Densities. Harvested in 1961 and 1962 at Brookings, South Dakota

Spacing	Alfalfa Plants per acre	Variety: Ranger	Variety: Teton	Average
(In.)	(No.)	(Tons)	(Tons)	(Tons)
42	3,556	.70	.90	.80
21	14,224	1.94	2.02	1.98
10.5	56,895	2.78	2.92	2.85
5.25	227,579	5.63	5.58	5.60

Table 2. Average Hay Yields for Alfalfa and Nordan Crested Wheatgrass Grown in a Mixture at Brookings in 1962

Spacing	Alfalfa Plants per acre	Yield per acre: Alfalfa	Yield per acre: Wheatgrass	Total
(In.)	(No.)	(Tons)	(Tons)	(Tons)
42	3,556	.38	2.60	2.98
21	14,224	1.59	2.16	3.75
10.5	56,895	4.48	.87	5.35
5.25	227,579	5.24	.97	6.21

probably have resulted if still closer spacing had been used. Maximum yields were not obtained with fewer than 227,579 plants per acre. A population density of this level is regarded as the minimum for obtaining high alfalfa hay yields at Brookings in years of normal or above normal rainfall.

Similar results were obtained in 1962 with plots which had been overseeded with Nordan crested wheatgrass. The difference between the lowest and the highest yields of the alfalfa component in table 2 is 4.86 tons per acre. Although the dry matter production of the grass declined as the alfalfa density increased, total hay production was greatest at the closest spacing. In view of these results, it is believed that the stand of the legume is of major consequence in hay production with grass-legume mixtures.

Density of Hay Fields

In order to estimate the stand condition of alfalfa fields currently in use for forage production, plant counts were made at 25 locations in 5 counties in eastern South Dakota. Fields which contained only alfalfa were randomly selected and three to five quadrates at representative sites were recorded. Each quadrate consisted of an area of 4 square feet. The results are shown in table 3.

Fifty-five per cent of the fields sampled had less than 200,000 and 17% contained less than 100,000 alfalfa plants per acre. The range observed was from 72,600 to 468,270. In view of the results obtained at Brookings, it seems probable that many of these fields are producing less than maximum yields. Although the economic loss to farm operators in the eastern part of the state due to less than optimum stands of alfalfa is difficult to estimate, it would appear to be considerable.

In those growing seasons in which moisture is more limited than in the years included in this study, a yield loss would probably not exist. Direct evidence with alfalfa is not available but experience with other forage crop species indicates that yields are maintained rather than depressed by increasing numbers of plants even though soil moisture is deficient. Thus, a field with 300,000 plants per acre would produce as much hay in a drought year as a field with 150,000 plants per acre but would yield more in a favorable season.

In order to obtain and maintain productive alfalfa hay fields, stress these three management techniques: (1) use inoculated seed of a recommended disease resistant, winter-hardy variety, (2) plant the seed in a firm, moist, well-prepared seedbed, and (3) harvest the last cutting prior to September 1.

Always inoculate all legumes with efficient strains of nitrogen fixing bacteria. Maximum yields will not usually be obtained unless nodulation takes place. Sow the seed in well-prepared soil at a depth of ½ inch or less. In most of South Dakota, seeding in early spring is preferred over fall plantings. One pound of alfalfa seed contains approximately 200,000 seeds. Rate of sowing is therefore not a limiting factor in obtaining stands if weather conditions are favorable.

Table 3. Population Density of Alfalfa Hay Fields in Eastern South Dakota in 1962

Plants per acre	Frequency
(No.)	(%)
100;000 or less	17
100,000-150,000	21
150,000-200,000	17
200,000-250,000	8
Above 250,000	38

Once an adequate stand is obtained careful management will assure a longer life for the field. The alfalfa plant must be given time after the last cutting to recover and replenish food reserves stored in crown and root tissues prior to winter. Unless this storage occurs, severe winter kill may result. Three to four weeks of vegetative growth prior to the first killing frost is sufficient.

South Dakota's climate is severe and alfalfa plants must excel in resistance to cold and winter desiccation to survive. Varieties currently recommended for hay production are Ladak, Ranger, and Vernal. Rambler and Teton are suggested for the legume component of pasture mixtures. The performance of these strains has been proved by thorough testing for several years at a number of locations within the state.

Scab to be serious disease problem in '63

SCAB DISEASE is going to be a serious problem for South Dakota small grain farmers this year. Ray Kinch, agronomist in charge of the South Dakota State Seed Testing Laboratory, terms the infection "the worst I have seen in my 15 years experience in the state."

In a survey of 210 samples of wheat, barley, oats, and flax just tested, germination ranged from 24 to 99 percent. The average germination was 82 percent. Wheat averaged 60 to 70 percent germination. "Ordinarily germination on these small grains should average 90 percent or above," he says.

The agronomist said the infection is not confined to South Dakota but is a general condition found in the northern Great Plains states. He found the infection to be a little more severe in eastern South Dakota than in western areas. Unusual weather conditions during the growing season last year aggravated the scab problem.

Durum wheats have been most seriously infected

Estrus Synchronization

an experiment which could lead to better timed swine breeding and farrowing

Authors

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The idea of controlling the heat period of farm animals is not new, but intensive research in this area was not initiated until recently. As interest in artificial insemination increased, the desirability of controlling (synchronizing) the estrus cycle of swine became evident.

It was soon discovered that boar sperm could not be frozen and still retain their fertilizing capacity in a similar manner as used for dairy cattle or beef cattle sperm. While research in this country on freezing boar spermatozoa is making progress and scientists are optimistic, there has been no major breakthrough in keeping the sperm viable beyond 2 to 4 days after collection.

Controlling the heat cycle would greatly enhance the artificial insemination program, especially if fresh semen must be used. Knowledge of the time of heat would permit the scheduling of semen collection, delivery to the farm, and insemination of gilts. Several sows and gilts could be bred on 1 day rather than one or two animals at a time.

In addition to aiding the artificial insemination program, synchronization offers more advantages to the swine producer. He can set the time of breeding and farrowing and have all sows and gilts farrow within a relatively short time, or he can "space" the farrowings. Sizes of litters farrowed at the same time would be more uniform, an advantage in management and marketing. Synchronization should virtually eliminate the management problem of keeping a multiple farrowing program on schedule.

We began research on estrus synchronization at South Dakota State in 1960. Five experiments have been completed and two more are in progress. The purpose of the experiments has been to determine the proper level of hormones and the sequence of administering these hormones for satisfactory estrus control.

We administered two hormone-like compounds (6 chloro-6-dehydro-alpha-17-acetoxy progesterone [CAP] and 17 ethynyl estradio), at various levels and for varying lengths of time. CAP exhibits progesterone activity, while ethynyl estradiol has estrogen activity.

Six to eight month old gilts were grouped and checked for heat by vasectomized boars. After their estrus cycles are known, the gilts were allotted on the basis of stage of estrus cycle. It was desirable that each treatment lot have gilts at different stages of the estrus cycle. The hormones were fed by thoroughly mixing them into the feed. While on treatment all gilts were hand-fed 3 pounds of feed twice daily to furnish 6 pounds per head daily. During the period of hormone feeding, gilts were checked for heat with vasectomized boars. After treatment, fertile boars were used for breeding in experiments 1, 2, 3, and 4.

All Gilts Slaughtered

All gilts on experiment were eventually slaughtered. Some were slaughtered during treatment, some were slaughtered at the end of treatment and others after a post treatment heat period (25 days of pregnancy). The reproductive tracts were recovered and evaluated for condition of the uterus, size and number of follicles and *corpus lutea*. Embryos were counted and measured from bred gilts.

Experiment 1 and 2. In experiment 1, CAP was fed at levels of 120, 240, or 540 milligrams (mg.) per head per day, whereas in experiment 2 CAP was fed at levels of 3.25, 16.25, 32.5, or 97.5 mg. per head per day. Ten gilts were fed each level for 18 days. Examination of reproductive tracts in experiment 1 indicated that the levels used were too high.

In experiment 2, five of the remaining six gilts (four were slaughtered during treatment) in the lots given 32.5 mg. daily were in heat within 7 days after treatment. The 97.5 mg. level appeared to be too high, while the 3.25 and 16.25 mg. levels did not inhibit heat.

Experiment 3. CAP was fed at levels of 25 or 50 mg. per day or injected at 12.5, 25, 50, or 75 mg. per gilt daily. Six of 10 gilts fed 25 mg. per day were in heat 5 to 7 days after the termination of treatment and 4 of these conceived. Two of the remaining four gilts were in heat and conceived 1 cycle later. These gilts were synchronized, but failed to exhibit heat of the first cycle after treatment. Two gilts did not return to heat and they were slaughtered 42 days after treatment. Their reproductive tracts appeared normal. The bred gilts were slaughtered at 25 days of pregnancy. They had an average of 12 embryos (range of 7-22).

Only three of 10 gilts fed 50 mg. CAP were in heat within 7 days after treatment. Six were in heat 14 to 27 days after treatment. The reproductive tract of the remaining gilt appeared normal, but three others had cystic ovaries.

Injection of the compound was not effective in controlling estrus.

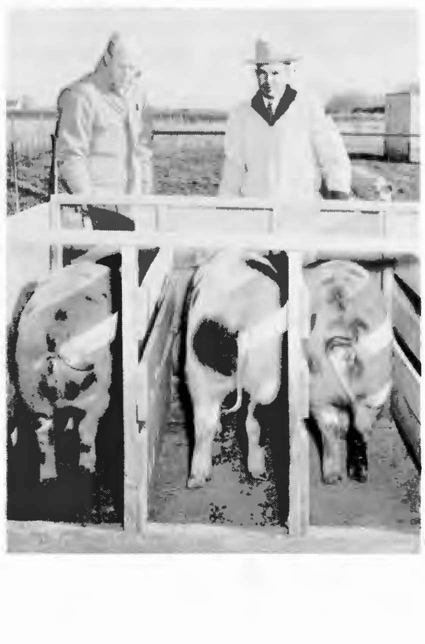
Experiment 4. CAP was fed at the rate of 25 mg./gilt/day simultaneously with one of five levels of 17 ethynyl estradiol (1, 4, 8, 10, or 15 mg./gilt/day) for 18 days to 48 gilts. At least one gilt on each treatment combination exhibited cystic follicles at slaughter. Only 18 gilts returned to heat following hormone withdrawal, with a range of 3 to 28 days elapsing between end of treatment and occurrence of heat. The lowest proportion of gilts returning to heat was observed at the 10 and 15 mg. levels of 17 ethynyl estradiol. Of 15 gilts from which information on fertility was obtained, 14 were pregnant when slaughtered.

The small number of gilts mated on any single treatment combination prevents any conclusions on treatment effects on fertility, although overall conception rate appeared normal. Embryonic survival did not appear to be adversely affected by treatment. Of 20 gilts not exhibiting estrus after hormone withdrawal, 14 had morphologically normal uteri and ovaries and the remaining six exhibited cystic ovaries at slaughter. Reproductive tracts were not recovered at slaughter from five gilts.

When compared to earlier trials synchronization of estrus was not improved by the inclusion of 17 ethynyl estradiol in the hormonal treatment.

Experiment 5. The estrogen, 17

Robert Fritschen and Dr. Seerley observe gilts in this close-up of the stalls. Gilts ate at their leisure and would not permit another gilt to force them out.



Stalls were used to individually feed gilts when hormones were included in the ration. This insured each gilt a full ration, and eliminated the problem of a "boss" gilt. Each stall is 19 inches wide and 6 feet long.

ethynyl estradiol, was fed at either 14 or 20 mg. per head daily for 10 days to 48 gilts, followed by CAP at 25 or 50 mg. per head daily for an additional 10 days. Twenty-nine gilts were expected to be in heat during the 10 day estrogen feeding period, assuming the hormone treatment did not block physical manifestation of estrus. Of these 29, 19 came in heat during this period. The estrus cycle intervals of these animals were 17-22 days, with the exception of two gilts with cycles of 14 and 15 days. No animals exhibited heat during CAP treatment.

Fifteen of 22 gilts (68%) retained for observation on post-treatment response exhibited estrus 4 to 7 days after hormone withdrawal. A sixteenth animal came in heat 11 days after end of treatment. The remaining six gilts had no grossly detectable ovarian defects at slaughter. The incidence of cystic ovaries was greatly reduced from previous trials, as only four of the 48 gilts were cystic at slaughter. No substantial differences in response between treatment combinations were noted.

In conclusion, this series of experiments have provided the following information:

1. Early experiments showed that 25 or 50 mg./head/day of CAP inhibited the estrus cycle in gilts. When CAP was fed alone, especially at high levels, a high incidence of cystic ovaries occurred. Also, apparent silent heat periods after treatment (failure to accept a boar at the first expected heat period, yet showing visual symptoms of heat and followed by a normal second expected heat) were frequent among the gilts.
2. Feeding ethynyl estradiol simultaneously with CAP was not beneficial in eliminating cystic ovaries nor improving synchronization.
3. The sequence of feeding ethynyl estradiol followed by CAP appeared more effective for control of ovarian function than CAP alone.
4. In the small number of gilts bred, conception rates and embryonic survival among the gilts returning to heat appeared to be normal under the regimes tested.

The ovary on the left shows normal functional corpora lutea and developing follicles. The right ovary shows a cystic condition. Enlargement of the follicles was caused by improper hormone treatment.

The experiments in progress are designed to provide more evidence on the value of feeding the estrogen hormone first, followed by the progestrogen. After more evidence of satisfactory heat control is obtained, subsequent experiments designed to critically evaluate fertility will be conducted.

Although the use of a hormone treatment to control estrus and conception in swine is not available to the producer on a practical basis, experimental results at this and other stations appear promising and warrant further investigations in this area.

Oahe Intermediate Wheatgrass: a new opportunity

There will be a new cash crop opportunity available to some farmers and ranchers in South Dakota next year. It comes in the form of certified seed production of Oahe Intermediate Wheatgrass.

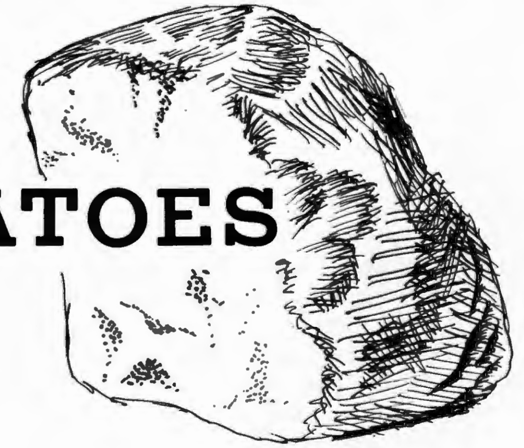
The wheatgrass was developed by grass breeder J. G. Ross of the South Dakota State College Agricultural Experiment Station staff, and released for increase in 1960. It is adapted to all areas of the state.

Oahe is a nutritious and palatable forage for all livestock and has proved itself in Experiment Station test plots around the state. Best of all, breeders have incorporated a high seed yield characteristic into this grass. This factor is lacking in most other types of intermediate wheatgrassses, making seed production expensive and risky.

According to L. O. Fine, head of the Agronomy Department, about 2,500 pounds of seed was released by the Foundation Seed Stocks Division to farmers last fall through county crop improvement associations. Barring adverse weather conditions there should be between 5,000 and 10,000 pounds of seed available to South Dakota farmers and ranchers this fall. Applications for about 8,000 pounds of seed were received last year.

"Since the seed was developed in South Dakota, farmers here will have an initial advantage in getting in on the ground floor for seed production," Fine said.

Control of Decay in Pre-cut SEED POTATOES



by Kenneth D. Fisher

Having seed-potatoes ready to plant is an annual problem for every potato grower. Although the problem can be avoided by use of mechanical seed cutters or use of small tubers instead of seed pieces, the usual practice involves hand cutting larger tubers into 3 to 6 seed pieces. If cutting proceeds too slowly, planting is held up.

Decay may occur in seed pieces cut several days before planting if they are not held at the correct temperature or if they are not properly healed. If adverse weather conditions delay planting, decay of cut seed may be extensive. Seed piece decay contributes to poor stands, as well as reduced yield and inferior quality.

Precutting Avoids Decay

Research at the South Dakota Agricultural Experiment Station indicates these problems can be avoided by pre-cutting seed potatoes, a recent development being adopted in Maine, Idaho, and other potato producing areas. Pre-cutting involves cutting seed potatoes 2 or 3 months prior to planting. There are two major advantages. First, potatoes can be cut in January and February when time is not a critical factor and adequate labor supply is available. Secondly, pieces thoroughly suberized (healed) are less susceptible to seed piece decay if cool, wet weather conditions prevail at planting time.

Dr. Fisher is a former assistant professor of plant pathology

A study of seed piece decay in pre-cut seed potatoes was made in 1961 and 1962. Norland and Red Lasoda, the two most widely planted varieties in South Dakota, were used in all tests. Potatoes were cut in January and February, held at 65°F. for 3 days after cutting, and then replaced in cold storage (40°F.) until 2 weeks prior to June planting. As a check, potatoes from the same lots were held in continuous cool storage and cut 24 hours prior to planting.

Captan Used

In both pre-cut and fresh-cut lots, half of the seed pieces were dipped in 50% Captan (2.5 lbs./100 gallons) for 1 minute immediately after cutting in order to compare treated with non-treated seed pieces. Twenty-five hill plots replicated four times were planted at Brookings. Stand counts were made after emergence. Yield data and percentage of U. S. No. 1 tubers were recorded at harvest time.

Trial Results

The incidence of seed piece decay in pre-cut seed potatoes prior to planting was very low (figure 1). After 90 days storage at 40°F., 98% of the treated and 95% of the non-treated Norland seed pieces were sound. With Red Lasoda, 100% of the treated and 98% of the non-treated seed pieces were healthy. The lack of seed piece decay is attributed to the storage conditions which promoted rapid healing of the cut surfaces. Holding cut seed potatoes at 65°F. for 3 days prior to cool storage is critical. At this temperature healing is relatively rapid and wounds through which decay organisms might enter are corked over.

Plant emergence from pre-cut and fresh-cut seed pieces of both varieties were similar (table 1). Treated pre-cut seed pieces of both varieties produced better stands than non-treated pre-cut seed pieces. Treatment of fresh-cut seed pieces had no effect on plant emergence. From the 1961 data, it appears that seed piece treatment of pre-cut Norland and Red Lasoda tubers pro-

(Continued on page 18)

Table 1. Stand Count 35 Days After Planting of Pre-cut and Fresh-cut Seed Potatoes

Variety	Treatment*	Stand (%) Pre-cut	Fresh-cut
Norland	treated†	87	89
	non-treated	80	89
Red LaSoda	treated	92	87
	non-treated	73	90
LSD 5%: Within cutting time		5	6
Between cutting time		N.S.‡	

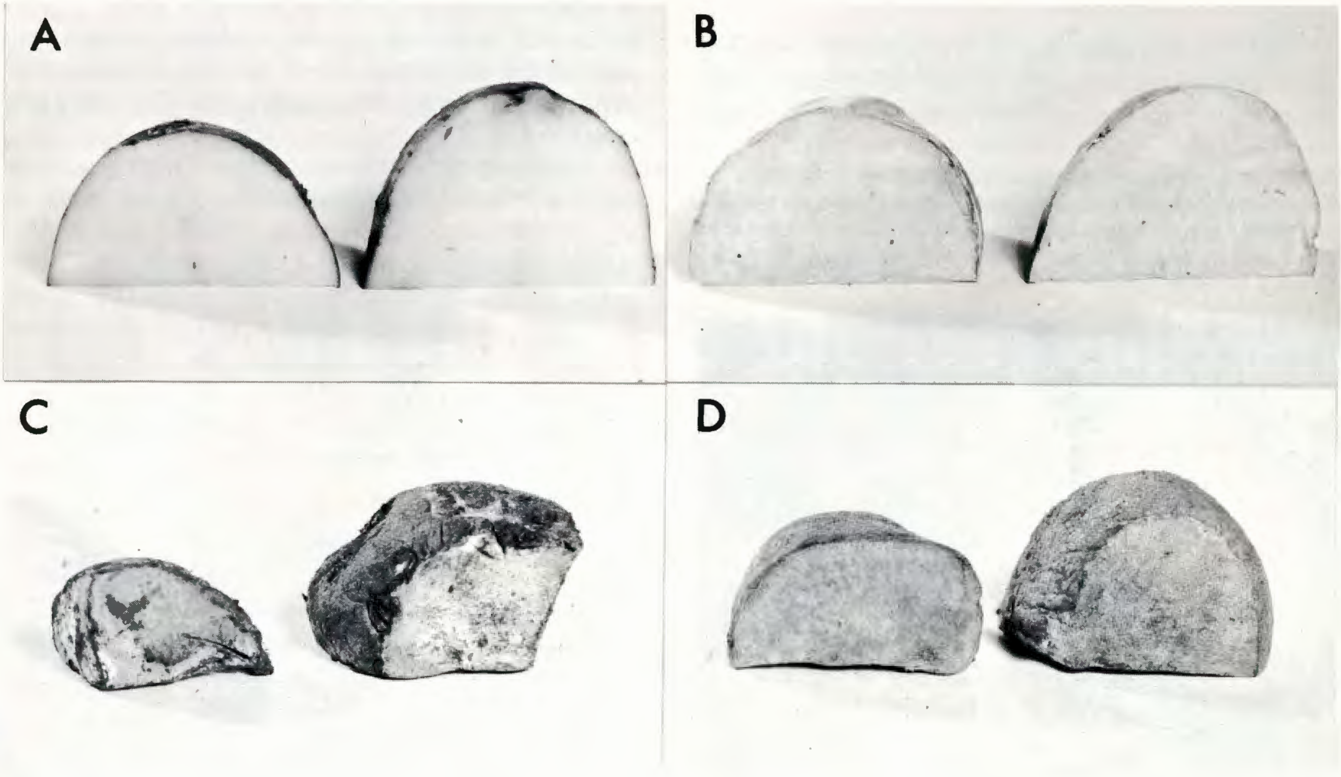
*Mean of four replications each.
†Captan 50% WP dip@2.5 lbs./100 lbs.
‡The differences between numbers in the same column are not large enough to be considered statistically significant.

Table 2. Yield and Percentage U. S. No. 1 Tubers of Pre-cut and Fresh-cut Seed Potatoes*

Variety	Treatment	Yield (Cut/A.) Pre-cut	Fresh-cut	(U. .S. No. 1 (%) Pre-cut	Fresh-cut
Norland	treated†	219	237	88	86
	non-treated	203	202	89	90
Red LaSoda	treated†	241	242	90	94
	non-treated	250	261	93	90
LSD 5%		N.S.‡	N.S.	N.S.	N.S.

*Mean of four replications each.
†Captan 50% WP dip @ 2.5 lbs./100 lbs.
‡Differences between numbers in the same column are not large enough to be considered statisically significant.

Figure 1: Seed pieces cut at planting time, A) non-treated, B) treated with a 7.5% Captan dust. Seed pieces prepared 90 days before planting and stored at 40°F, C) non-treated, D) treated with 7.5% Captan dust.



THAT OLD ELE

by RAYMOND WA

soil testers use new procedure

NITROGEN is one of the most limiting plant food elements in South Dakota soils. For this reason, the Soil Testing Laboratory has developed a testing procedure to evaluate the nitrogen supplying ability of the soil. The new test will enable the nitrogen recommendations to be more dependable.

Four Factors Considered

Several lab procedures have been studied for estimating the available nitrogen supplying power of the soil. Four factors were considered in developing a procedure for routine lab analysis. It had to be (1) accurate, (2) rapid, (3) inexpensive, and (4) related to nitrogen response in the field. The rapid colorimetric organic matter test was selected because it correlated well with nitrogen fertilizer response, and it was easily adapted to routine analysis. Variations of this test are used by soil testing labs in several other states.

The rapid organic matter test involves weighing out a known quantity of soil, and oxidizing the organic matter in the soil with potassium dichromate and concentrated sulfuric acid. When the organic matter is oxidized, the orange potassium dichromate changes to green. The intensity of the green color is measured with a colorimeter (the darker the green, the more organic matter is present).

This method determines the "readily oxidizable organic matter," about 75% of the total soil organic matter.

Organic Matter 6.7% Nitrogen

The relationship of the organic matter content to total soil nitrogen content is shown in figure 1. The high correlation value (0.976) shows that the nitrogen test (organic matter) measures the total amount of soil nitrogen accurately. The relationship also shows that the organic matter in the soil contains about 6.7% nitrogen.

The total amount of soil nitrogen is not available to plants in any one year because it is in the organic form. It is estimated that for medium textured soils (loams and silt loams) 1% of the total organic nitrogen is released for a small grain crop (2% for a row crop) in 1 year.

To illustrate the release of organic nitrogen for an oat crop, select a soil containing 3% organic matter in a plow furrow depth. An acre of soil 6 inches deep weighs 2 million pounds. A soil containing 3% organic matter, therefore, would contain 60,000 pounds of organic matter (2,000,000 x .03). If the organic matter contained 6.7% nitrogen, the plow layer of soil would have 4,020 pounds of nitrogen per acre (60,000 x .067). If 1% of the nitrogen is released per

(Continued on page 14)

Ray Ward, instructor in agronomy, checks here some of the over 8,000 soil samples which have been tested for nitrogen since the new technique was adopted. Farmers send soil in special bags, which can be obtained from County Agents' Offices.

Carson

Ward

Paul Carson is an associate professor of agronomy

Raymond Ward is an instructor of agronomy

ɅENT NITROGEN

ʀᴅ and Paul Carson

Paul Carson, associate professor of agronomy, fills out the recommendation form which is sent out to each farmer who sends in a soil sample. Recommendations are made for phosphorus and potash as well as nitrogen.

recommendations now sounder

THE ARTICLE on the facing page, "Soil Testers Use New Procedure," presents substantial evidence that yield increases from nitrogen fertilizer were related to the organic matter content of the soil. The relationships established will be used to show how nitrogen fertilizer can be used most profitably by South Dakota farmers.

Two management systems were discussed in the article. The continuous cropping system is a rotation of corn-oats, corn-corn, etc., and does not include the use of manure or legumes in the rotation.

The other system presented is that of fallow, where the land was fallowed the year prior to seeding. In all plots studied, the available phosphorus level in the soil was assumed to be adequate, or phosphorus fertilizer was applied so that it would not be a limiting factor for small grain production.

N Returns Increase as Organic Matter Decreases

The calculated return from nitrogen fertilization of small grain on continuously cropped land increases as the organic matter level in the soil decreases (figure 1). The effect of organic matter level on the profitability of three nitrogen rates (20, 40, and 60 pounds per acre) is also shown in this figure. The return from applied nitrogen is calculated as the increase in income above the nitrogen cost.

To calculate the return that could be expected at different nitrogen rates, the average percent yield increase for the three nitrogen rates in relation to the organic matter content was calculated by use of a regression equation.

Yield Increases Calculated

As an example, when an average oat yield of 30 bushels per acre is used, the yield increase at a certain organic matter level can be calculated for the three nitrogen rates. If a soil having 3% organic matter content is used, the yield increases would be 12, 22, and 24 bushels of oats for the 20, 40, and 60 pound rates of applied nitrogen.

Referring to figure 1, if oats were $.60 per bushel, the yield increases would gross an extra $7.20, $13.20, and $14.40, respectively. When a value of $.12 a pound is placed on the nitrogen, the cost of the applied nitrogen is $2.40, $4.80, and $7.20, respectively. Therefore, to find the gain from added nitrogen, the cost of the

(Continued on page 16)

Soil Testers use new procedure—(Continued from page 12)

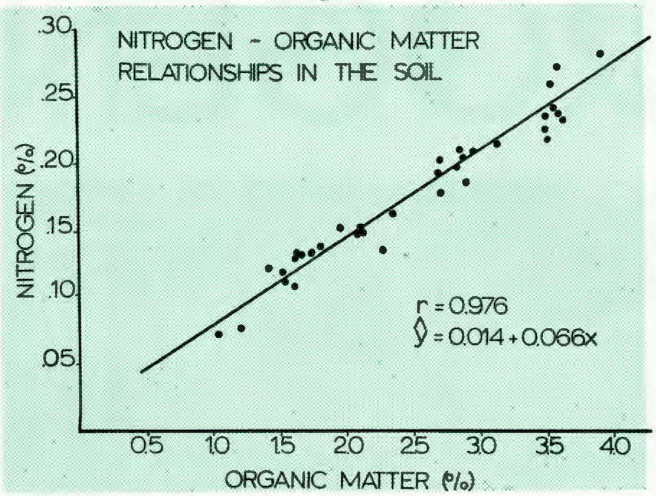


Figure 1. The relationship of the soil organic matter content to the total supply of nitrogen in the soil.

year, the oats crop will have 40 pounds of nitrogen for growth.

A 48 bushel oat crop will use about 40 pounds of nitrogen. An additional 26 pounds of nitrogen will be used for an 80 bushel yield. As the plant is able to take up about 60% of the added nitrogen, an additional 40 pounds would have to be applied to supply the plant with the 26 pounds needed to increase the yield to 80 bushels.

The influence of organic matter on the response of small grain to nitrogen fertilizer is presented in figure 2. The percent yield increase to 40 pounds of nitrogen produced two different regression lines. These lines are the effect of the past cropping history. The lower line was an effect of fallow the year previous to the small grain crop. Continuous cropping without the use of legumes, manure, or nitrogen fertilizer in previous years produced the relationship of the upper line.

More Organic Matter, Less Response to N

Continuous cropping (upper line) shows a highly significant correlation between yield increases from applied nitrogen and soil organic matter content. As the amount of soil organic matter increases the expected yield increase from nitrogen will decrease. The points on the figure for continuous cropping show the response to nitrogen and organic matter content for each field plot studied. Although scattered, the points are the significant correlations that show, on the average, nitrogen response will decrease as organic matter increases. Therefore, the response to nitrogen at a certain organic matter content would be determined by use of the continuous cropping line.

110% Response with 2% Organic Matter

For example, if a soil contains 2.0% organic matter, the expected response to nitrogen would be 110%. If an average of 10 bushels of wheat is grown on this field, a nitrogen addition (40 pounds in this case) would give an increase of 11 bushels wheat. A 21 bushel wheat yield would result with nitrogen fertilizer under average conditions of continuous cropping, non-legume rotations, and no applications of manure.

Fallow, in the preceding year, influences the nitrogen response greatly. The lower line of figure 2 represents the fallow system. The correlation of percent yield increase to organic matter in the soil was highly significant. As under continuous cropping, the nitrogen response decreases with an increase in soil organic matter.

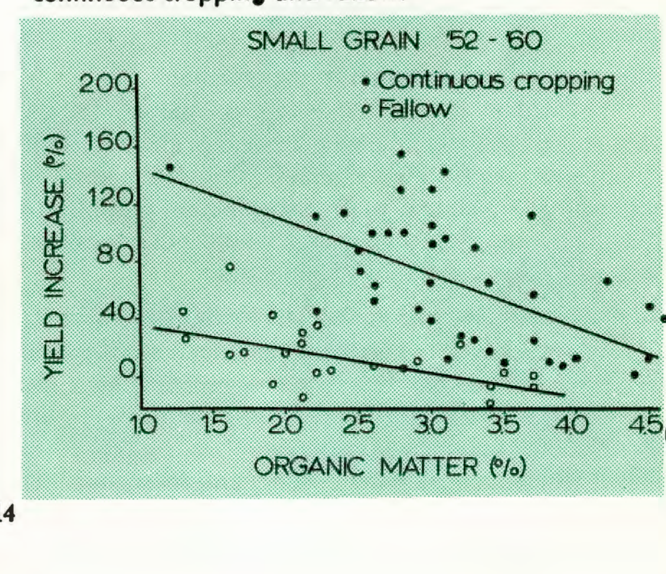
A soil with 2% organic matter under fallow will show a 20% yield increase with nitrogen fertilizer (40 pounds in this case). The 20% yield increase was determined by using the fallow line (lower line). If a wheat yield of 20 bushels was produced on the field without nitrogen, a 4 bushel yield increase could be expected, with an addition of the fertilizer.

3.2% "Breakeven" on Fallow

Under fallow, an organic matter content of 3.2% is the break-even point as far as nitrogen responses are concerned. If a soil contains more than 3.2% organic matter, nitrogen fertilizer is likely to decrease the yield of small grain.

Several factors affect the release of organic nitrogen in any one year. One is the texture of the soil. Coarse textured soils will release more nitrogen in a year than fine textured soils, if the organic matter content in the soil is the same. A sandy loam soil may release up to 2% nitrogen for a small grain crop, while

Figure 2. The relationship of the soil organic matter content to the percent yield increase from 40 pounds of applied nitrogen on the soil management systems of continuous cropping and fallow.



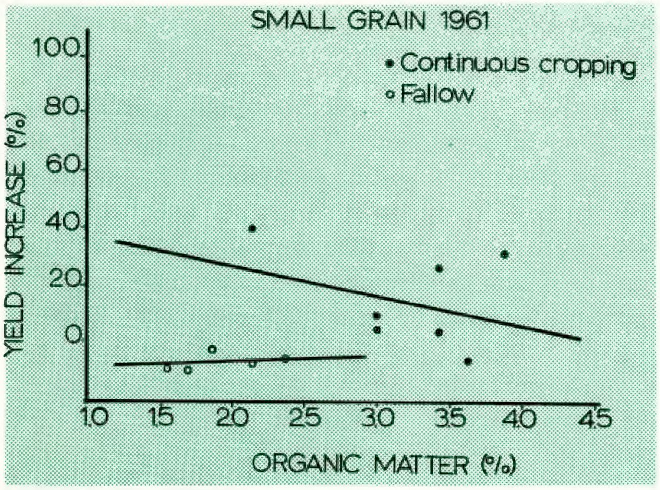


Figure 3. The relationship of the soil organic matter content to the percent yield increase from 30 pounds of applied nitrogen on the soil management systems of continuous cropping and fallow in 1961.

a clay soil may release only 0.5% nitrogen for a small grain crop, if the soil contains the same amount of organic matter and the soils are on similar slopes and drainage patterns.

Cropping History Important

Cropping history is the second factor to consider, (figure 2). Under fallow conditions, where there is a two years' supply of available nitrogen for one crop, the yield response to nitrogen fertilizer was much smaller. When legumes (alfalfa or clover) precede the small grain crop, a generous supply of nitrogen will be available to the crop. This is due to the nitrogen fixing ability of the microorganisms (Rhizobia) associated with the legume, and also the higher nitrogen content of the plant material plowed under.

The effect of the past use of legumes, manure, and fallow cannot be measured by the nitrogen test, but these factors are important considerations when recommending nitrogen fertilizer. The only information agronomists have about these factors is the information on the "Soil Sampling Information Sheets." It is important therefore that the information sheets be filled out as completely and accurately as possible when submitting soil samples.

Climate Studied

Climate is the third factor that influences the release of soil nitrogen, and the response to nitrogen fertilizer. Figures 3 and 4 illustrate the effect of rainfall on nitrogen fertilizer response.

The growing seasons encountered in 1961 and 1962 were quite different. In 1961 the soil moisture supply was limited in most areas of South Dakota, compared to the adequate soil moisture supply in 1962. Under fallow conditions when the yield of small grain is limited by moisture, the available nitrogent supply in the soil is large enough for maximum crop yields. But when the yield is not limited by moisture, the available nitrogen supply in the soil will not be enough so that crops can reach maximum yields without additional nitrogen.

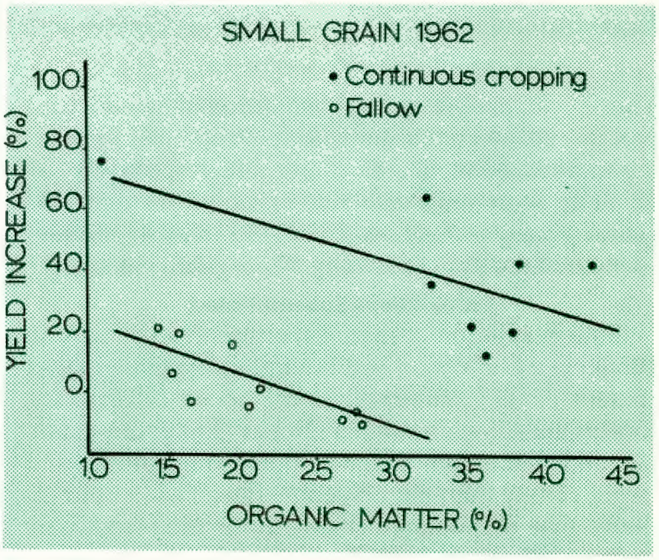


Figure 4. The relationship of the soil organic matter content to the percent yield increase from 30 pounds of applied nitrogen on the soil management systems of continuous cropping and fallow in 1962.

The relationship of the small grain yield increase on continuous cropping from applied nitrogen to the soil is good. The continuous cropping curves (upper lines of figures 3 and 4) are about parallel, indicating that a true relationship does exist between nitrogen fertilizer response and organic matter content in the soil. Because of the low soil moisture level in 1961, the response to nitrogen fertilizer was less. At 2% organic matter, there was a 30% yield increase in 1961, compared to a 60% increase in 1962.

Rainfall More Critical on Fallow

Rainfall during the growing season influenced the response to nitrogen more drastically on fallow. In 1961, nitrogen additions depressed the yields at all levels of organic matter. The response in 1962 did show an increase in yield at the lower organic matter levels. These results verify the fact that the available soil moisture supply has an effect on the yield response of small grain to additional nitrogen.

The fourth influencing factor concerning the amount of nitrogen that is released in one year is the type of crop grown. As mentioned before, about 1% of the organic nitrogen is released in 1 year for a small grain crop and about 2% for a row crop. For established grass pastures about 0.5% organic nitrogen is released in 1 year.

Recommendations now sounder—(Continued from page 13)

nitrogen would be subtracted from the gross return. The 20, 40, and 60 pounds of nitrogen would then produce an additional income above its cost, amounting to $4.80, $8.40, and $7.20 per acre, respectively.

The most profitable rate of added nitrogen to small grain for the period 1952-1960 was 40 pounds per acre on a soil containing 3% organic matter.

Calculations Substantiated

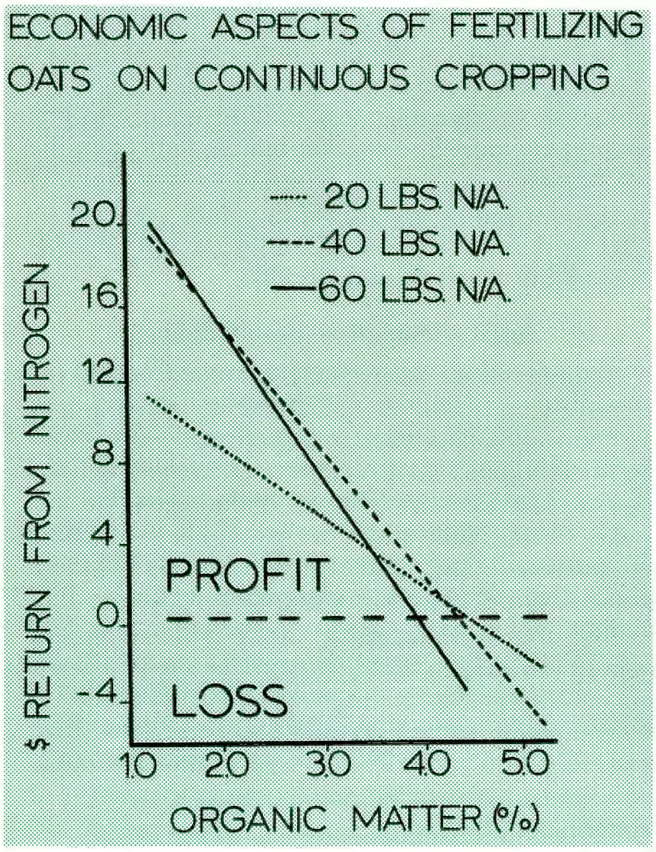
The results of a field experiment with oats in Brookings County on soil having an organic matter content of 3.2% substantiate the above calculations. Results are shown in table 1. Notice that in this example, added nitrogen at the 60-pound rate produced a larger return than the 30-pound rate. This would indicate that 60 pounds per acre or a rate somewhere between 60 and 30 pounds would produce the maximum yield increase or gain for a soil containing 3.2% organic matter.

60 Pound Rate Not Justified

The gain from using 60 pounds of nitrogen per acre is higher than 40 pounds when soil has less than 2% organic matter; however, the increased gain is so small that it does not justify the risk involved by using the 60 pound rate. The figure shows that 40 pounds of nitrogen will be profitable on soils having an organic matter content of 4.2% or less. Additions of nitrogen fertilizer on soils containing 4.2% or more organic matter are not likely to be profitable. At organic matter levels between 3.5% and 4.2%, nitrogen applied at rates of less than 40 pounds per acre may be more profitable. This will depend somewhat upon the past management of the soils tested.

The economic aspects of applied nitrogen on fallow land are shown in figure 2. This figure is similar to figure 1 in that the return from fertilizer nitrogen is shown in relationship to the organic matter level in the soil. An average wheat yield of 12 bushels per acre without added fertilizer nitrogen served as a basis for the calculation of the return from the nitrogen. Twenty and 40 pound rates of nitrogen were studied in this case.

Figure 1. The influence of organic matter on the return obtained from 20, 40, and 60 pounds of nitrogen applied on continuously cropped land for the production of oats. The average oat yield without applied nitrogen is 30 bushels per acre and the price per bushel is $.60. Cost of the nitrogen is $.12 per pound, including application.



20 Pounds Best on Fallow

Nitrogen applied at the rate of 20 pounds per acre was found to be the optimum rate on the fallow system (figure 2). A gain may be expected on a soil containing less than 2.8% organic matter when 20 pounds of nitrogen is applied.

The yield increase from 30 pounds of nitrogen on wheat in Harding County (table 2) in 1962 serves to verify the calculations represented in figure 2. Notice that the yield on the plot with no additional nitrogen in table 2 (39 bushels per acre) was much higher than on the long time average yield (12 bushels per acre) used in the calculations for figure 2.

'62 Moisture Gives High Check

In this example, the check yield was much higher because of the abundant supply of moisture in 1962. A return of $2.40 per acre above the cost of 30 pounds of nitrogen is similar to what can be expected on the average (about $2.50) when the soil organic matter level is 1.6%.

Return from additional nitrogen in a continuous cropping system can be influenced by factors other than the organic matter content of the soil. Two of these are the use of legumes in the rotation and application of manure. Legumes release considerable amounts of nitrogen for crop growth that are not reflected in the organic matter test. The effect of the legume crop will usually last 3 or more years. When having a soil tested, it is important to identify the

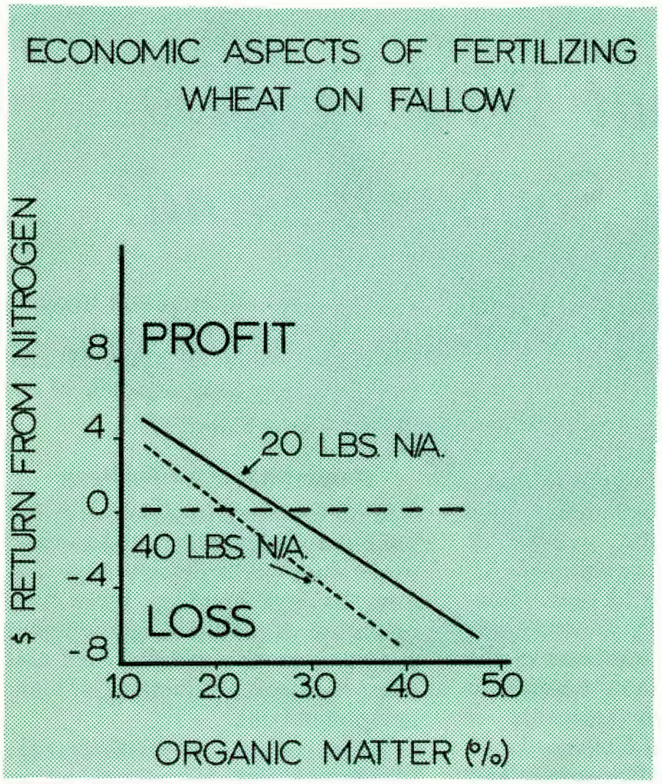


Figure 2. Influence of organic matter on the return obtained from 20 and 40 pounds of nitrogen applied on fallowed land for the production of wheat. The average wheat yield without applied nitrogen is 12 bushels per acre and the price per bushel is $2.00. Cost of the nitrogen is $.12 per pound, including application.

year the legume was grown so that the nitrogen supplied by the legume crop can be fully evaluated.

Adjust for Manure Application

Barnyard manure also influences nitrogen supplying ability of a soil. Each ton of manure supplies about 10 pounds of available nitrogen. If sizable amounts of manure are applied to the soil, the addition of nitrogen fertilizer should be adjusted accordingly.

Fertilizer nitrogen applications may be cut in half or completely dropped if the evaluation of the past management shows that more nitrogen is released in the soil than would be released under average cropping conditions. The organic matter soil test and the evaluation of the past soil management by the State College Agronomists can give you a good, profitable nitrogen recommendation for small grain crops.

The most promising rate of nitrogen fertilizer appears to be 40 pounds of nitrogen per acre on continuous cropping without the use of legumes or manures. There normally is a return above the cost of applying 40 pounds of nitrogen on soils containing less than 4.2% organic matter. At higher levels of organic matter, it is usually not profitable to apply additional nitrogen.

Twenty pounds of nitrogen per acre appears to be best on small grain under a fallow system. A return above the cost of applying 20 pounds of nitrogen per acre can be expected on fallowed soils with less than 2.8% organic matter.

Table 1. The Influence of Nitrogen Fertilizer on the Yield of Minhafer Oats in Brookings County During 1961*

$N + P_2O_5 + K_2O$	Yield	Increased yield	Increased gross return†	Cost of nitrogen‡	Increased return from applied nitrogen
lbs./A.	bu./A.	bu./A.	$	$	$
0+30+0	38	—	—	—	—
30+30+0	56	18	10.80	3.60	7.20
60+30+0	65	27	16.20	7.20	9.00

*Plot was located on a Vienna loam with an organic matter test of 3.2%. The plot was corn in 1960.
†Price of oats was $.60 per bushel.
‡Cost of nitrogen was $.12 per pound, including application.

Table 2. The Influence of Nitrogen on the Yield of Lee Wheat in Harding County During 1962*

$N + P_2O_5 + K_2O$	Yield	Increased yield	Increased gross return†	Cost of nitrogen‡	Increased return from applied nitrogen
lbs./A.	bu./A.	bu./A.	$	$	$
0+20+0	39	—	—	—	—
30+20+0	42	3	6.00	3.60	2.40

*Plot was located on a Morton loam soil with an organic matter test of 1.6%. The plot was fallow in 1961.
†Price of wheat was $2.00 per bushel.
‡Cost of nitrogen was $.12 per pound, including application.

SEED POTATO DECAY

(Continued from page 10)

motes better stand (table 1). However, treatment of fresh-cut tubers did not affect stand under conditions of these experiments.

There was no significant differences in total yield and percentage U. S. No. 1 grade tubers between pre-cut and fresh-cut seed of either variety. Differences between treated and non-treated seed pieces were not significant. Differences in stand between treated and non-treated pre-cut seed pieces did not appear to affect total yield and percentage U. S. No. 1 tubers.

Agree with MAES

Results of these experiments agree with recent investigations at the Maine Agricultural Experiment Station. Pre-cut seed may yield as well as regular seed, provided the pre-cut seed pieces are properly healed, stored, and are healthy when planted. Further work is necessary to determine if seed piece treatments would be required for other varieties of potato. For three years the Plant Pathology Department at State College has pre-cut and treated many experimental selections and lines of both red and white potatoes. Loss due to seed piece decay has never been a serious problem.

Advantages of pre-cutting seed potatoes should not be overlooked. Growers who wish to use this method are advised to try only a small quantity of seed the first year. The following procedure is recommended:

1) Cut seed potatoes directly from cold storage.
2) Treat cut seed pieces.
3) Place seed pieces in a room at 60-65°F. where relative humidity (75-100%) and adequate ventilation are present. A small fan is sufficient for 1 to 300 pounds of seed. It would be best to spread the seed pieces out so cut surfaces do not stick together.
4) After three days at 60-65°F., store at 40°F. until planting time. *The holding period at 60-65° is very important.* This temperature is essential for suberization. If healing does not occur, seed piece decay will not be retarded.

What Will You Do With Soilbank Land?

WHAT WILL you do with land coming out of soil bank contracts during 1963? That was the question kicked around by a group of panelists at a crop, weed, and pest control conference held recently on the campus of South Dakota State.

Panel members included a farm management spelialist, a livestock specialist, and an agronomist. All have had more than 10 years of experience with South Dakota agriculture and all are members of the Cooperative Extension Service or Experiment Station segments of South Dakota State College. L. O. Fine, head of the Agronomy Department was moderator.

Six Alternatives

Extension farm management specialist Art Anderson said there are about six alternatives that a farmer or rancher might consider. He could leave it in the soil bank—if contracts are extended; use it for pasture; use it for hay; use it for seed production; incorporate it back into the cropping program; or use the land for recreational development.

"The one he picks should be determined by considering a number of factors," Anderson said. Payment for soil bank acres in South Dakota ranges from $5.77 per acre in Fall River County to $16.07 per acre in Lincoln County. The average payment rate for South Dakota in 1962 was $10.47 per acre.

Schubeck Agrees

Fred Schubeck, experiment station agronomist, felt the first the best alternative, especially if land is subject to wind and water erosion. Other good reasons for putting it back in the soil bank might be if the land has extreme slopes in it that make it hard to farm or if it contains low spots where drainage is a problem.

Jim O'Connell, extension livesock specialist, commented on the livestock inventories in South Dakota and present grazing capacity of existing range and pasture.

Opportunities for Beefmen

"For the beef producer the soil bank acres present an opportunity to produce more pasture hay, legume, haylage or silage for a beef operation. In addition, government programs favor expanded beef and other livestock production," O'Connell pointed out.

"Most pastures in South Dakota are either already overgrazed or stocked to the hilt right now. Even a slight drought could make the pasture situation acute on many farms," he said.

Grass seed production is a possibility for some farmers and ranchers. Certified grass and alfalfa seed, the kind in demand by eastern markets, could provide good cash income for some who like this type of farm operation.

Another alternative is to get this land back into the cropping program of the farm. For soils with medium textures, fairly good drainage but no erosion problem, cropping may easily be the best alternative," according to Schubeck.

Handling Claypans

He suggested several alternatives for handling land containing clay pan or slick spots. Experiments indicate that wedges of organic matter placed every few feet in clay pan soils have helped increase yields in these areas. Researchers are not certain about the best method for farming these areas so that the wedges continue to serve their purpose over a long period but without interfering with other steps of the farm operation.

Comparing genetic differences of laying hens

by Walter Morgan

Egg production can be increased either by changing the environment of the chicken or by changing the chicken, genetically. Although feeding, housing, and management have an important influence on the production of the flock, this article is concerned with methods for evaluating improvements attributable to breeding. Genetic differences occur when the breeder practices selection or uses different mating types, such as inbreeding and crossing.

Flock Averages Important

When attempting to improve egg production through breeding, it is more meaningful to consider flock averages rather than the performances of individual hens to measure qualities such as egg size, hen-day production, adult weight, and broodiness. This is true for a number of reasons. Hens have a relatively short life cycle of approximately 18 months, and investment per hen is low compared to other livestock on the farm. If one particular hen is being observed and she dies, then all of the data are lost. Also, for the many qualitative characters related to egg production, larger numbers of hens produce more valid averages than do smaller flocks or single hens.

Even the averages of relatively large flocks of hens are meaningless unless they can be compared to something. A given year's performance could, for example, be compared to the performance of previous years; but the early fluctuations measured by this method may be primarily due to environmental changes rather than to changes initiated by breeding improvement. In order to have a dependable standard, or yardstick, for measuring breeding improvement, it is desirable to have a control stock with which the different experimental genetic combinations may be compared.

Standards Being Raised

An old cliche states that "nothing is good or bad—except by comparison." Thus, 20 years ago an average egg production of 220 eggs per year for a flock would have been exceptionally outstanding. By our present-day standards 220 eggs would be a good average, but not exceptional. Flexibility of comparisons is good, but should not be used to cover up the actual quantitative improvements.

New Selection Tool

Thus, flock improvement selections have been based upon changing standards of performance. Originally, much progress was gained by individual selection; the hen which laid the most eggs was the best hen irrespective of whether she weighed five pounds or eight pounds and irrespective of whether her sisters laid many or few eggs. More recently, rate-of-production has been used as a tool for selection purposes. Within the past five years a shorter period of time for measuring production rate has been used. With this method it is not necessary to wait until hens are two years old before progeny can be saved.

What then should be considered as the yardstick, or "control," for specifically measuring the genetic change in a breeding program? Generally, geneticists considered that differential performances come under the influence of (1) the genetic make-up of the hen, (2) the effect

Dr. Morgan is a professor of poultry science of the environment, and (3) interactions between these two.

In any program for comparison such as the one involving a comparison of the egg laying performance of hens from different breeding combinations, it is desirable to reduce the effect of the environment (2 above) to a minimum. If all of the stocks being tested are exposed to the same variables (temperature changes, etc.) valid comparisons can be arrived at. Errors in comparisons that result from environmental variables can be minimized by using certain statistical tools.

Trials at Four Stations

It is much more satisfactory to the poultryman if he can compare original performance summaries, such as egg production, before they have been subjected to mathematical correction factors. On the other hand, the correction factors themselves must be formulated, and the most common method for doing this is to attempt to reduce the variables to one and use the value of this correction factor as a basis for recalculation. An example of this is found in the experimental trials at four substations in South Dakota (Cottonwood, Eureka, Highmore, and Newell) where the performances of flocks of hens which were derived from different breeding combinations are currently being evaluated.

Facilities Standardized

In the trials with flocks at Cottonwood, Eureka, and Highmore, we attempt to keep environmental (non-genetic) variables low by standardizing the facilities. Each station has a hen-house divided into four pens of equal size. Each pen holds 60 hens and allows approximately 3⅓ square feet per hen; the flocks at each substation total 240 hens. Equipment is essentially the same at each station. All of the hens for these three substations are hatched at the same time, in mid-April, eliminating the necessity of providing a correction factor for the effect of different hatching dates upon eventual egg production—and there is a difference. Then, all of the chicks are brooded and raised together; thus being exposed to the same environmental fluctuations. At housing time, they all are vaccinated and transported by truck from the Experiment Station at Brookings to the substations. Laying mash for all of the hens throughout the laying year is prepared at Brookings and all receive the same mash diet.

Although efforts are made to reduce variables to a minimum, some differences are not subject to control. For example, each substation has a different caretaker and there are differences in structural materials for the hen houses, in local water content, and in length of time required to truck the pullets from Brookings to the substation. Even if all of the chickens were from a common breeding stock, the four pens of hens at Eureka would probably have different monthly averages than would the hens at Cottonwood or Highmore. These differences in egg production, which are due to environmental (temperature, particularly) and interracting genetic - environmental differences, (which might be associated with management), are subject to year-to-year fluctuations but are usually relatively small.

"Yardstick" Established

A policy in practice at the substations is to have a common stock at two or more stations to measure these differences, if they do exist. The relative performance of these hens (one pen of 60 hens at each of the stations) is used to measure the location differences. In 1955, for example, single-cross hens from Rhode Island Red SD-11 and Barred Plymouth Rock SD-21 were at each of three substations. In addition, three other mating types were distributed at each of the stations. During the 1955-1956 test year, ten mating types were represented at the three substations. Any differences in the common stock averages served to measure the location differences, and also served as a "yardstick" to measure the genetic differences in the other nine pens.

Averages for the SD-11 X SD-21 stocks are given in table 1; the numbers in parentheses represent individual pen deviations from the SD-11 X SD-21 overall average for all three substations. Table 2 presents a similar comparison except that the values are averages from all four pens at the substations rather than from only the common stock (SD-11 X SD-21) pen.

Averages from each of the 12 pens are included in table 3. It shows that the individual pen deviations, again in parentheses, are much greater when compared to the station averages than are the deviations of a given control stock between stations as presented in table 1. The small deviations in table 1 increase confidence in the use of this single-cross stock as a yardstick for purposes of comparison.

Random Mating at Cornell

Several years ago poultry geneticists in the United States realized that a common control stock which could be distributed widely to experiment stations in the nation would serve a useful purpose. Several strains of White Leghorns were bred together over a 2-year period at Cornell University. From this origin a large population of randomly mated (without selection) chickens has been established.

A flock of these Random Control White Leghorns is maintained at the South Dakota Experiment Station at Brookings. During the 1959-1960 test year, a pen of these purebred controls was sent to each of the four test stations; Highmore, Eureka, Cottonwood, and Newell. Their performances are recorded for measurements of egg size, hen-day production, adult weight, and broody hens. The performance averages of the control stock are included in table 4. A few correction factors are suggested by these data. At Cottonwood, in 1959-1960, egg-size was significantly higher than would be expected. Consequently, a lowering of the values by approximately 1 ounce per dozen for each of the four pens at Cottonwood would be feasible. Similarly a raising of the value for hen-day production is indicated by the deficit deviation for the Random Control White Leghorn pen at Cottonwood. It is inter-

Table 1. Performance Averages for Singlecross SD-11 X SD-21 Hens at Three Different Locations, 1955-56

	Pen averages			Average for all
	Cottonwood	Eureka	Highmore	stations
Egg size*	25.2(—0.1)	25.2(—0.1)	25.6(+0.3)	25.3
Hen-day production	50.8(+0.1)	50.3(—0.4)	51.0(+0.3)	50.7
Adult weight	6.4(+0.1)	6.3(0.0)	6.1(—0.2)	6.3
Broody hens	22.0(+4.0)	14.0(—4.0)	19.0(+1.0)	18.0

*Egg size is in units of ounces per dozen, hen-day production is percentage, adult weight is in units of pounds and broody hens is the number of hens brooding.

Table 2. Performance Averages Arranged by Substation, 1955-56

	Pen averages			Average for all
	Cottonwood	Eureka	Highmore	stations
Egg size*	25.3(—0.1)	24.9(—0.5)	26.0(+0.6)	25.4
Hen-day production	52.5(+0.6)	53.2(+1.3)	50.1(—1.8)	51.9
Adult weight	6.0(0.0)	5.8(—0.2)	6.1(+0.1)	6.0
Broody hens	6.8(—1.3)	7.3(—0.8)	10.3(+2.2)	8.1

*Same footnote as table 1.

Table 3. Performance Averages Arranged by Test Groups, 1955-56

	Pen				Average for all
Cottonwood	1	2	3	4†	pens
Egg size*	25.8(+0.5)	23.2(—2.1)	27.1(+1.8)	25.2(—0.1)	25.3
Hen-day production	53.3(+0.8)	55.4(+2.9)	50.5(—2.0)	50.8(—1.7)	52.5
Adult weight	6.2(+0.2)	4.7(—1.3)	6.7(+0.7)	6.4(+0.4)	6.0
Broody hens	1.0(—5.8)	0.0(—6.8)	4.0(—2.8)	22.0(+15.2)	6.8

	Pen				Average for all
Eureka	1	2	3	4†	pens
Egg size	26.4(+1.5)	23.9(—1.0)	24.1(—0.8)	25.2(+0.3)	24.9
Hen-day production	49.8(—3.4)	51.4(—1.8)	61.4(+8.2)	50.3(—2.9)	53.2
Adult weight	6.3(+0.5)	6.2(+0.4)	4.4(—1.4)	6.3(+0.5)	5.8
Broody hens	8.0(+0.7)	6.0(—1.3)	1.0(—6.3)	14.0(+6.7)	7.3

	Pen				Average for all
Highmore	1	2†	3	4	pens
Egg size	25.6(—0.4)	25.6(—0.4)	26.4(+0.4)	26.4(+0.4)	26.0
Hen-day production	47.4(—2.7)	51.0(+0.9)	53.9(+2.8)	48.0(—2.1)	50.1
Adult weight	6.0(—0.1)	6.1(0.0)	6.1(0.0)	6.1(0.0)	6.1
Broody hens	8.0(—2.3)	19.0(+8.7)	8.0(—2.3)	6.0(—4.3)	10.3

*Same footnote as table 1.
†Pens containing SD-11 X SD-21 hens.

Table 4. Performance Averages of Random Control White Leghorns Arranged by Substations, 1959-60

	Cottonwood	Eureka	Highmore	Newell	Average for all stations
Egg size*	25.4(+0.9)	24.1(—0.4)	24.2(—0.3)	24.1(—0.4)	24.5
Hen-day production	55.9(—3.9)	64.2(+4.4)	59.5(—0.3)	59.4(—0.4)	59.8
Adult weight	4.5(+0.1)	4.4(0.0)	4.5(+0.1)	4.1(—0.3)	4.4
Broody hens	3.0(—1.8)	5.0(+0.2)	3.0(—1.8)	8.2(+3.4)†	4.8†

*Same footnote as table 1.
†There are 80 hens per pen at Newell instead of 60. Consequently these numbers have been adjusted to a flocksize of 60.

esting to note that the values for egg-size and hen-day production vary inversely, as would be expected.

Broody at Newell

With the possible exception of Newell, no correction for adult body weight is indicated by the data. A disproportionately large number of hens was broody at Newell; however, only a small percentage of hens in all four of the pens had broody periods.

By using this yardstick control stock, the Random Control White Leghorn, it is now possible to compare changes brought about when employing many different mating systems and methods of selection with systems used by other experimenters. Not only can the productive performance traits at different locations (substations) within South Dakota be compared, but results in South Dakota can be compared with results in other states. Hens from this control stock have been entered by Cornell and Purdue in national tests in which commercial stocks participate. The Regional Control White Leghorns are being maintained by matings of designed randomization at Purdue to provide available reintroduction of the stock whenever and wherever needed. This means that year-to-year comparisons as well as locational comparisons may be made. To date, this provides the most stable control for comparing progress, or regression, which is available.

Time Will Tell

It may be that when a relatively high plateau of egg laying hens has been reached, geneticists cannot improve stocks by using presently employed techniques. Perhaps the best mating system will be one which involves a designed randomization, thus providing maximum heterogeneity. Only time will tell. But as different techniques are used for experimentation it is important to have an anchor to which to tie—a yardstick stock for comparative purposes.

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R. C. Wahlstrom
Animal Husbandry