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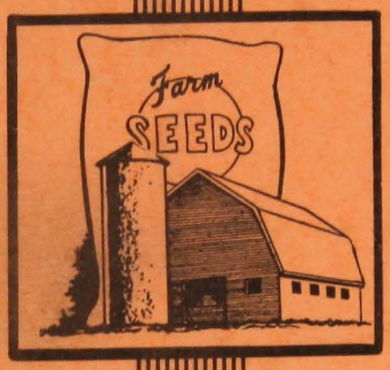
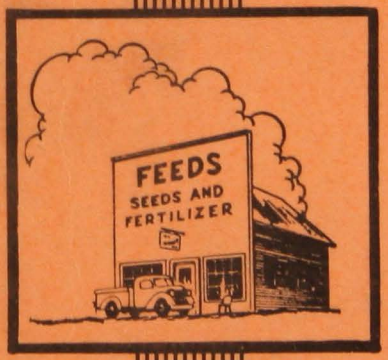


Minnesota Retail Dealer Conferences

- Seed
- Fertilizer
- Agricultural Chemicals

1962



conducted by

MINNESOTA EXTENSION SPECIALISTS in
SOILS, AGRONOMY, PLANT PATHOLOGY and ENTOMOLOGY

FERTILITY AND LONG TERM SOIL PRODUCTIVITY- BACKGROUND FOR A SOUND SALES PROGRAM

Merle Halverson, Lowell Hanson, and Curtis Overdahl
Extension Soils Specialists

The contribution of fertilizer use to recent improved efficiencies in agricultural production is well known. There is, however, honest concern in many quarters about the impact of sustained high yields upon the continuing ability of our soils to produce for the future.

How will sustained high yields affect soil organic matter content and structure? What are the effects upon the water infiltration and retention capabilities of soils? Soil erodibility? Does one-crop agriculture adversely affect the physical and chemical properties of soils?

The answers aren't necessarily short or simple. They do, however, have their roots in a consideration of some simple questions:

(1) What kind of a job do plants do?

(2) What are the needs of plants in doing this job?

(3) What do soil conditions have to do with providing their needs?

(4) How might the higher yields brought about by liming, fertilizer use, and other modern management practices affect these soil conditions over long periods of time?

An understanding of plant functions and needs will enable us to recognize the soil conditions that affect such needs for better or worse. Later we'll take a look at how those soil conditions might be influenced by sustained high production over long periods of time.

The Job Plants Do

Q: What are plants, anyway?

A: Plants are chemical factories capable of changing non-living naturally-occurring substances into living material of value to man and other animals.

The "raw materials" are found in the carbon dioxide of the air and in the water and minerals of the soil. Energy from the sun provides the "power source." Simple sugars are the first "finished product;" once formed, these can be converted into starches, fats, and oils for storage in seeds and fruits against the time when they are broken down to provide energy for initial growth to a new generation of plants. Or, the sugars may be converted to cellulose, which goes into the construction of cell walls, enabling plant parts to grow and remain rigid. Through yet another "route" the sugars combine with nitrogen, sulfur, phosphorus, and other soil elements to form the "building blocks" of proteins and nucleoproteins. The latter substances are the very stuff of which living matter is made.

The basic process by which plants use energy from the sun to change carbon dioxide and water into sugar is called photosynthesis. Free oxygen is given off to the air in this process.

Q: If plants need energy from sunlight to operate, how can they live in the dark?

A: By burning the stored sugars and starches manufactured in daylight. This process is called respiration.

In respiration, sugar and oxygen combine to produce carbon dioxide, water, and energy. The energy thus released enables plants to sustain life in the dark.

Actually photosynthesis (sugar manufacture) and respiration (sugar breakdown) can occur at one and the same time. When the former exceeds the latter, plant sugars accumulate. When the reverse is true, sugars tend to disappear.

Get this: Plant roots do work in taking up mineral nutrients from the soil. Work requires energy. Energy is provided through respiration. Respiration requires that the root system have a supply of oxygen (air). No root air, no mineral nutrient uptake, no plant!

Clue: The productive soil is one that can provide favorable amounts of both water and air to the root system at all times.

Q: How much of the dry matter produced by a crop comes from the soil minerals?

A: Only 3 to 5 percent. The rest has its origin in carbon dioxide and water.

But the soil mineral elements are important out of all proportion to the amounts in which they occur. Thirteen of these elements are essential to plant growth. Withhold one or more of them and you no longer have a plant.

Nitrogen, phosphorus, and potassium - the primary nutrient elements - are required in relatively large amounts and are often present in short supply in soils. The secondary elements (calcium, magnesium, and sulfur) are also needed in large amounts but soil shortages of these are less common. The remaining seven (iron, boron, manganese, copper, zinc, chlorine, and molybdenum) are termed trace elements and are needed only in minute amounts.

Clue: The productive soil is one that can supply all of the essential mineral elements in needed amounts at the proper times.

Plant Needs

We've already mentioned some of these in our consideration of plant functions. Here they are in summary:

(1) Soil Water (H_2O): Provides the hydrogen and some of the oxygen needed for sugar manufacture. Water is also the medium in which mineral nutrients are taken up and moved around within plants.

(2) Soil Air: Provides root systems with the oxygen needed for sugar breakdown, a process resulting in release of the energy necessary for mineral nutrient uptake and plant growth.

(3) Above-Ground Air: Furnishes leaves with the carbon dioxide (carbon and oxygen) needed in sugar manufacture. While amounts vary, there is usually about 3 pounds of carbon dioxide in 10,000 pounds of air.

(4) Radiant Energy: This is the source of "power" used by plants to chemically "weld" carbon, hydrogen, oxygen, and soil minerals together into the sugars, starches, proteins, and other materials that comprise plant tissue.

(5) Temperature: Most plants grow best at 50 to 100° F. At temperatures above or below these figures, growth rates decrease markedly.

Temperature directly affects the formation and breakdown of sugar, water, and nutrient uptake and movement, and enzyme activity.

Clue: Much heat is needed to raise the temperature of water. Soils with high water holding capacities warm up slowly!

(6) Mineral Nutrients: We've discussed these in our consideration of plant functions.

(7) Soil Reaction: Acid soil conditions affect plant growth by reducing the availability of certain essential mineral elements. Soil phosphorus, for example, is less available under acid conditions in soils containing iron and aluminum. Also, many of the beneficial soil microorganisms thrive poorly in "sour" soils.

Obviously, plants have a complex set of needs. Providing these in the best possible combination is a big order. Some can be manipulated by man; others can't.

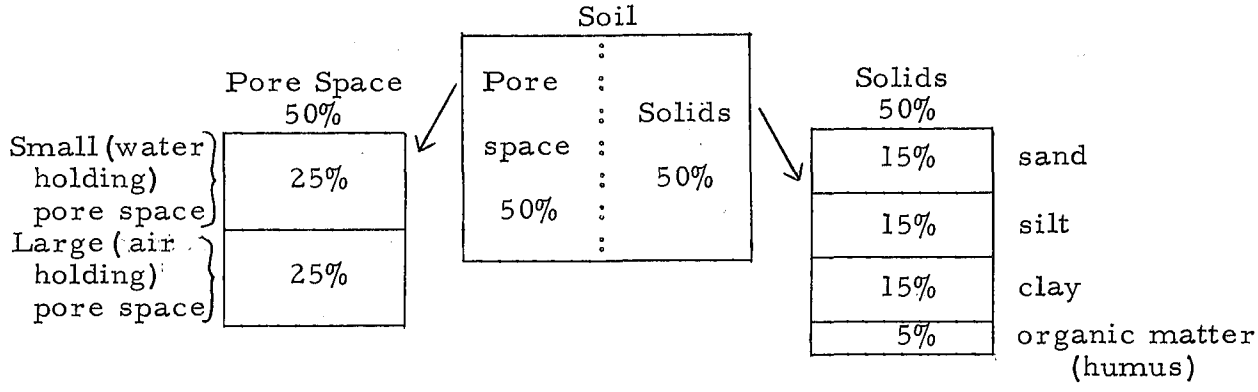
It would, for example, be impractical to regulate carbon dioxide supply in most kinds of agricultural production. Too, we have little control over the total amount of sunlight reaching plants. Total water supply - except under irrigation - depends on the vagaries of weather. Yet when any one of these "uncontrollable" plant needs is present in unfavorable supply, crop production suffers.

The controllable plant needs are those that can be manipulated through working with the soil. Soil water, soil air, soil reaction, mineral nutrient supply, and temperature are the important ones. Most are interdependent; it's difficult to change soil conditions to favor one of these needs without affecting the others.

To see why this is true, let's consider soil conditions in relation to their effect upon plant needs.

Soil Conditions and Plant Needs

(A) Effect of Soil Physical Composition



As shown above, an "ideal" soil is one consisting of solids and pore space in approximately equal volumes. The solid portion includes sand, silt, clay, and organic matter in the approximate amounts indicated. Clay and organic matter particles are microsopically tiny. The pore spaces occurring among these are sufficiently small to enable water to be held against the pull of gravity. It is this small pore space that provides soils with their capacity for holding water.

Conversely, the pore spaces occurring among sand and silt particles are too large to retain water against the pull of gravity. This large pore space is what provides soils with their air-holding capacity.

Our "ideal" soil is one in which the volumes of small (water-holding) and large (air-holding) pore space are equally distributed. Such soils have the built-in ability to provide plant root systems and soil microorganisms with favorable air, water, and temperature relationships under a wide variety of rainfall conditions.

When compared with our "ideal," sandy soils contain less clay and organic matter and proportionately more sand. This results in an increased amount of air-holding pore space at the expense of water-holding capacity. Their low water and high air contents enable sandy soils to warm up quickly and provide a plentiful oxygen supply to plant roots. Inability to supply crops with enough water during periods of infrequent rain is their most serious shortcoming.

Clay soils represent an opposite extreme. While they contain vast amounts of total pore space, relatively little is of the large or "air-holding" variety. Ability to store moisture supplies for crop use during drought periods is a feature in their favor. However, when clay soils are completely charged with moisture they warm up slowly and provide inadequate air supply to roots. Reduced rates of photosynthesis and respiration, lowered nutrient uptake, restricted microbial activity, and reduced crop yields are the inevitable result.

(B) Effect of Organic Matter

It would be difficult to overemphasize the important role of organic matter in promoting and maintaining soil conditions favorable to plant growth.

Well decomposed organic matter (humus) can hold vastly greater supplies of water and mineral nutrients than equal amounts of the finest clay. This feature is of obvious importance in improving the unbalanced air-to-water relationship existing in sandy, droughty soils. It also favors the retention-against-leaching of mineral nutrients applied as fertilizers to such soils.

In clay soils, small increases in humus content induce favorable physical effects far in excess of the proportionate amounts added. This effect results from the property of cohesion which enables humus to bind very small clay particles together into larger granules. The water holding capacity of well-granulated clay soils is found among the tiny pore spaces within these granules. The large pore spaces occurring among the granules provide such soils with their air capacity.

Through improving granulation in clay soils, we induce increased air capacity with a concomitant decrease in water capacity. Improved temperature conditions, better rainfall infiltration, and reduced water and soil loss through runoff and erosion are some of the favorable results.

As crop residues, green manure crops and barnyard manures undergo decomposition in the soil to form humus, carbon dioxide - the gas necessary to sugar formation - is given off as a byproduct. In solution with soil water, carbon dioxide forms an effective weak acid solvent which hastens release of essential plant nutrient elements from the soil minerals. Certain of the soil trace elements - iron is an example - are thought to be "protected" against fixation to unavailable form by humus.

Clue: You can't change the organic matter content of a soil without affecting soil air, water, temperature, and nutrient relationships for better or worse.

(C) Effect of Soil Reaction

Liming acid soils set off a "chain reaction" that favorably alters the whole regime of soil conditions affecting plant growth. Improved availability of soil and fertilizer mineral nutrients is one direct result; increased microbial activity and the provision of calcium and magnesium for plant growth, are others.

The favorable indirect effects are many. As soil nutrient availability is improved plant growth is stimulated, providing greater amounts of high quality organic residues for return to the soil. Improved microbial activity hastens the transformation of these residues into humus form. The increased humus supply, in turn, enhances the water and nutrient holding ability of sandy soils. In clay soils, improved granulation, better air-water and temperature conditions, improved rainfall infiltration and reduced run-off and soil erosion loss, are some of the effects.

The facts leave little room for doubt; proper liming is basic to any management program on acid soils.

(D) Effect of Soil Nutrient Status

There is good reason to suppose that soils limited in their capacities to supply the essential mineral nutrients will eventually become limited in other ways. Uncorrected nutrient deficiencies tend to worsen with removal of each new crop. Reduced plant residue yields fail to match annual soil organic matter losses under continuing cultivation. Deteriorating soil structure follows with its associated ill effects upon internal air-water and temperature relationships. Impaired rainfall infiltration capacity, accelerated runoff, and increased erosion hazard provide the final chapter to this logical chain of events.

Fertility and Long Term Productivity

The mineral nutrients supplied to soils through fertilization and liming provide only one link in the complex chain of plant needs. Fertility alone won't cure inadequately drained, strongly acid, or extremely droughty soils - irrespective of their nutrient status. It is equally true that inattention to weed, insect, disease, and crop varietal considerations can make fertilizer use a disappointing experience on the most productive soils.

The bulk of Minnesota's agricultural plant is centered on young soils having existing physical conditions well suited to high production. On vast acreages of these soils, mineral nutrient supply and soil reaction limit crop yield more severely than the other plant needs taken singly or in combination. Given present technology and climate, there is solid scientific evidence to suggest that such soils can continue to produce at high levels indefinitely. Constant attention to sound soil and crop management practices will be basic to attainment of any such goal. Here are some reasons why:

1. Fertilizers and liming, where needed, increase the amounts of crop residues produced for return to the soil. In most types of farming, crop residues provide the most important single source for replenishing soil organic matter lost through continuing cultivation.

Here are a few examples of how fertilizer treatments can effect not only immediate yields but also crop residue. These research results are from A. C. Caldwell's fertility plots at Morris in 1957.

	Bushels of Corn		Tons of Corn Forage	
Crop	Check plot	NPK plot	Check plot	NPK plot
1st year corn	92	119	11.5	12.7
2nd year corn	58	103	7.4	13.2

2. Fertilizers and lime improve the quality of plant residues produced. Residues of high nitrogen and phosphorus content decompose more rapidly and leave more humus after initial decomposition is complete - than equal amounts of residue having lower nutrient content.

3. Tillage is a soil impoverishing practice; it induces greater soil aeration, increased microbial activity and more rapid organic matter loss. Any practice favoring reduction in tillage favors retention of soil organic matter. Minimum tillage and chemical weed control are two examples. These practices - coupled with availability of cheap chemical fertilizers - have helped make continuous cropping to high value, high-residue-yield row crops a reality on many level lying soils.

Summary

Efficient production through high yields is necessary if Minnesota farmers are to compete successfully in the existing economy. An important by-product of higher yields is the associated increase in quantity and quality of crop residues. Under prudent management such residues can - over time - contribute significantly to the maintenance and improvement of soil conditions favorable to plant growth. These considerations suggest that those soils now under continuous management for economical high production will also be the most productive soils of tomorrow.

The Agricultural Extension Service is pleased to bring to the fertilizer dealers of Minnesota this condensed presentation of basic soils information. The authors know of no better background for a sound sales program.

FACTS ABOUT DOLLARD AND LAKELAND RED CLOVER

William F. Hueg, Jr.
Extension Agronomist

For the past 15 years research workers at the Minnesota Experiment Station have said that good homegrown commercial seed of medium red clover was as good as any improved varieties available. This position has changed because of new information about the disease resistance of Dollard and Lakeland, two relatively new and recommended red clover varieties. Seed of Dollard is becoming more plentiful and the production of Lakeland seed in 1961 assures the possibility of more seed for planting on Minnesota farms in 1962.

Red clover diseases are a major factor in reducing yield and quality of the crop. The longevity or persistance of stand is also affected by disease. The diseases that are most damaging are northern anthracnose, powdery mildew, leaf spots, viruses, and root rots. These diseases are most severe in humid parts of the state, but can occur anywhere if the proper conditions exist.

Dollard and Lakeland are resistant to northern anthracnose and virus diseases. Lakeland carries resistance to powdery mildew. Field trials at Duluth and Grand Rapids where anthracnose and virus have been severe the past three years clearly show that Lakeland and Dollard were less injured by anthracnose and virus when these diseases were prevalent. The superiority was shown by plant resistance and reflected by higher yields of .2 to .3 of a ton per acre over the checks which were commercial strains.

Certified Seed A Good Buy

With only a few cents difference in price for certified seed of these varieties compared with commercial strains, the extra yield soon outweighs the extra price. Table 1 shows yield data from Grand Rapids and Duluth. Table 2 shows performance of these varieties in the north central region.

Table 1. Forage yield, tons per acre 1958-1960

	Grand Rapids 3-yr. average	Duluth 1959
Lakeland	3.71	2.80
Dollard	3.80	2.73
Commercial	3.57	2.43
Pennscott	3.24	2.68
Kenland	3.22	2.50

Table 2. Forage yield, tons per acre, regional data 1956-1959

	21 experiments first crop year	7 experiments second crop year
Lakeland	2.98	2.30
Dollard	2.96	2.33
Pennscott	2.78	1.81
Kenland	2.76	1.74

Because of the shorter domestic seed supply of medium red clover and the possibility of increased importation of European unadapted red clover varieties, dealers should make every effort to stock certified seed of these two varieties. Make your customers aware of the disease resistance, yield, and quality difference of these varieties. They should not complain about price when they know the facts.

DOMESTIC CLOVER SEED PRODUCTION LOW IN 1961

William F. Hueg, Jr.
Extension Agronomist

The production of red clover and alsike cover seed in the United States during 1961 has resulted in below average seed supplies. Red clover seed production is 21 percent lower than the 1950-59 average, and alsike clover is 74 percent less than the 1950-55 average. Because of this situation the price of clover seed has been firm.

The high price situation as well as a short supply already has and will further encourage importation of European seed. Several problems arise from this situation:

1. This seed is unadapted. By law 10 percent of the seeds are stained red to identify its European origin.

2. Forage yields are lower than with adapted varieties. This will cause direct loss to farmers. In 1952-54 eight states cooperated with ARS, USDA to compare again clover seed from domestic and foreign sources. As in previous studies, European varieties gave lower forage yields than domestic varieties. In twelve trials the differences in hay yields exceeded 30 percent in favor of domestic varieties.

3. The danger of polluting domestic seed stocks is a threat to placing red clover on a variety basis. In recent years, several red clover varieties have been introduced by USDA and state experiment stations. These varieties have been usually superior to commercial seed in disease resistance, forage quality, and yield. They are greatly superior to European varieties.

There has been considerable interest in Minnesota for production of certifiable varieties of red clover. For these reasons seed dealers are encouraged not to stock this European seed. If they do there is a increased danger of contaminating fields with unadapted materials.

The demand for certifiable varieties of red clover is good in many eastern states such as New York, Pennsylvania, and New England. With the introduction of two varieties, Dollard and Lakeland, seed producers in Minnesota have an opportunity to produce seeds of varieties with increasing demand. The superior characteristics of these varieties have already been described. If you know of producers interested in certified seed production of these two red clover varieties, encourage them to contact Carl Borgeson, Agronomy Seed Stocks, St. Paul, Minnesota for information on Foundation Seed.

MORE DOLLARS FROM EARLY CUT FORAGE

William F. Hueg, Jr.
Extension Agronomist

A successful forage program considers many items. When these are properly assembled, they lead to efficient and economic production of feed nutrients. As dealers in agricultural supplies, you are interested in seed of superior varieties, fertilizers which will provide proper plant nutrition, and herbicides and insecticides for control of weeds and insects. If one or more of these production items are left out of a production program, the chances of success are reduced.

In order to make these production items more worthwhile to farmers you may wish to encourage them to adopt proven management practices. The best seed, correct fertilizer treatment, or use of herbicides and insecticides may be wasted if other management practices are overlooked. One of the practices of proven worth is early cutting of forages for hay or silage.

During 1960 at six locations and in 1961 at 10 locations in Minnesota, information on yield and quality of forage mixtures harvested at different dates and frequency of cutting were obtained. These demonstrations were conducted in cooperation with county agricultural agents or branch station personnel. These plots were placed over the state as shown in figure 1. All were harvested according to the schedule in table 1.

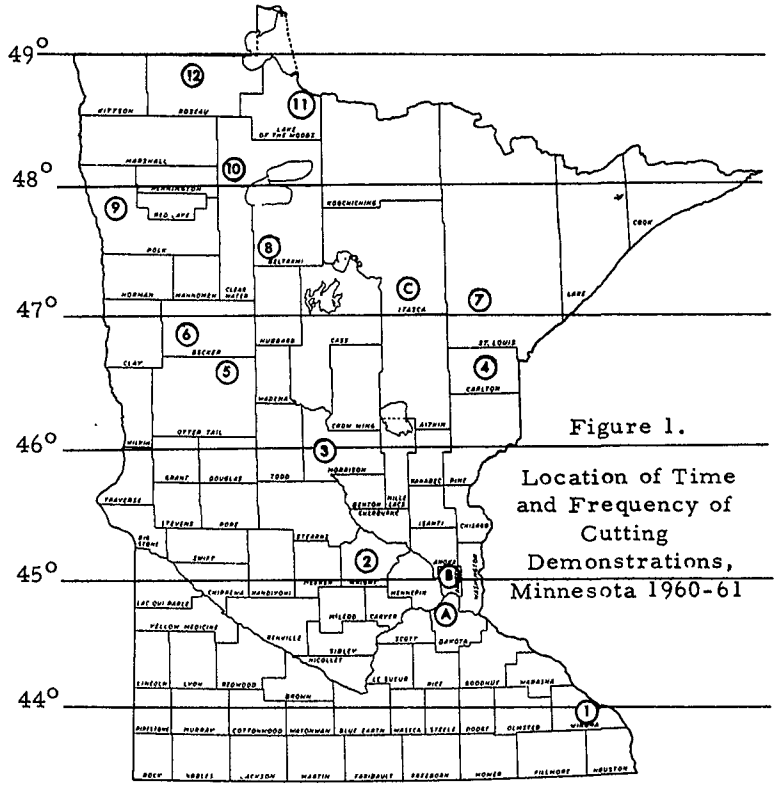


Figure 1. Location of Time and Frequency of Cutting Demonstrations, Minnesota 1960-61

Table 1. Cutting schedule for time and frequency of cutting demonstrations

Plot	Treatment	Cutting Date 1960	Cutting Date 1961
I	3X - early	June 1-3 July 15-17 Aug. 30-31	June 1-2 July 13-14 Aug. 30-31
II	3X - median	June 15-17 July 27-29 Aug. 30-31	June 15-16 July 27-28 Aug. 30-31
III	2X - late	June 24-26 Aug. 10-12	June 22-23 Aug. 17-18
IV	2X - very late	July 5-6 Aug. 30-31	June 29-30 Aug. 30-31

One proven way to obtain the high potential feeding value of forage crops is to harvest in the early growth stages. Early cutting may result in lower yield of forage per acre, but the improved quality leads to more effective use of the forage. Table 2 shows the composition of the forage mixtures harvested during 1960 and 1961. Three values of quality are considered: protein, fiber, and total digestible nutrients. TDN is calculated from the protein and fiber by formula and is an indication of the nutrients available for growth, maintenance and production. Note the close agreement between the two years.

Table 2. Composition of alfalfa-grass mixtures harvested at different growth stages. Average of six locations in 1960 and 10 locations in 1961
- Minnesota -

1st Cutting	1960 Percent Composition			1961 Percent Composition			
Date	TDN	Fiber	Protein	Date	TDN	Fiber	Protein
6-2	72.2	23.5	21.2	6-2	70.1	24.3	19.3
6-16	62.2	29.9	17.2	6-15	62.4	31.0	17.2
6-26	59.1	33.0	14.9	6-23	59.5	32.0	13.6
7-6	57.2	35.1	12.9	6-30	56.4	34.5	12.2
2nd Cutting							
6-8 weeks regrowth	61.8	31.5	16.9		62.1	30.8	16.6
3rd Cutting							
5-6 weeks regrowth	70.1	24.7	21.8		66.6	27.4	19.0

The first cutting is presented in more detail because it shows the greatest change in quality. The magnitude of change in second or third growth is relatively narrow. Table 3 shows the average daily changes which occur as the first cutting forage matures. It should be noted that the actual change in TDN during the first 14 days was 67 and 54 percent respectively in the two years.

This first two weeks is a critical period because of the rapid increase in fiber content. The fiber increase is 65 percent for both years. Animal nutritionists have found that animal intake of forage is markedly reduced when fiber exceeds 30 percent.

Table 3. Change in percent composition of alfalfa-grass mixtures, first cutting. Average of 6 locations in 1960 and 10 locations in 1961
- Minnesota -

Component	Per Day		Total	
	1960	1961	1960	1961
Fiber	+.28	+.34	+ 9.6	+10.2
Protein	-.24	-.25	- 8.3	- 7.1
TDN	-.44	-.49	-15.0	-13.7

The net loss of protein and TDN during 1960 and 1961 averaged .71 percent per day. The daily gain in fiber averaged .31 percent. The predicted loss in intake and digestibility is approximately one percent per day. The delay from June 2 to July 6 in harvest should have resulted in a 34 percent loss. The actual loss for 1960 was 32.9 percent. During 1961 the harvest delay from June 2 to June 30 should have resulted in a 28 percent loss. The actual loss was 31 percent.

Extra Protein From Three Time Cutting

The foregoing is information of interest and useful as a basis for developing an educational program. However, livestock feeders are more concerned with interpretations of such data that can be used in planning their farm business. Table 4 shows the dry matter yield and protein per acre during the two years.

Table 4. Effect of time and frequency of cutting on dry matter yield and protein per acre. Average of 6 locations in 1960 and 10 locations in 1961.
- Minnesota -

Treatment	1960			1961		
	Dates	DM/ acre (tons)	Prot./ acre (lbs.)	Dates	DM/ acre (tons)	Prot./ acre (lbs.)
I	6-2, 7-16, 8-29	3.3	1289	6-2, 7-15, 8-29	3.0	1096
II	6-16, 7-28, 8-29	3.6	1332	6-15, 7-27, 8-29	3.4	1214
III	6-26, 8-12	3.3	1037	6-23, 8-18	3.5	990
IV	7-6, 8-29	3.7	1028	6-30, 8-29	3.6	943

The decision as to the best date to harvest to take advantage of yield and quality will depend on the number of acres to be harvested and equipment available. The class of forage consuming livestock to be fed may also be a factor. One obvious fact from these demonstrations is that quality deterioration is very similar regardless of location, and therefore delay in harvest should be avoided.

If the usual method of harvest has been two-time cutting such as illustrated by treatment IV, the quality of the forage measured in terms of protein, can be improved markedly by changing to treatments I or II, which are three-time cuttings. This improved quality averaged 200 to 300 pounds more protein per acre.

If only 20 to 30 acres of hay are to be harvested, treatment II dates may be the better choice. When 60 to 100 acres are to be harvested it may be a better choice to begin harvest sometime after June 2, but with harvest completed by June 16. The expected result would be a slightly higher yield of dry matter than I, but less protein than obtained in II. With good assurance of achieving this quality such harvest planning becomes worthwhile.

Implications of Change in Harvest Schedule

1. Because of higher quality in the forage, less protein supplement will be needed. At a value for protein of 10 cents per pound, this can mean a $20-$30 per acre savings. In many instances extra corn or oats will be needed to provide adequate energy levels.

2. With the extra protein and TDN produced from the three-cutting schedule more animal production should result. The 300 pounds more protein and 400 pounds more TDN will produce approximately 1000 pounds of 4 percent milk. At 3¢ per pound this would be $30 more income per acre from early cut forage.

3. Extra equipment may be needed to accomplish early cutting, such as field conditioners, mow drying systems, or a new silo to handle hay crop silage. Based on 100 tons of hay equivalent (1 ton of good hay equals 3 tons of good silage) 6 to 9 acres of hay producing 3 tons per acre will meet the annual cost of such equipment. This equipment further assures getting high quality forage because of reduced leaf and vitamin loss.

4. The use of pre-emergence herbicides with row crops may make it possible for timely harvest of the first hay crop by delaying the first cultivation. The cost of the herbicides will be covered adequately by the improved forage quality. Note: This is a good selling point to encourage farmers to purchase and use pre-emergence herbicides on row crops.

5. Farmers who get greater returns from forages by adopting an improved cutting schedule will be better customers for; high quality seed of superior varieties, fertilizers, insecticides and other supplies needed for high yields and profitable production. Because returns from forage acres will be improved, the farmers' cash position should improve and remove many of them from your credit list. This point has already been proven in many states with well developed forage programs.

CHEMICALS FOR WEED CONTROL IN 1962

Harley J. Otto
Extension Agronomist

The University of Minnesota Agricultural Experiment Station continues to evaluate promising new chemicals developed by chemical manufacturing companies. Each year those new chemicals which are available and are promising are compared with the older ones to determine their relative effectiveness for controlling weeds in specific crops.

The chemicals which give the best performance in research tests are included in county demonstrations. In 1961, weed control results were obtained on some 60 demonstration trials in corn and 35 trials in soybeans. Results from these trials are given in tables 1-4.

Time of Application

The time of application of chemicals can be grouped into 4 classes:

1. pre-plowing--chemical applied to soil and/or plant foliage before plowing.
2. pre-planting--chemical applied to soil before crop is planted. Usually the chemical is incorporated into the soil by one or more tillage operations.
3. pre-emergence--chemical applied to the soil after crop is planted but before it comes up. Usually applied at planting time.
4. post-emergence--chemical applied to crop and weeds after they are up.

Many of the chemicals developed in recent years are used in pre-emergence applications. When chemicals are applied at this time, their effectiveness is quite dependent on soil type, rainfall after application and other environmental factors. Hence, they are often less reliable than chemicals applied after the crop and weeds have emerged. Pre-emergence applications do have certain advantages, however.

1. The chemical can be applied at planting, thus saving a trip over the field.
2. The first cultivation can often be delayed. This may allow more time for putting up high quality hay on farms with both row crops and hay.
3. The number of cultivations may be reduced.
4. Weeds in the row can be more nearly controlled than where cultivation is the only means of weed control.

Pre-emergence herbicides often give better results on well prepared seedbeds than on poorly prepared seedbeds.

Granular vs Spray Form for Herbicides

Farmers have shown a great deal of interest in granular herbicides during recent years. The advantages and disadvantages of granular herbicides compared to the spray form are given below:

Advantages:

1. Granular herbicides are ready to use as they come from the package. They do not need to be mixed with water.
2. Operator does not have to haul water during application.
3. Application equipment is simpler to operate and maintain than spray equipment.

Disadvantages:

1. Cost per pound of active ingredient is somewhat more for granular than spray materials.
2. Use of granular materials is limited to soil applications since foliar applications of granules are not effective. Farmers using granular materials will usually need both the granular applicator and sprayer.
3. Granular materials require more storage space per pound of active ingredient than spray materials since they usually contain a lower percentage of active ingredient.
4. Presently available granular applicators often give poorer distribution of the herbicide than sprayers.

Comparisons of granular and spray materials have been made in research and county demonstration trials during the past four years. Granular Atrazine has not given as consistently good weed control as the wettable powder spray. Conversely, Randox and Randox-T have given consistently better results in the granular than in the liquid form.

Granular applicators are more likely to apply materials uniformly on well prepared seedbeds than on poorly prepared seedbeds. The applicator must be calibrated to be certain of the amount of chemical being applied.

Chemicals

Some of the herbicides being sold in the state are listed below with comments about them. Rate of application refers to pounds of active ingredient per acre on a broadcast basis.

Randox:

1. Use - annual grass control in corn, soybeans and sorghum.
2. Rate of Application - 4 pounds per acre.
3. Time of Application - pre-emergence.
4. Precautions - very irritating to the skin and eyes. Handle with extreme caution.

Randox-T:

1. Use - control of annual grasses and broadleaved weeds in corn.
2. Rate of Application - approximately 3.5 pounds CDAA + 7 pounds TCBC per acre (4 1/2 quarts liquid or 30 pounds granular product per acre).
3. Time of Application - pre-emergence.
4. Precautions -
   a. Irritating to skin and eyes.
   b. Avoid use on soybeans.

Simazine:

1. Use - control of grasses and broadleaved weeds in corn.
2. Rate of Application - 2-4 pounds per acre. Heavier rate on finer textured soils or soils with high organic matter content.
3. Time of Application - pre-emergence.
4. Precaution - residue in soil has damaged susceptible crops in rotation following corn.

Atrazine:

1. Use -
   a. Weed control in corn.
   b. Quackgrass control. Experiments in Minnesota and Wisconsin have shown Atrazine to be very effective in controlling quackgrass with a fall or early spring application followed by spring plowing. Corn can be planted following treatment.
2. Rate of Application -
   a. Weed control in corn: 2-4 pounds per acre. Use higher rate on fine textured soils or soils with high organic matter content.
   b. Quackgrass control: 3-4 pounds per acre.
3. Time of Application for weed control in corn:
   a. Pre-emergence
   b. Post-emergence - Chemical can be applied up to 3 weeks after planting. Should be applied before weeds are 1 1/2 inches tall. Most of the uptake by the plant appears to be through the roots rather than the leaves.
4. Precaution - susceptible crops have been injured in rotation following corn.

Amiben:

1. Use - control of annual grasses and broadleaved weeds in soybean seed fields.
2. Rate of Application - 3 pounds per acre.
3. Time of Application - pre-emergence.
4. Precaution - early stunting of soybeans has been observed under some conditions. However crop usually outgrows injury.

Carbyne:

1. Use - control of wild oats in small grains, flax, and sugar beets.
2. Rate of Application - 4-6 ounces on small grains and flax; 10-12 ounces on sugar beets.

3. Time of Application - post-emergence, when wild oats are in 2-leaf stage. Time of application is quite critical.
4. Remarks:
   a. Widely tested under farm conditions in Minnesota and North Dakota.
   b. Results were encouraging but in many cases wild oats were not adequately controlled.
   c. Flax and small grain injury has been observed in research plots. Injury on flax has been more severe than on small grains.

Avadex:

1. Use - control of wild oats in small grains, flax, and sugar beets.
2. Rate of Application - 1 1/4 to 2 pounds per acre.
3. Time of Application - pre-planting. Chemical is quite volatile and must be incorporated soon after application.
4. Remarks -
   a. Tested in several locations.
   b. More promising than Carbyne for use on flax.
   c. Injury to small grains has been observed.

2, 4-D and MCPA:

1. Use - broadleaved weed control in corn, small grains, pastures, etc.
2. Time of Application - post-emergence. The use of 2, 4-D ester as a pre-emergence treatment on corn not recommended because of erratic results and injury to corn.
3. Rate of Application - see University of Minnesota bulletin on weed control in field crops.

Dalapon:

1. Use - grass control in flax and sugar beets.
2. Rate of Application -
   a. Flax - 3/4 pound per acre.
   b. Sugar beets - 3-4 pounds per acre.
3. Time of Application - when grasses not more than 2 inches tall.

Summaries of Results in County Demonstration Trials

Tables 1-4 present results from county demonstration trials conducted in 1961. Evaluations of these trials were made twice during the growing season. The early evaluations were made approximately five weeks after the chemicals were applied while the late evaluations were made in early September. One-half of each trial was cultivated at the same time as the remainder of the field and one-half was left uncultivated.

The results from early vs late evaluations in the uncultivated plots are given in table 2. Note that Atrazine gave longer-lasting weed control than Randox or Randox-T. Table 3 gives comparisons of cultivated and uncultivated plots at the early evaluation. Although all chemicals gave better weed control when cultivated than when not cultivated, chemicals such as Randox, Randox-T, and 2, 4-D benefited more than Atrazine from the cultivations.

Table 5 gives a summary of the demonstration results during the past two and three years. Some chemicals were included in the trials only two years while others were used three years. The formulations of two of the chemicals were changed during the trial period. The granular Atrazine which was included in 1960 tests was formulated on attaclay and contained 8 percent active ingredient while the material in tests in 1961 was formulated on an ammonium sulfate base and contained 20 percent active ingredient. The ratio of CDAA to TCBC in Randox-T was changed between the 1960 and 1961 seasons. Consequently the rate of application in 1960 was 3 pounds CDAA plus 7.5 pounds TCBC per acre and the 1961 rate was 3.5 pounds CDAA + 7 pounds TCBC per acre. Randox was applied at 5 pounds CDAA per acre in 1959 and 1960 and 4 pounds per acre in 1961.

The system for classifying the degree of weed control was different in 1959 and 1960 than in 1961. In 1959 and 1960, weed control was classified as good, fair, and poor while in 1961, results were reported in five categories (below 50 percent control, 50-75 percent control, 75-85 percent control, 85 percent to 95 percent control, and over 95 percent control). In combining the data, the 1961 category below 50 percent control was classified as poor, the 50-75 percent category was classified fair and over 75 percent was classified good.

TABLE 1

EARLY EVALUATIONS
WEED CONTROL IN CORN
UNCULTIVATED PLOTS
1961

Chemical	Pounds A.I. or A.E. per acre	Percent of plots in each class			
		Grasses		Broad-leaved weeds	
		75-85% control	over 85%	75-85% control	over 85%
Randox	4	18	10	2	4
Randox-T	3.5 CDAA + 7 TCBC	27	14	23	19
Atrazine	2	19	27	7	60
Atrazine	3	21	41	9	66
Atrazine	4	21	56	11	72
Atrazine (Post)	3	19	40	9	61
2,4-D ester	2	5	8	6	17
Granular Randox	4	24	32	9	6
Granular Randox-T	3.5 CDAA + 7 TCBC	37	36	24	31
Granular Atrazine	3	20	31	13	44
Granular 2,4-D ester	2	3	3	6	12

TABLE 2

EARLY VS LATE EVALUATIONS
WEED CONTROL IN CORN
UNCULTIVATED PLOTS
1961

Chemical	Pounds A.I. or A.E. per acre	Percent of plots showing over 75% weed control			
		Grasses		Broad-leaved weeds	
		Early	Late	Early	Late
Randox	4	28	10	6	5
Randox-T	3.5 CDAA + 7 TCBC	41	10	42	26
Atrazine	2	46	43	67	54
Atrazine	3	62	68	75	81
Atrazine	4	77	74	83	80
Atrazine (Post)	3	59	64	70	82
2,4-D ester	2	13	2	23	12
Granular Randox	4	57	23	15	20
Granular Randox-T	3.5 CDAA + 7 TCBC	73	23	55	55
Granular Atrazine	3	51	46	57	71
Granular 2,4-D ester	2	6	0	18	13

TABLE 3

CULTIVATED VS UNCULTIVATED PLOTS
WEED CONTROL IN CORN
EARLY EVALUATIONS
1961

Chemical	Pounds A.I. or A.E. per acre	Percent of plots showing over 75% weed control			
		Grasses		Broad-leaved weeds	
		Cultivated	Un-cultivated	Cultivated	Un-cultivated
Randox	4	51	28	28	6
Randox-T	3.5 CDAA + 7 TCBC	61	41	60	42
Atrazine	2	65	46	76	67
Atrazine	3	75	62	79	75
Atrazine	4	83	77	86	83
Atrazine (Post)	3	67	59	76	70
2,4-D ester	2	28	13	44	23
Granular Randox	4	67	57	49	15
Granular Randox-T	3.5 CDAA + 7 TCBC	82	73	69	55
Granular Atrazine	3	71	51	70	57
Granular 2,4-D ester	2	26	6	36	18

TABLE 4

WEED CONTROL IN SOYBEANS
UNCULTIVATED PLOTS
1961

Chemical	Pounds A. I. per acre	Percent of plots in each class			
		Grasses		Broad-leaved weeds	
		75-85% control	over 85%	75-85% control	over 85%
EARLY EVALUATIONS					
Randox	4	29	34	7	7
Granular Randox	4	20	54	15	4
Amiben	3	24	56	26	33
Alanap	5	6	15	7	15
Granular Amiben	3	24	59	15	52
Premerge (Early Post)	3	3	7	32	12
LATE EVALUATIONS					
Randox	4	14	24	0	4
Granular Randox	4	14	28	13	4
Amiben	3	21	46	17	29
Alanap	5	7	14	12	8
Granular Amiben	3	21	55	25	41
Premerge (Early Post)	3	8	0	8	17

TABLE 5

WEED CONTROL DEMONSTRATION RESULTS
TWO AND THREE YEAR SUMMARIES

Chemical	Years in test	Percent of trials in each class					
		Grasses			Broad-leaved weeds		
		good	fair	poor	good	fair	poor
CORN							
Randox	1959-61	28	42	30	2	27	72
Granular Randox	1959-61	46	34	20	11	30	59
Randox-T	1960-61	30	46	24	30	44	27
Granular Randox-T	1960-61	53	33	14	40	38	22
Atrazine (2#/A)	1960-61	49	32	19	66	22	6
Atrazine (3#/A)	1959-61	76	17	7	82	13	5
Granular Atrazine	1960-61	58	29	14	62	26	13
2,4-D ester	1960-61	7	19	74	14	31	54
Granular 2,4-D ester	1960-61	6	23	70	16	34	50
SOYBEANS							
Randox	1959-61	55	38	7	15	27	58
Granular Randox	1959-61	66	31	4	22	31	47
Amiben	1959-61	69	25	6	65	28	7
Alanap	1960-61	16	40	44	14	38	47

A NEW CHEMICAL FOR SELECTIVE WEED CONTROL IN CORN AND SOYBEANS

Prepared by
Harley J. Otto, Extension Agronomist
University of Minnesota

Common Name: Linuron (tentative)

Trade Name: Lorox

USDA Registration: This chemical has been granted federal registration as follows.

Corn: Field corn grown for grain only.
Dosage: Up to 3 pounds active ingredient per acre.
Use: Pre-emergence application to soil or post-emergence directed spray when the corn is 12-18 inches tall.
Limitations: Do not apply within 60 days of harvest. Do not feed treated forage to livestock.

Soybeans: Seed crop only.
Dosage: Up to 2 pounds active ingredient per acre.
Use: Pre-emergence application to soil.
Limitations: Do not feed treated forage to livestock. Do not use seed from treated crop for food, feed or oil.

Formulation and Marketing: This chemical will be sold in limited quantities in 1962 as a 50 percent active ingredient wettable powder.

Minnesota Results:

This chemical was tested at several experiment stations in 1961 under the number, Du Pont herbicide 326. It was tested in pre-and post-emergence applications on corn and pre-emergence applications on soybeans.

On the heavy textured soils where the chemical was used, 3 pounds active ingredient per acre in pre-emergence applications did not control weeds adequately. Higher rates (4-6 pounds active ingredient) were required for adequate weed control. Post-emergence applications of 1½ pounds were effective in controlling the weeds. Over-all post-emergence applications severely damaged corn in these tests. This points up the need for directed sprays to minimize chemical contact with the corn plant.

In most of these tests, this chemical appeared to be more effective in controlling broad-leaved weeds than grasses. However, in some of the post-emergence applications, it was equally effective on both types of weeds.

This material is not yet recommended because of inadequate data.

* * * *

RECOMMENDED CROP VARIETIES FOR 1962

Harley J. Otto
Extension Agronomist

New varieties on the recommended list for 1962 are: Goodfield Oats, Lindarin Soybeans, and Goldtop Sweet Clover. Descriptions of these varieties are given below. More complete information on varieties "Recommended," "not adequately tested," and "not recommended" can be found in University of Minnesota Agricultural Experiment Station Miscellaneous Report 24, "Varietal Trials of Farm Crops."

Goodfield Oats--This variety is medium-early in maturity, somewhat lower in yield than other varieties of similar maturity and high in test weight. It has short straw and very good lodging resistance. Goodfield is recommended for situations where lodging is a severe problem. It is resistant to smut, to all races of stem rust found in the area and to most races of leaf rust prevalent in Minnesota. This variety was developed by the Wisconsin Agricultural Experiment Station from the cross Clintland X (Garry X Hawkeye - Victoria).

Lindarin Soybeans was developed at the Indiana Agricultural Experiment Station from a cross of Ottawa Mandarin X Lincoln. It is similar in yielding ability, maturity, and oil content to Harosoy. It is shorter than Harosoy, and more resistant to lodging. Lindarin is recommended for the Southern corn maturity zone.

Goldtop Sweet Clover--This yellow-blossomed biennial sweet clover variety was bred at the Wisconsin Agricultural Experiment Station. It has outstanding seedling vigor, is disease resistant, and produces good forage yields. Goldtop is later than Madrid, the other recommended yellow-blossomed sweet clover, but earlier than Evergreen, the recommended white-blossomed variety.

Seed supplies of Lakeland red clover and Pembina wheat which were added to the recommended list previously appear to be adequate for the 1962 season. Seed of Pembina wheat is available from Minnesota certified seed producers and the Canadian embargo on this variety has been removed.

Certified Lakeland red clover seed has been produced in California and should be available for 1962 planting.

Wheat Sedimentation Test

The U. S. Department of Agriculture has announced that loan price premiums for the 1962 hard wheat crop will be based on a sedimentation test rather than on the protein test which has been used in the past. The sedimentation test is reported to measure protein quality as well as quantity while the protein test measures only protein quantity.

Although Lee, Selkirk, and Pembina, the recommended varieties of hard red spring wheat for Minnesota, all give satisfactory results in the sedimentation test, Pembina has produced the highest values.

Data collected from experiments conducted at three Minnesota locations (Rosemount, Morris, and Crookston) over a three year period show the relative values of these varieties. The following average results were obtained:

	Lee	Selkirk	Pembina
Yield (bushels/acre)	34.3	35.3	34.6
Sedimentation value	58	59	66
USDA loan premiums for these values (cents/bushel)	14	14	24
Gross income per acre (assuming $2.00/bushel base loan price)	$73.40	$75.54	$77.50

A complete list of recommended varieties of field crops follows:

Oats--Ajax, Andrew, Burnett, Garry, Goodfield, Minhafer, Minton, Rodney.

Barley--Kindred, Parkland (for northwest counties), Traill

Spring Wheat--Bread: Lee, Pembina, Selkirk
Durum: Lakota, Langdon, Wells

Winter Wheat--Minter

Rye--Adams, Caribou, Elk

Flax--Arny, B5128, Bolley, Marine, Redwood

Soybeans--Acme, Chippewa, Comet, Flambeau, Grant, Harosoy, Lindarin, Merit, Norchief, Ottawa Mandarin

Alfalfa--Ranger, Vernal

Red Clover--Dollard, Lakeland

Birdsfoot Trefoil--Empire

Sweet Clover--Evergreen, Goldtop, Madrid

Bromegrass--Achenbach, Fischer, Lincoln

Timothy--Itasca, Lorain

Kentucky Bluegrass--Park

Sudangrass--Piper

Field Peas--Chancellor, Stråℓ

Navy Beans--Michelite, Sanilac

Sunflowers--Arrowhead

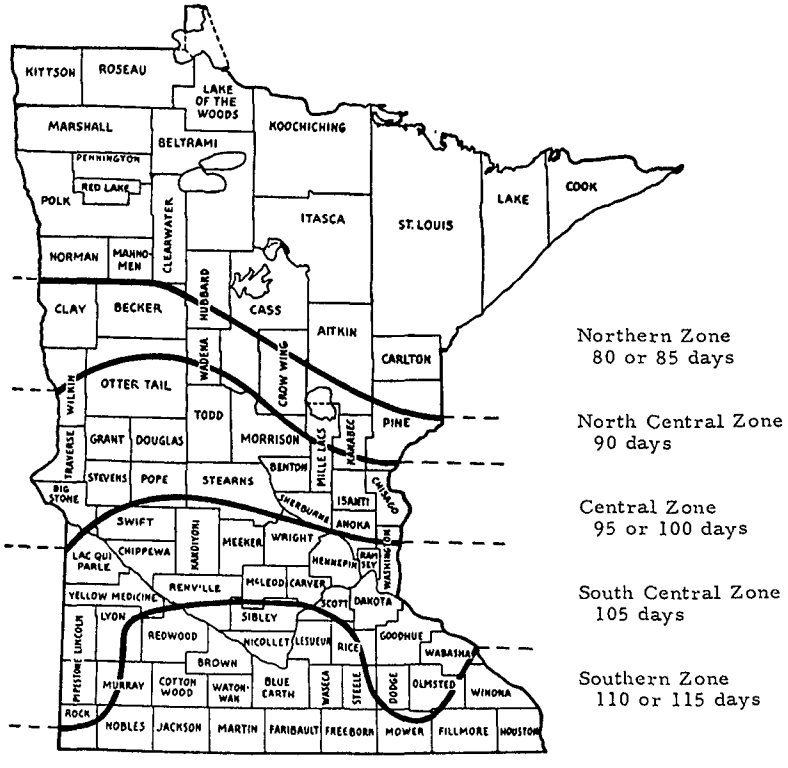
THE NEW MINNESOTA CORN HYBRID MATURITY LAW

Harley J. Otto
Extension Agronomist

In 1961, the Minnesota legislature amended the portion of the State Seed Law which applies to hybrid corn maturity. These amendments place most of the duty of determining maturity classification on the originator or owner of the hybrid rather than on the experiment station.

The director of the Agricultural Experiment Station is responsible for determining the corn growing zones of the state and publishing a list of day classifications for each of the zones. These day classifications refer to the approximate number of days of growing season required for corn plants to mature after emergence.

The zones established and day classifications are shown on the following map:



Hybrids labeled for a particular day classification must not vary more than 4 percentage points in kernel moisture from the average of three or more standard hybrids when grown in the zone of adaptation. The director of the Agricultural Experiment Station and the Commissioner of Agriculture decide which hybrids will be used as standards for each classification. The experiment station, when requested to do so by the Commissioner of Agriculture, will test hybrids to determine whether they are correctly labeled.

The hybrids being used as standards at present are:

Northern Zone	80 days	AES 101, Morden 77, AES 204
	85 days	AES 203, Minhybrid 803, Wis. 255
North Central Zone	90 days	Minhybrid 804, Wis. 270, Wis. 275
Central Zone	95 days	Minhybrid 611, Minhybrid 612, Nodak 502
	100 days	Minhybrid 608, Wis. 355A, Wis. 453
South Central Zone	105 days	Minhybrid 507, Minhybrid 513, Wis. 464A
Southern Zone	110 days	Minhybrid 508, Minhybrid 511, Minhybrid 409
	115 days	Minhybrid 408, Minhybrid 412, Minhybrid 415

Hybrids too late in maturity for the 115 day Southern zone rating will be classified as 120 days O zone or 125 days O zone. Hybrids too early for the 80 days N zone classification may be rated as 75 days N zone.

The law also provides for a program of pre-testing the maturity of hybrids by the Agricultural Experiment Station for companies which have not distributed seed in the state during the past ten years.

CROP DISEASES IN MINNESOTA IN 1961

Herbert G. Johnson
Extension Plant Pathologist

The severity of plant diseases varies considerably from year to year. Many diseases are found every year, but they cause relatively little damage. Each year, however, conditions occur that cause certain diseases to build up to severe proportions.

Control measures must be geared to:

1. Frequency of occurrence
2. Cost of control and value of crop
3. Timing (when is the disease most easily controlled?)
4. Forecasts and warnings

Certain control measures are generally advisable:

1. Selection of disease resistant varieties
2. Obtaining of healthy seed and planting stock
3. Seed treatment
4. Crop rotation
5. Proper timing of planting and harvesting
6. Good cultural conditions

The following plant diseases are important in Minnesota for various reasons. Some cause serious crop damage and yield losses, some are important on crops that are grown on a limited scale, some are important because good control measures are available even though the losses the diseases cause are not always severe, others are important because they are spectacular and many people request information on them.

Corn Stalk Rot and Lodging -- This disease and lodging problem is present every year, but was somewhat more severe in 1961 than in many previous years. It is the most costly disease problem of our most valuable agricultural crop. See attached Fact Sheet "Stalk Rot and Lodging of Corn" for details on this disease. Entomology Fact Sheet No. 7 "Chemical Control of Soil Insect Pests of Corn," Entomology Fact Sheet No. 14 "Controlling Corn Rootworms," and Miscellaneous Report 28 "Minnesota Hybrid Corn Performance Trials" give additional information on the control of this problem.

Northern Corn Leaf Blight -- This disease was present in the southern counties of Minnesota in 1961 although it was less severe in 1961 than it was in 1960. Field inspection in mid-September 1961 showed about 15 percent of the leaf surface of corn plants affected in the most severely infected fields. Losses are believed to have been negligible. An enclosed sheet copied from a Nebraska report gives a good description of this disease.

Holcus Leaf Spot of Corn -- This is not a serious disease, but it is common in many seasons. It is a bacterial disease that causes a round to oblong leaf spot about 1/8 to 1/4 inch in diameter. The spots are usually gray and may have a reddish margin. Extended rainy weather early in the season

usually increases the incidence of this disease. The heaviest infections are generally at the ends of the leaves, and the lower leaves of the plants are generally the most heavily infected.

Loose Smut of Barley -- Incidence of this disease in 1961 was about 1 percent on the average, down from a high of 6.5 percent in 1959. Much of this reduction is believed to be due to the elimination of heavily infected seed lots by the use of the "embryo test." This test which shows the percentage of barley-seed embryos infected with the loose-smut fungus is in operation now. Procedures for obtaining tests on barley seed samples are as follows:

1. Obtain a random and representative sample of the seed lot.
2. Send about 1 pint of the seed for the test.
3. Send the sample to:
   Minnesota Crop Improvement Association
   Institute of Agriculture
   University of Minnesota
   St. Paul 1, Minnesota
4. Enclose a check in the amount of $5 for each sample, made out to the Minnesota Crop Improvement Association.
5. Be sure that return address and sample identification are plainly marked on the package or enclosed.
6. Mark the package "Smut Test."

Barley seed should be tested for loose smut before it is cleaned and graded to save expense in case the percentage of loose smut is too high to warrant use of the grain for seed By all means do not apply seed-treatment chemicals to the seed before testing since this would make the grain unfit for feed or industrial uses. Chemical seed treatment will not control loose smut of barley or wheat. Planting of barley seed with a low percentage of or free from infected embryos is the best method of control.

See attached fact sheet "Barley Smuts" for additional information.

Leaf Spots and Kernel Blights of Barley -- Spot blotch, net blotch, Septoria blight, and powdery mildew are some of the leaf spot diseases of barley. They are present every year and little can be done to control them. Plant breeders are attempting to develop resistance to these diseases, but progress is slow. Kernel blights are caused by many of the same organisms and others.

Barley Stripe Mosaic -- This disease is also known as false stripe. It is caused by a virus and is seed-borne. It is present every year in varying amounts. The disease causes yield losses, but specific information has not yet been published. The U. S. Department of Agriculture has been working on this disease for several years at North Dakota. Progress is being made in reducing the incidence of the disease by building up disease-free seed stocks. New varieties, in general, have a lower percentage of infected seeds than old stocks of old varieties. Any variety can be cleaned up however. Control of this disease is expected to be accomplished by seed certification programs. This is another refinement in the program of continued seed improvement.

Alfalfa Leaf Spots -- Three or four different fungi cause leaf spots on alfalfa in Minnesota. There is no specific control for these diseases. The best recommendations are cutting the crops on time according to good agronomic practices and fertilizing according to recommendations and soil tests.

Alfalfa Bacterial Wilt -- The alfalfa varieties recommended by the Minnesota Agricultural Experiment Station have the highest degree of resistance to this disease of available varieties. Promote vigorous growth by good cultural practices and fertilizing as necessary.

Winter Killing of Alfalfa -In the spring of 1961 some reports of extensive losses of alfalfa stands were reported from the west central part of Minnesota. All varieties were apparently affected. This was traced to the occurrence of an ice sheet on parts of fields. The ice sheet had developed when snow cover partially melted and then froze again This situation can occur at any time and place that the proper conditions come about.

Black Rot and Blackleg of Cabbage and Related Plants -- The control methods for these diseases are clear cut and practical, but every year severe losses are suffered by many growers. These losses can nearly always be traced to the omission of one or more of the necessary control measures. There are two phases to this control: Hot-water treatment of seed and crop rotation. Some counties have a day or two each spring when hot-water seed treatment is done on a group basis. This treatment can be arranged for in other counties.

Bacterial Diseases of Tomato -- At least three different bacterial diseases can attack tomato in Minnesota. The bacteria that cause these diseases are seed-borne and can also live over winter for one season in crop refuse. Hot water seed treatment and crop rotation are the recommended controls for these diseases. Plants produced in southern states and shipped north to this area sometimes carry another bacterial disease that has killed entire plantings early in the season.

Damping-Off of Bedding Plants -- Every spring several calls are received for help in controlling damping-off of vegetable and flowering plant seedlings. A complete program of soil sterilization and sanitation is the best procedure. Chemicals are sometimes very helpful after the trouble has started. One of the best materials for this purpose is PCNB (trade name Terraclor). This material is available in a 4-pound trade package of 75 percent wettable powder. An attempt is being made to have a one or two pound package available also. A half tablespoon of this fungicide in a gallon of water is a good drench for control of damping-off. A tablespoonful of captan or ferbam fungicide per gallon of water used in combination with PCNB is often better.

Onion Smut -- Liquid formaldehyde was used to treat a 30-acre field of commercial onions in Minnesota in 1960 and 1961 for control of onion smut. Results appeared to be very good. This is an economical treatment and still it is the best that has been devised for the control of this disease.

Anthracnose of Cantaloupe -- Cantaloupe is a relatively minor crop in Minnesota, but to those who are growing it as a market crop it can be very important. In 1960 a four-acre field of fine fruit was made unmarketable in a few days by anthracnose disease. This disease can be controlled by timely applications of fungicides.

Cucumber Diseases -- Several diseases can be limiting to the production of cucumbers either by reducing yield or by damaging the fruits so that they are unsaleable. Some of these diseases are: scab, angular leaf spot, anthracnose, bacterial wilt, mosaic, and powdery mildew. A disease control program including: mercury treatment of seed, crop rotation, and chemical application to the growing crop is needed to control all of these diseases.

Apple Scab -- This is one of the most serious diseases of apples. Commercial producers must control this disease every year or losses may be severe. This disease has been severe on some ornamental flowering crab apple trees in recent years.

Cedar-Apple Rust -- This is one of the most spectacular diseases of plants. In the spring of the year the large, orange-colored, gelatinous horns coming out of the galls on the cedar trees bring on a flood of calls to various offices for an explanation. Then in late summer the large red and yellow spots on apple leaves bring more calls. The apple fruit is also attacked. A fact sheet on this disease is included.

Other fact sheets and information included are:

Plant Pathology Fact Sheet No. 1 "Late Blight of Potatoes"

Plant Pathology Fact Sheet No. 2 "Disease Control for Strawberries"

Plant Pathology Fact Sheet No. 7 "Flax Diseases"

Reprint from "Horticulture" entitled "edible wild mushrooms"

Plant Disease Specimen Data Sheet - This may help you diagnose some plant troubles.

CHEMICALS COMMONLY RECOMMENDED FOR USE IN MINNESOTA FOR CONTROL OF PLANT DISEASES

Herbert G. Johnson
Extension Plant Pathologist

Many seed and fertilizer dealers carry a supply of pest control chemicals. The sale of these materials fits in well with the other products they handle. People who purchase seed and fertilizer often wish to buy pest-control materials at the same time or later. They will rely to a great extent upon the advice of the dealer and will expect him to have information and materials available. Answers to requests for information on pest control that are given by public or private agencies often include recommendations for use of chemicals. Persons who receive such information appreciate a local source of supply.

The great number of agricultural chemicals on the market today cause considerable confusion for most people who sell them or use them and for those who are in a position to make impartial recommendations as well.

An attempt to set up recommendations for sales and use based on a minimum number of chemicals presents problems; however such an attempt will be made here. Recommendations for use of these chemicals on food crops must be checked with limitations for use on specific crops.

Fungicide	Some Uses
1. Captan	Fruit diseases--apple, plum, cherries, strawberry, raspberry (does not control rust of apple), ornamentals' diseases.
2. Maneb	Vegetable diseases--potato, tomato, cucurbits. Ornamentals' diseases

The above fungicides will control 80-90 percent of the common diseases of fruits and vegetables in Minnesota of the types of diseases that can be controlled by spray or dust applications.

3. Ferbam	Fruit diseases--apple (including rust), plum, cherries, raspberry. Ornamentals' diseases.
4. Karathane, or Mildex, or Sulfur	Powdery mildew control
5. PCNB	Damping-off of seedlings. Club root of crucifers Rhizoctonia diseases Soil drench for root and crown disease control.

6.	Organic seed-treatment fungicide: Captan, or Chloranil or, Dichlone, or Thiram	General seed treatment. (Volatile mercury seed treatment chemicals preferred for cereal grain crops.)

Other fungicides than those listed above may be preferred for specific purposes. Others may be cheaper and yet satisfactory for some purposes. Commercial growers and some home gardeners may require other fungicides in addition to these. Whether spray or dust materials or both should be kept in stock is a matter of preference of the customers in an area.

Following are some of the materials commonly recommended, some of their trade names, persons who are likely to use them, and some of the diseases that they control. The "Commercial Fruit Spray Guide," the "Commercial Vegetable Pest Control Guide," the "Home Fruit Spray Guide," and other bulletins, folders, leaflets, fact sheets, etc., give additional information on pest control. These publications are available from the Bulletin Room, University of Minnesota, Institute of Agriculture, St. Paul 1, Minnesota and from County Extension Offices.

1. Zineb -- some trade names: Chemform Spray Zineb, Dithane Z-78, DuPont Fungicide A, Ortho Zineb Wettable, Parzate Zineb Fungicide, or liquid mixture Nabam (Dithane D-14, Ortho Nabam Liquid Spray, Parzate Liquid Nabam Fungicide, Thiodow-Liquid, etc.) plus zinc sulfate. Used commercially by potato and tomato growers. Also widely used for control of many fungus diseases in the home yard and garden. Controls a wide range of fungus diseases including early and late blight of potatoes and tomatoes, rusts, etc. Recommended in some states as a soil treatment for control of black root rot of strawberry. May be recommended for general use in control of leaf-spot diseases of ornamentals.

2. Captan -- some trade names: Orthocide 50 Wettable, Orthocide Garden Fungicide, Stauffer Captan 50-W, Stauffer Captan Garden Fungicide. Used commercially by fruit growers. Also widely used for control of many fungus diseases in the home, yard and garden. Controls a wide range of fungus diseases, including apple scab, graymold fruit rot of strawberry and some "damping off" and root rot in soil. May be recommended for general use in control of leaf spot diseases on ornamentals.

3. Maneb -- some trade names: Dithane M-22, Manzate Maneb Fungicide. Used commercially by many tomato growers in other states. It is known to control five fungus leaf-spot diseases of tomatoes. Has many of the same characteristics as zineb, but is superior to zineb in some respects. This use of this fungicide is increasing for potato spraying in Minnesota. Gives better control of early blight of potato than zineb. Very good for control of rose blackspot. May be recommended for general use in control of leaf spot diseases on ornamentals.

4. Ferbam -- some trade names: Black Leaf Ferbam Wettable Powder, Chipman Ferbam 76, Coromate, Ferberk, Fermate Ferbam Fungi-

cide, Karbam Black, Lebanon 76% Ferbam, Niagara Carbamate, Nu-Leaf Black Fungicide, Orchard Brand Ferbam, Penco Ferbam, etc. Used by some greenhouse operators, raspberry growers, and in home yards and gardens. Controls most fungus diseases of raspberry canes and leaves, rusts, and many leaf spots. One of the best materials for control of rust on apple. Contains iron which may correct iron deficiency in some crops when used as a foliage application.

5. Sulfur -- for control of powdery mildew, rust, and some other fungus diseases. Available as dusts and sprays.

6. Karathane or Mildex (both are trade names for the same material)-- Specific for control of powdery mildew. Superior in some respects to sulfur for this purpose.

7. PCNB -- trade name Terraclor. Used regularly by many greenhouse operators. Used primarily as a soil treatment for the control of Rhizoctonia and Sclerotinia diseases, potato scab, club root of cabbage, and others. Most commonly sold as a 75% wettable powder but is available also as dusts and an emulsifiable concentrate.

8. Lime Sulfur -- an old material replaced by newer chemicals for many purposes. Still recommended for raspberry disease control as a spray in early spring when leaves are 1/4 to 1/2 inch long. Sold as either a liquid or wettable powder.

9. Antibiotics -- some trade names: Agrimycin 100, Agristrep, Miller Streptomycin Antibiotic Spray Powder, Ortho Streptomycin Spray, Phytomycin. Used primarily for control of bacterial diseases such as fireblight of fruit trees. It will control the blossom-blight phase of fireblight but not the shoot-blight phase.

10. Actidione -- this is a trade name. Another antibiotic that is used to control certain fungus diseases such as: Cherry leaf spot, powdery mildew, white pine blister rust, rust galls on cedar, turf diseases, and others.

11. Ortho Phaltan 50-W-- A new fungicide produced by the California Spray-Chemical Corporation. Controls black spot and powdery mildew of roses. Controls many other plant diseases, but present restrictions limit its use on food crops.

12. Dodine -- trade name Cyprex. Produced by American Cyanamid Co. A new fungicide that shows great promise for control of apple scab. Has a long residual effect and is described as a local systemic. Penetrates the leaves killing some of the fungus that has already entered the leaf and protects against infection from inside the leaf. Cleared for use on commercial apples up to 7 days from harvest.

13. Dyrene -- this is a trade name. A new fungicide produced by Chemagro Corporation. This material has been cleared for use on celery, potatoes, dry onions and tomatoes. It is reported to give good control of various fungus diseases in many parts of the country.

14. Copper-Zinc-Chromate -- Trade name Miller 658 Fungicide. Produced by Miller Chemical & Fertilizer Corporation. Crops in this area for which it is cleared for use are: celery, grapes, potatoes, tomatoes, and cucurbits. It has given a good control of late blight of potatoes. The three metals in this chemical are all trace elements which could give some benefits from that standpoint.

15. Formaldehyde -- is a good fungicide for many purposes. It is being recommended for soil fumigation, treatment of wood and other materials that may carry plant-disease organisms, and for control of onion smut in the field. The recommended form of material for all these uses is the 37% commercial formaldehyde (liquid).

16. Seed treatment materials. See USDA Misc. Pub. No. 219, Oct. 1957 entitled "Treat Seed Grain" for recommendations on grain crops.

The following Organic Seed Protectant Materials are good for general seed treatment where protection from soil-borne disease organisms is desired.

Common Name	Some Trade Names
Captan	Captan, Orthocide
Chloranil	Spergon
Dichlone	Phygon
Thiram	Arasan, Thiram

General - The above materials can be obtained as single materials or as proprietary materials in combination with other chemicals. As proprietary materials the size of the package is usually small and is adapted for home use. The single materials usually come in larger packages which are intended more for commercial use. Recommendations for use as shown on package labels and bulletins must be followed closely to avoid residues in food products. Precautions in handling must also be studied and followed closely to avoid accidents.

The materials that control a wide range of plant diseases such as captan, zineb, and maneb may be recommended for trial on ornamentals or vegetables on which they are approved for problems in which the exact recommendation is not known. If one material does not control the problem, another may be tried; however, care must be used to recommend materials only for those food crops on which approval has been given.

farm and home

PLANT PATHOLOGY NO. 1

FACT SHEET

Late Blight of Potatoes

HERBERT G. JOHNSON

Can late blight of potatoes be successfully and economically controlled? The answer is yes, for it is being controlled by a number of growers. Losses from the disease occur as reduced yields and/or infected tubers. Chemicals must be used judiciously if the most effective and economical results are to be obtained. Although we are working toward the day when disease surveys and readings from field instruments will help us set up spraying or dusting schedules, we are not ready for that yet. Information on epidemics can help to determine the amount of chemicals to apply.

CONDITIONS REQUIRED FOR INFECTION

What are the peculiarities of this disease that we must consider in planning a sound control program? This disease has been a potential danger to potato crops for about 115 years. Many plant pathologists have contributed to our present-day knowledge of the disease. We know for instance, that the right fungus (Phytophthora infestans), a susceptible host (the potato), and favorable weather conditions are necessary if the disease is to develop.

Temperature and moisture ranges over which specific phases of growth and development occur are known. Temperatures vary about 20 to 25 degrees from day to night in Minnesota. Periods in which night temperatures average about 50 degrees F. and day temperatures average around 70 degrees F. are favorable for the fungus. When the above temperatures are combined with moisture conditions that keep foliage wet for 12 or more hours at a time, the fungus grow and develop rapidly. Relative humidity above 90 percent, heavy dews, and rains all help to provide the moisture required. Prolonged periods of the above temperature and moisture conditions set the stage for a severe epidemic.

Cool, moist weather during the night is favorable for spores to develop on old lesions and also for these spores to germinate and grow into new leaf areas. Wind and splashing rain move the spores around for relatively short distances from old infection spots to healthy leaf tissue. After the fungus has entered the leaf, the warmer day temperatures favor rapid growth of the fungus in the leaf. Under favorable conditions these new infection spots will be producing spores in 4 to 6 days.

Dry conditions stop spore production, and high temperatures of 95 degrees and above practically stop growth of the fungus in leaves, but not in the stems. Spores are again formed on the stem lesions when conditions become favorable.

SOURCES OF LATE BLIGHT FUNGUS

Where does the fungus come from in the spring and summer? Present information indicates that it gets its start from local sources. It may winter over in stored tubers. Some of these tubers may be in good condition in the spring and be cut for seed. The fungus grows up the stem from the seed piece and produces spores on the stem and leaves. Infected tubers may be discarded and thrown out on dumps where spores will be produced. Occasionally, infected volunteer plants may start from tubers that have been in the field over winter. The above sources appear to give the fungus its initial start in the spring and summer. Close attention to sorting of seed and destruction of all discards will do a great deal to prevent the start of late blight.

CONTROL OF LATE BLIGHT

Now, what are the rules to follow in control of the disease in the field? No exact procedure can be described that will give the maximum control with the greatest economy for all seasons. Several suggestions can be given, however, that will provide the grower with a basis for a sound program.

All the varieties of potatoes grown at present are susceptible to late blight. Therefore, it is necessary to use suitable fungicides for control of the disease. The following spray and dust materials have given good control:

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Commercial Sprays

Material*	Form	Percent actual chemical	Amount per 100 gallons
Zineb	Wettable powder	65	1½ lbs.
Nabam	Liquid	19	2 quarts plus 3/4 lb. zinc sulfate
Maneb	Wettable powder	70	1½ lbs.
Copper	Wettable powder		Follow label directions

* These materials are sold under trade names such as the following:

Zineb -- Chemform Spray Zineb, Dithane Z-78, Ortho Zineb Wettable, Parzate Zineb Fungicide

Nabam -- Dithane D-14, Ortho Nabam Liquid Spray, Parzate Liquid Nabam Fungicide, Thiodow Liquid

Maneb -- Dithane M-22, Manzate Maneb Fungicide

Copper -- C. O. C. S., Copper A, Basicop, Tri-Basic Copper Sulfate, Cupro-K, Ortho 53

Sixty to 100 gallons of spray per acre should be applied when the plants are 6 to 8 inches tall. The rate should be increased to 125 to 150 gallons per acre when the plants are fully grown.

Commercial Dusts

Zineb, maneb, and copper materials are made up as 6 to 8 percent dusts. These should be applied at rates of about 20 lbs. per acre on small plants and increased to rates of 40 lbs. per acre on large plants.

Home Garden Sprays

Zineb, Maneb, or copper wettable powders may be mixed with water at the rate of 1 level tablespoonful per gallon. Spray mixtures containing one of the above materials may be used according to the manufacturer's directions.

Home Garden Dusts

Materials given under "Commercial Dusts" or these materials in combination mixes may be dusted on plants. Cover plants thoroughly. Best results are obtained if application is made when plants are wet.

Many people prefer sprays for maximum coverage of plants; while others prefer dusts because the machinery is lighter and can be used under more adverse field conditions. Dusters are usually cheaper than sprayers; but dust is more expensive than spray material. Sprayers can be used in higher wind velocities than dusters. Dusters do not require water. High-pressure sprayers give a finer mist and better leaf coverage than low-pressure sprayers. Sprays do not bother the operator as much as dusts. Air blast sprayers apparently do a good job of plant coverage with about half the volume of water required for high pressure sprayers. Each grower should pick the type of material and type of machine that best suits his situation.

Fungicides may be applied from the time the plants are 6 inches tall or even earlier if necessary. The time will depend upon: the presence or absence of the fungus, the weather, and the determination of the grower to control the disease. Additional applications should be made at intervals of not more than 10 days. The interval should be shortened if generally favorable weather conditions prevail for the disease to develop.

A half inch of rain, whether it occurs at once or over several days, will remove much of the chemical. Intensive schedules of 5-day intervals are often used for short periods. One cardinal rule to remember is that the fungicide is a protectant which must be on the leaves before the spores land on them. Treatment after the fungus has grown into the leaves will not stop growth of the fungus but can only prevent new infection points from starting. Therefore, the chemical must be applied as soon as possible after rains to protect the plants before the next rain or dew occurs.

PREVENTION OF TUBER INFECTION

The fungus must be controlled on the foliage and stems if tuber infection is going to be prevented with certainty. Tuber infection occurs when spores are washed by rains from the tops of plants into the soil to the tubers. This usually requires heavy rains, and we never known when heavy rains will occur. Therefore, the fungus must not be allowed to grown on the foliage up to the time that the vines are killed. Hilling the plants up in high ridges will help prevent tuber infection by diverting rain water away from the rows. The tuber crop can sometimes be saved following a heavy infection of vines, by immediate and complete killing the vines. (Chemicals are preferable because they generally kill all of the above-ground parts of the plants although mechanical beating is often quite satisfactory.) Many infected tubers will rot and about two weeks after vine killing the sound tubers can be harvested.

WATCH FOR FIRST SIGN OF LATE BLIGHT

All sources of information should be watched as a guide to the relative intensity of spraying or dusting operations that are required during the season. Field inspections, reports of blight from distant and local areas, weather data--particularly from temperature and humidity recording instuments in potato fields--and rainfall records are the means by which the intensity of chemical application must be based. Remember--when you see the first sign of blight in your field, it may be too late to prevent some loss because there may be more infection than is apparent.

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farm and home

PLANT PATHOLOGY NO. 2

FACT SHEET

Disease Control for Strawberries

HERBERT G. JOHNSON

High yields of high-quality berries are the objective of most strawberry growers. Many people remember certain years when crop production seemed almost ideal. For some reason or reasons excellent crops are not produced every year. Weather conditions that damage the crop are beyond our control in most cases. Much of the loss is caused by diseases, insects, and weeds and to a great extent these pests can be controlled. Only the diseases will be discussed here, however a sound strawberry production program will include organized control of all pests.

FUNGICIDE APPLICATIONS FOR ESTABLISHED PLANTS

The production of the best possible crop from existing plantings is of immediate interest. Use chemicals to control diseases such as leaf spots and fruit rots on these plantings.

The first recommended treatment in the spring is a dormant application of one of the phenyl mercury acetate compounds. Apply this treatment before new growth starts. Remove mulch, if present, before new growth starts and apply the fungicide immediately. If the mulch is left on the plants until new growth starts, eliminate this treatment or try it on only a limited portion of the planting. This application acts as an eradicant for fungus spores that would later cause leaf spots and fruit rots. Federal regulations require that this material not be applied to plants while fruit is present.

Approved rates of application are 1/2 pint of 10% solution per 100 gallons of water and not over 250 gallons of that spray mixture per acre. For small amounts the rate is approximately 1 teaspoonful of 10% solution per 2 gallons of water. Phenyl mercury acetate is sold under various trade names and in various concentrations. If a wettable powder is recommended at a rate of 4 ounces per 100 gallons of water, small amounts can be made up at a rate of 1 level teaspoonful per 3 gallons of water. Follow the recommended rates on the labels for materials of other concentrations. Cover live plants and old leaves liberally with the spray.

Insecticides are generally recommended at bud stage (just before bloom). Apply one of the following organic fungicides, at the rate given, in combination with the insecticides.

Spray Application

Fungicide*	Lbs. per 100 gallons	Tablespoons per gallon	Last application before harvest
Captan 50% W.P.	1½ to 2	1	No time limitation
Ferbam 76% W.P.	1½ to 2	1	20 to 30 days
Zineb 65% W.P.	1½ to 2	1	7 days

*These fungicides are sold under trade names such as:
Captan - Orthocide 50 Wettable, Orthocide Garden Fungicide, Stauffer Captan 50-W, and Stauffer Captan Garden Fungicide.
Ferbam - Black Leaf Ferbam Wettable Powder, Chipman Ferbam 76, Coromate, Ferberk, Fermate Ferbam Fungicide, Karbam Black, Lebanon 76% Ferbam, Niagara Carbamate, Nu-Leaf Black Fungicide, Orchard Brand Ferbam, Penco Ferbam.
Zineb - Chemform Spray Zineb, Dithane Z-78, Ortho Zineb Wettable, Parzate Zineb Fungicide.

Dust Application

You can apply dusts of captan, ferbam, or zineb of 5 to 10% concentration instead of sprays. For best results apply dusts when the plants are wet or damp.

Make additional applications of the above fungicides at intervals of 7 to 10 days up to the limitation given on the above table. Captan may be applied up to and during harvest. Generally, make harvest applications immediately following picking of ripe fruit.

Powdery mildew occurs at times on strawberries. Karathane or Mildex 25% wettable pow-

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der at the rate of 3/4 to 1 pound per 100 gallons of spray or 1/2 to 3/4 level tablespoonful per gallon may be applied. These materials must not be applied later than 21 days before harvest.

The above fungicides may be applied to June-bearing varieties after harvest. The limitations given above for "last application before harvest" must be followed for everbearing varieties.

An application of phenyl mercury acetate (same as the spring dormant treatment) may be applied in the fall after the plants are dormant, but before a mulch is applied. Normally in Minnesota this would be in late October.

Planting Stock and Soil Problems

Some plant disease problems must be corrected before plantings are made. The plants or soil may be infected or infested with disease organisms that would later cause problems.

Winter Injury

In recent years some growers have lost many plants in new plantings and surviving plants have often been weak. Low yields generally result. Plant damage is apparently caused by several factors including winter injury to the plant beds from which new plantings were made. The injury is most likely to occur if the plants are exposed to alternating warm and cold temperatures during the winter. Snow cover or mulching with hay, straw, leaves, or other such material reduces the chance of winter injury.

Virus

Research work on strawberry diseases has shown that most plantings are infected with viruses. In spite of this infection many plantings that have been well cared for have produced good crops. The U. S. Department of Agriculture has produced new stocks of common varieties that are free from viruses. Increases in yields have been found in some tests where virus-free plants have been compared with virus-infected plants of the same varieties. Virus-free stocks of many varieties are being made available to commercial nurseries. Get these new stocks for new plantings when available.

Strawberry viruses are spread by aphids. Virus-free plants will become infected after a few years unless these insects are carefully controlled. For commercial fruit growing or home gardens it is perhaps better to obtain new plants every few years than to try to control the spread of the viruses.

Nematodes

Parasitic nematodes are small, round worms that usually measure from about 1/64 to 1/16 of an inch long. Some species of nematodes cause serious diseases of strawberries when they occur in high numbers. Root-knot nematodes cause characteristic knots or galls on the roots. Some symptoms of root-knot and of other nematodes are: stunting, yellowing of leaves, reduced yield of berries, reduced production of runner plants, wilting, and general loss of vigor. Severe infestations of nematodes on strawberry plants have been found in a few cases in Minnesota.

Nematode root diseases are almost impossible to diagnose from symptoms alone. To make an accurate diagnosis, nematodes must be recovered and identified from the diseased plant. This can only be done in a specially equipped laboratory by trained personnel. Whenever a nematode problem is suspected, collect approximately 1 quart of soil together with the roots of a few diseased plants from the suspected field. Place samples in a plastic bag to prevent drying and mail them to Nematode Survey, Department of Plant Pathology and Botany, Institute of Agriculture, University of Minnesota, St. Paul 1, Minnesota.

Nematode Control

The basic principle of nematode control in strawberries is planting only Nematode-free strawberry plants in nematode-free soil. Only a few commercial suppliers make an attempt to supply nematode-free strawberries, but more nurseries are producing such plants each year. Additional information is available in U. S. Department of Agriculture Leaflet No. 414 entitled "Reducing Virus and Nematode Damage to Strawberry Plants."

Eliminating nematodes from the soil is at best a rather expensive and difficult task. The basic method of field-scale nematode control is soil fumigation, i.e. application of chemicals to the soil which will kill nematodes. Obtain information on soil fumigation from the Extension Plant Pathologist.

Black Root Rot

The term black root rot is used to describe a variety of symptoms in which roots are black, many plants die, and remaining plants are often weak. The cause has been traced to: winter injury, root rot, virus infection, or nematode infection. It appears, in Minnesota, to be associated more with the condition of the planting stock than with the soil on which the plants are grown.

At present the best recommendations for control are: use sound, healthy plants; sort plants at planting time to eliminate weak ones and those with discolored roots; use virus-free and nematode-free plants; plant on new ground that has not been in strawberries for several years; and use a good program of soil fertility and insect control. Soil fumigation for the control of fungus diseases can be used if necessary.

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PLANT
THOLOGY
NO. 3

FACT SHEET

Stalk Rot and Lodging of Corn

HERBERT G. JOHNSON

Corn is the most valuable field crop in Minnesota. Nearly 6,000,000 acres produce about 30,000,000 bushels of grain each year. Stalk rot and the lodging that results from it has been estimated to cause an average annual loss from 5 to 10 percent of the crop or from 15 to 30 million bushels of grain.

Severely lodged corn in southern Minnesota, November 1956

LOSSES FROM STALK ROT AND LODGING

Yield Loss

Corn plants inoculated with stalk-rot fungi have been found to yield up to 35 percent less than similar plants which were not inoculated. Field tests have been used to obtain such figures.

Dropped Ears

Much of the corn that is produced on plants with stalk rot is not harvested because many ears have dropped to the ground before harvest and the mechanical harvesters are unable to pick all of the ears from lodged plants.

Volunteer Plants in Following Crop

Corn seed left in the field as a result of lodging produces volunteer plants in the following year. These may reduce the yield of the current crop, especially soybeans, through competition. Corn seed from the volunteers is objectionable when mixed with soybean seed.

CAUSE OF STALK ROT

Stalk rot is caused by fungus infection. Fungi of the genera Gibberella and Diplodia are most commonly associated with stalk rot of corn in Minnesota. These fungi are present in living and dead corn plants, in the soil, and they also grow on many other dead plants. Gibberella also causes scab and root rot of cereal grains. Spores of these fungi are carried by the wind. The fungi that cause stalk rot of corn can, therefore, be expected to be present in all corn fields all of the time. These fungi enter corn plants through the roots and grow up through the stalks. They also enter the stalks through buds and through wounds such as insect tunnels.

RESULTS OF STALK ROT

Fungus infections of roots and stalks of corn plants result in a general weakening of the plants. Severely infected plants often die prematurely. Such plants generally have small ears with poorly filled kernels and correspondingly low yields.

Corn roots are often damaged and weakened by fungus infection and insect attack. Plants with damaged roots aften lean over severely during rains and strong winds. Such plants often do not straighten up during the season.

FACTORS AFFECTING STALK ROT AND LODGING

1. Today, seed of hundreds of hybrid lines of corn is available for the planting of commercial fields. These hybrid lines differ from each other in many characteristics including resistance to fungus infection and resistance to leaning and breakage.

2. Corn in thick stands tends to lodge more than corn plants in thin stands.

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3. A fertility imbalance in the soil such as low potash or excessively high nitrogen can also contribute to corn lodging.

4. Soil-insect infestations contribute to corn lodging. High populations of the northern corn rootworm are usually associated with this type of lodging.

5. Overmature corn often lodges severely. The longer corn stalks are exposed to weather, the more likely they are to be broken.

6. Corn fields with high yields tend to lodge more than those with lower yields.

7. Some weed chemicals cause a brittleness to develop in corn stalks following treatment. This brittleness is present in corn for about 10 days following treatment with 2,4-D. Affected plants often break if high winds occur during the brittle period.

CONTROL OF STALK ROT AND LODGING

Stalk rot and lodging of corn can be reduced if certain practices are followed. Complete elimination of stalk rot and lodging is not possible at present. The following recommended practices have been found to be effective in reducing stalk rot and lodging of corn in Minnesota. Use all of the recommended practices. They are economical for commercial corn growing and they are in agreement with other recommended practices for corn growing in this state.

Hybrid Selection

Planting of lodging-resistant corn hybrids is the simplest and cheapest way of reducing losses from lodging. Information on performance of hybrids should be obtained from all available sources. Miscellaneous Report 28 "Minnesota Hybrid Corn Performance Trials" is published each year by the Agricultural Experiment Station, University of Minnesota. A copy can be obtained by writing to the Bulletin Room, University of Minnesota, St. Paul 1, Minnesota. Neighboring states publish similar reports. Comparative performance of corn hybrids can often be observed firsthand by inspecting corn plots that have been planted by experiment station personnel or by employees of hybrid seed-corn companies.

Plant Population Control

Up to a certain point (which varies from place to place and season to season) yields per acre increase with the number of corn plants per acre. However, lodging also increases as the number of plants per acre increases. The problem is to know how many plants produce the highest yield with the least lodging. This figure will depend upon the hybrid used and the water and nutrients available in the soil.

Available information indicates that an average of 16,000 to 18,000 plants per acre at harvest time on fields with high-yield potential is a good compromise for obtaining high yields and preventing excessive lodging. A 10 to 15 percent loss of plants from various causes must be anticipated. Therefore, plant from 18,000 to 20,000 seeds per acre. Fields with lower yield potential should have populations at harvest time of about 14,000 plants per acre.

Fertility Balance Control

A good fertility balance should be maintained in the soil if excessive lodging is to be prevented. Excessively low potash or high nitrogen is most commonly found associated with corn lodging. A low potash level in the soil can be detected by a routine soil test. Nitrogen is sometimes applied in high amounts in anticipation of high yields. Good yields may be obtained, but excessive lodging can result in harvesting losses that will more than offset the additional yield gained. Potash and phosphorus should be applied as indicated by the soil test and the rate of nitrogen applied. (See Extension Bulletin 277 "Guide to Fertilizer Use in Minnesota").

Soil Insect Control

The northern corn rootworm is the soil insect that is most often associated with corn lodging in Minnesota. These small worms eat the corn roots and if they occur in large numbers they can cause damage that will result in severe lodging. The rootworms can be controlled by crop rotation or by application of certain insecticides to the soil. See Entomology Fact Sheet No. 7 "Chemical Control of Soil Insect Pests of Corn."

Harvest Early

Harvest corn as soon as possible after it has reached the stage of maturity you want. The longer standing corn is exposed to the weather the more lodging is likely to occur. Recently developed practices permit earlier harvesting than formerly. Corn to be used for ear-corn or shelled-corn silage should be harvested at 35 to 40 percent ear moisture. Artificial drying permits the harvest of corn with up to 30 percent ear moisture. Whole-corn-plant silage also permits early harvest. Corn to be put into cribs for drying is usually harvested at 20 to 25 percent ear moisture.

Use of the above recommended practices will not insure that lodging will not result in any certain field; however, they have all been found to reduce lodging where they have been tried.

Follow the recommended practices:

1. Hybrid selection
2. Plant population control
3. Fertility balance control
4. Soil insect control
5. Early harvest

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PLANT
THOLOGY
NO. 4

FACT SHEET

CEDAR-APPLE RUST

Herbert G. Johnson

Do structures on your apple or cedar trees look like the illustration on this sheet? If so, they are infected with cedar-apple rust.

I--CONTROL OF THE DISEASE

ON APPLE TREES

An obvious, but often impractical, control of this disease is destruction of all rust-susceptible cedar trees within $\frac{1}{4}$ mile of apple trees. A more practical approach is spraying of apple trees to prevent infection. Follow these steps:

● Time to Apply: Pink and petal-fall stages of bloom. Also at full bloom if the blossom period is long due to cool weather. If cedar galls (swellings on the cedar twig caused by the infection of rust fungus) are still producing fresh "spore horns" after petal-fall stage of apples, make two more applications at 7- to 10-day intervals. (See explanation of "spore horns" in section III).

● Materials:

Ferbam fungicide--Trade names Black Leaf Ferbam Wettable Powder, Chipman Ferbam 76, Coromate, Ferberk, Fermate Ferbam Fungicide, Karbam Black, Lebanon 76% Ferbam, Niagara Carbamate, Nu-Leaf Black Fungicide, Orchard Brand Ferbam, Penco Ferbam, and others.

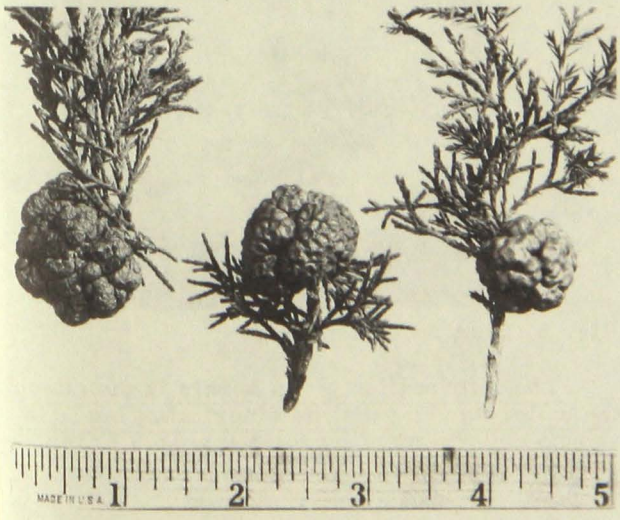

Fig. 1. Dormant galls on cedar.

Zineb fungicide--Trade names Chemform Spray Zineb, Dithane Z-78, DuPont Fungicide A, Ortho Zineb Wettable, Parzate Zineb Fungicide, and others.

General-purpose fruit sprays containing ferbam or zineb fungicides.

● Rate: One to $1\frac{1}{2}$ level tablespoons of ferbam or zineb wettable powder per gal. of water. Use spray mixtures as directed on labels.

ON CEDAR TREES

The disease generally does little damage to cedars. If, however, you wish to prevent infection on cedars, spray with the same materials and rates as given for apple trees. Spray at 7- to 10-day intervals from late July to early September. Removal of dormant cedar galls during fall, winter, and early spring will prevent spread of infection from cedar to apple.

II--LOSSES FROM THE DISEASE

● Fruit infection causes damage that reduces value for home use and lowers grade for commercial use (figure 5).

Fig. 2. Celatinous spore horns on cedar gall.

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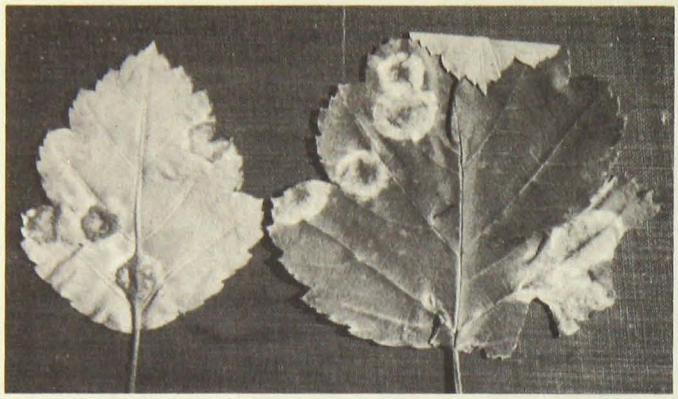

Fig. 3. Rust on apple leaves.

● Loss of leaves from infection causes reduction of size and quality of fruit in the current season.
● Infection over a period of years causes weakening of the tree with reduction of yield and may result in total lack of fruit production.

III--LIFE CYCLE OF CEDAR-APPLE RUST FUNGUS

This fungus (Gymnosporangium juniperi-virginianae) goes through a rather complicated series of events over a period of 2 years in completing its life cycle. Let's start with the galls on cedar trees in early spring... (figure 1).

During moist, warm days in the spring, usually in May, the galls take up water and gelatinous "spore horns" are forced out of little depressions in the surface of the galls (figure 2). These spore horns are made up of cells from which small spores are formed on the surface. As the spore horn drys, the small spores separate from the cells and are carried by the wind to apple leaves, fruits, and tender, young twigs. The small spores germinate during moist conditions and infect apple tissue. Small yellow spots form on leaves in about 2 weeks. These spots enlarge during the summer until they may be $\frac{1}{2}$ inch in diameter by August (figure 3). Meanwhile the fungus has grown down through the leaf and formed another kind of spot on the lower side of the leaf (figures 3 and 4). Spores from these spots are carried by the wind to susceptible cedar trees where they start new infections in late summer and early fall.

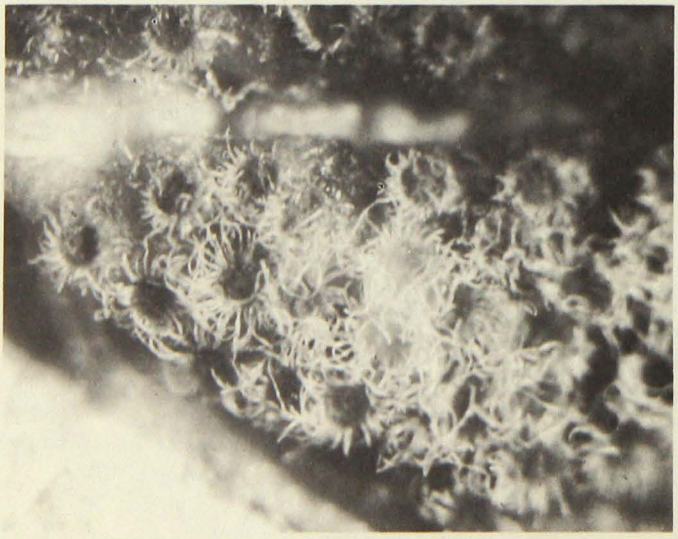

Fig. 4. Aecial stage of rust on lower side of apple leaf.

The next spring the new infections on cedar begin growing, and in June they are visible as small, brown, wart-like structures. These grow during the season and may reach a size of 2 inches in diameter. The next spring these galls will be mature and are ready to form the gelatinous spore horns. Now we are back where we started 2 years earlier. Actually two generations of galls may be present on cedar trees at one time, but they would be at different stages of maturity. Infected cedar trees usually have a generation of galls that are mature and ready to form spore horns in the spring.

IV--SUSCEPTIBILITY OF APPLES AND CEDARS TO RUST

Apple and cedar species and varieties differ in their relative resistance and susceptibility to rust. Use of the most resistant types will help greatly in preventing or reducing loss from the disease.

APPLE VARIETIES

Most resistant: Charlamoff, Hibernal, McIntosh, Northwestern, Red Delicious, and Wedge.

Intermediate: Cortland, Duchess, Erickson, Fireside, Golden Delicious, Haralson, Oriole, Patten, Prairie Spy, Redwell, and Whitney.

Most susceptible: Beacon, Dolgo, Jonathan, Minjon, and Wealthy.

SUSCEPTIBLE CEDARS AND JUNIPERS

Eastern Red Cedar (Juniperus-virginiana) and its varieties, Western Red Cedar (J. scopulorum) and its varieties (saxatilis--Mountain Juniper) and (depressa--Oldfield Juniper), Horizontal Juniper (J. horizontalis) and its varieties, and Savin Juniper (J. sabina).

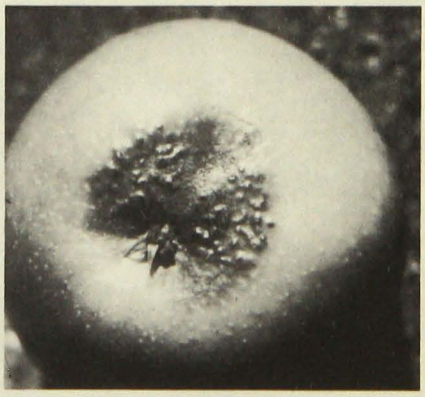

Fig. 5. Rust on apple fruit.

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O. 6

FACT SHEET

BARLEY SMUTS

H. G. Johnson and K. D. Fezer

Barley smuts are caused by fungi and have been a disease problem in the barley crop since it was first grown. At one time smut was just smut, but we now recognize three distinct species of smut on barley. Being able to distinguish among the three species is important when deciding which control measures to use.

Fig. 1 Left to right: head of loose smut, bare rachis after smut spores are gone, head of covered smut, and healthy head.

THREE SPECIES OF BARLEY SMUT

Loose smut, Ustilago nuda

This species was particularly troublesome in 1959 in Minnesota and North Dakota. The infected head is a loose mass of smut spores (figure 1). The dust-like spores are carried by air and some of them lodge in the flowers of healthy heads. If moisture and temperature are suitable, the spores will germinate, and germ tubes will enter the ovary of the flower and grow into the embryo of the developing seed. (See figure 2.) When the grain matures, the fungus becomes dormant; when the seed germinates, the fungus grows with the new plant and produces smutted heads.

Covered smut, Ustilago hordei

Grain heads infected with this fungus have membranes around the smutted kernels (figure 1). These membranes remain more or less intact until the grain is threshed. During threshing, the membranes are broken and the smut spores are spread onto and under the hulls of healthy kernels. The smut spores remain dormant on the grain in storage. When the seed germinates, the smut spores also germinate and infect the young plants.

Semi-loose smut, Ustilago nigra

Smutted heads look like loose smut (figure 1), but this disease acts like covered smut. The fungus goes through storage as spores on or under the hulls of barley kernels. The spores germinate and infect the young plants during germination of the seed. Semi-loose smut can be distinguished

Fig. 2. Barley embryo infected with the loose-smut fungus (left) and healthy embryo (right). Embryos are about 1/16-inch long.

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from loose smut only by observing the type of germination of the spores with a microscope. Less than 5 percent of the smutted heads collected from western and northwestern Minnesota in 1959 were semi-loose smut.

YIELD LOSSES FROM BARLEY SMUTS

Yield looses from barley smuts (in percent) are approximately equal to the percentage of smutted heads in the field.

WHAT DETERMINES THE PERCENTAGE OF SMUT?

Loose smut

The percentage of loose-smut infection in a new crop of barley depends on the percentage of smutted heads in the old crop, on the weather conditions at flowering time, and on the barley variety. A heavy infection in the field will often result in a fairly heavy infection in the new crop, but even fields with a light infection sometimes produce seed with a high percentage of smut. Weather at the time of flowering has a great effect. Cool, moist weather at flowering generally results in a heavier infection of the new crop than does hot, dry weather. All barley varieties currently recommended for use in Minnesota are susceptible to loose smut; although Kindred, on the average, has less loose smut than Traill.

Covered smut and semi-loose smut

Infection with these smuts depends on the amount of smut spores on the seed at planting time and on the temperature and moisture of the soil during germination.

CONTROL OF COVERED SMUT AND SEMI-LOOSE SMUT

Chemical seed treatments control these two smuts very well. The presence of the smut spores on or under the hulls of the seed makes chemical control possible. The volatile mercury seed treatment chemicals have very successfully controlled these diseases. These chemicals also protect the germinating seed from infection by other disease-causing fungi on the seed or in the soil. These chemicals can be applied at any time during the fall, winter, or early spring but at least 4 days before planting.

CONTROL OF LOOSE SMUT

Chemical seed treatment will not control loose smut of barley because the fungus is deep inside the seed in the embryo.

Large scale control

The only practical control of loose smut at present is to plant seed that is either free from the fungus or that has a very low percentage of infected embryos. This is made possible through the use of the embryo test. This is a laboratory test which involves treatment of seed with chemicals and microscopic examination; it requires special equipment and experience. This test accurately determines the percentage of infection in the seed. Lots with low percentages of smut can be saved for seed, and those with a high infection can be used for other purposes.

Following the heavy loose-smut epidemic in 1959, tests showed that sufficient seed with a low percentage of infection was available in the barley-growing area to plant the 1960 crop with good seed.

Interpretation of embryo test results

Results of the embryo test are given as a percentage of the seeds of a sample that have embryos infected with loose smut. The percentage loss in yield from loose-smut infection is about the same as the percentage of infected embryos. In some cases, the loss may be less than the percentage of infected embryos, but it should not be higher if the sample tested was truly representative of the lot. To estimate expected yield loss from loose smut, multiply the expected yield in bushels by the percentage of infected seeds and divide by 100. The result will be the expected loss in bushels For example, an expected yield of 40 bushels per acre and an embryo infection of 5 percent would result in a loss of not over 2 bushles per acre. On this basis, you can decide to save the grain for seed or use it in some other way.

Control of loose smut in infected seed

Loose smut in barley seed can be eradicated with hot water, or it can be moistened and stored in an airtight container. However, these treatments are slow and tedious; they require special equipment and experience and often reduce seed germination. They are practical only for treating small lots of valuable seed.

Through your county agricultural agent, you can obtain information on the various seed treatments and on the procedure for obtaining the embryo test.

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FACT SHEET

FLAX DISEASES

H. G. Johnson and R. A. Frederiksen

Several diseases of flax in Minnesota cause severe damage at times to the crop. Crop rotation, seed treatment, and the use of sound seed of the most disease-resistant varieties are the most practical and economical control measures. There are some diseases for which no resistant varieties have been developed and even with present recommended control measures, these diseases, may, at times, become severe. Most diseases tend to reduce the yield or quality of the crop, but seldom cause complete destruction. Misc. Report 24, Varietal Trials of Farm Crops, issued by the Agricultural Experiment Station, University of Minnesota, gives characteristics of flax varieties including their reaction to several diseases. The following is a description of common diseases and recommendations for control.

PASMO

Pasmo, caused by the fungus Septoria linicola, lives over winter in seed, chaff, and flax straw and attacks the growing crop the next season. Generally the disease becomes most severe as the crop nears maturity. This fungus attacks stems, leaves, and bolls. Bolls may fall off the plant, or

Fig. 1. Pasmo disease on flax stems. Infected areas are dark in color.

Fig. 2. Flax plant affected with aster yellows disease (left), normal plant (right).

seeds in the bolls may fail to develop because the pedicels immediately below them have been killed. Infected stems often have alternate healthy and brownish areas (figure 1) so that the stem has a "barber pole" appearance. All recommended varieties are attacked by this fungus, but some are more susceptible than others. The use of the most resistant varieties, seed treatment, and crop rotation give some control.

VIRUS DISEASES

Two virus diseases, aster yellows and crinkle, are known to affect flax and cause damage in Minnesota. These viruses are present to some extent every year, but generally are not severe. In 1957 aster yellows damaged the crop severely, and crinkle may have been important also. Both viruses are spread by the six-spotted leafhopper.

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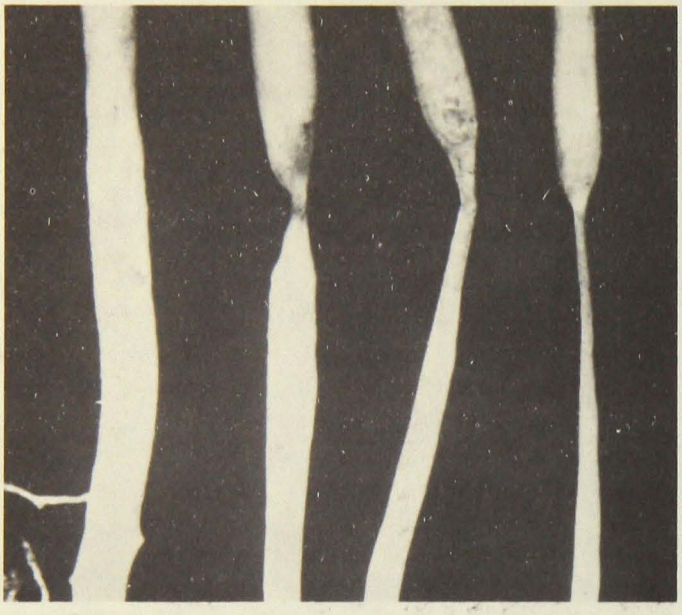

Fig. 3. Normal plant (left); three plants at right affected with heat canker at ground line.

Flowers of plants infected by aster yellows virus are yellowish-green, and bolls fail to develop (figure 2). Sometimes yellowish-green and normal flowers are present on the same plant. Effective control measures are not available at present. All recommended varieties are susceptible to this disease.

Crinkle disease of flax has been known only since 1956. The only visible symptoms are small enations or pimples on the underside of the leaves. The same virus causes the "blue dwarf" disease of oats. This disease can cause significant yield losses, but its incidence is low in most years. No resistant varieties are known.

SEEDLING BLIGHT

Seedling blight is often more severe on flax than on other field crops in Minnesota. The seed coat of flax frequently is damaged as the seed develops, and yellow seeded varieties are more susceptible to this natural damage than brown seed types. Seed often is damaged during threshing, and fungi on the seed or in the soil enter through cracks in the seed coat. Seed treatment is beneficial to flax, and the volatile-type mercury seed treatment materials are most commonly used. Experiment stations often report yield increases of several bushels per acre for a few cents' investment in seed treatment.

HEAT CANKER

High temperature at the ground line sometimes injures flax seedlings, especially during warm, clear days when the seedlings are too small to shade the ground. In severe cases the injured tissue collapses and the seedlings fall over and die (figure 3). With less severe injury, a swelling occurs in the injured region. Affected plants are usually stunted and often die prematurely. The overall effect is a reduction of the plant population and yield. Early planting, which reduces the chances of hot weather during the seedling stage, is the only practical control.

FUSARIUM WILT

Wilt is a soil-borne disease that builds up with repeated cropping of susceptible varieties on the same ground. Susceptible plants wilt and die throughout the season, but recommended varieties are highly resistant to wilt in commercial fields. All new lines of flax from plant-breeding programs are tested in wilt-infested nurseries (figure 4). The flax-wilt nursery at the Institute of Agriculture at St. Paul has been in operation since 1912, and Plot 30, the flax-wilt nursery at Fargo, North Dakota, has been in existence since 1900. All recommended varieties in Minnesota and North Dakota survived and grew vigorously in one or both of these nurseries before they were introduced as varieties.

ANTHRACNOSE

Anthracnose is a fungus disease that affects all parts of the flax plant. Seedling blight is the most common damage caused by this fungus in Minnesota, although in certain years this fungus commonly causes a leaf spotting. Stem cankers sometimes form at the ground line which look similar to those of heat canker. Seed may become infected during one season and cause seedling blight the next spring. The fungus overwinters also on infected flax straw. The use of sound seed, seed treatment, and crop rotation are the control measures. Recommended varieties are about equal in susceptibility.

RUST

This disease occurs first as yellow pustules on leaves and stems, and later turns to the black overwintering stage. Recommended varieties are immune to races of rust that are known to exist in North America. Rust has been rare in Minnesota in recent years except in fields of the old susceptible varieties.

Fig. 4. Fusarium wilt nursery at St Paul. Resistant lines of flax are vigorous while susceptible lines are dead or dying.

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for a culinary treat get acquainted with the

edible wild mushrooms

DR. CLYDE M. CHRISTENSEN, St. Paul, Minn.

A SPEAKING—and picking—acquaintance with wild mushrooms can add interest to any foray through the fields and woods, and zest to the meal afterwards—if you know your mushrooms. More than 4000 species or kinds of wild mushrooms have been described, and even an expert who devotes a lifetime to their study can hardly hope to know all of them. But one does not need to be an expert to become sufficiently familiar with some of the choicest and most common kinds to pick and eat them with perfect safety.

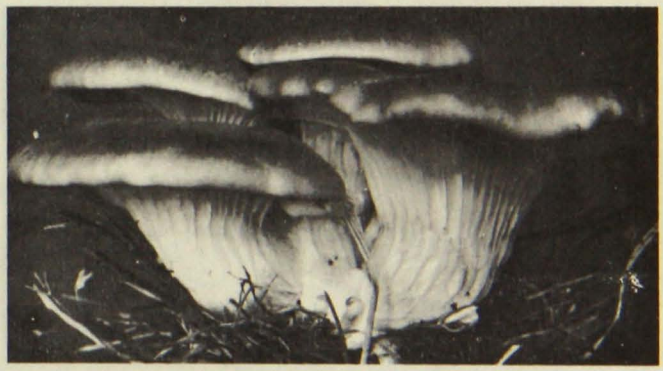
However, if you gather wild mushrooms to eat, adhere to two simple rules: 1. Learn thoroughly the characteristics and habits of some of the common, unmistakable, edible kinds, and, 2. Pick only those that you definitely know are good and wholesome. If you are doubtful, leave them alone.

A number of pamphlets and books are available that describe and illustrate many species for the beginner as well as for the more advanced mushroom hunter. Some of these are listed below. Your local library may have these or other mushroom books, so phone the library and ask. With a modicum of study the average person can learn to recognize many of the more common kinds.

In many communities, groups or societies have been formed for the collection and identification of fleshy fungi or mushrooms. The members go on hunts or field trips together, or meet a regular intervals during the mushroom season to display, compare, study and talk about the mushrooms they have found. Some of these mycological societies boast their own libraries dealing with mushrooms and their identification. Most groups have members with long experience in, and much enthusiasm for the collection, identification, preservation and cooking of wild mushrooms. These experts are willing and eager to share their knowledge and their enthusiasm, and their help can be invaluable to the beginner and very encouraging.

The individualist (God bless him!) may prefer to work alone. As proof that even a rank amateur, individualist or not, can quickly learn to identify some of the best wild mushrooms, a few common, easily recognized and choice kinds are here described and illustrated. All of these occur throughout most of the United States and Canada, and all but the shaggymane can be preserved by either drying or freezing.

Morel: *Morchella deliciosa* and other species.—*Time and place of appearance*—Midspring, in woods and orchards. *Description*—plants four to six inches high, consisting of a cylindrical stem ½ to one inch in diameter and a conical cap the outside of which is chambered somewhat like a sponge. Cap and stem are tan in color, hollow and brittle. *Edibility*—Super.



Pleurotus ostreatus

Oyster Fungus: *Pleurotus ostreatus. Time and place of appearance*—On decaying hardwood logs and trees, or on the ground above decaying roots—spring to fall. *Description*—caps white, each cap two to six inches wide, several caps one over the other in a clump, each cap tapering to a short, thick stem; gills white and extending down the stem. *Edibility*—Fair to excellent.

Fairy Ring: *Marasmius oreades. Time and place of appearance*—Spring to late fall, in lawns, golf course fairways, parkways, wherever there is permanent grass sod. *Description*—plants up to four inches high; cap one to two inches wide, off-white to tan, nearly flat or with a pronounced hump in the middle. Gills white, rather distant from one another. Stem central, about ⅛-inch in diameter. Both stem and cap are somewhat tough in texture. The plants come up in fairly dense clumps in circles or rings or partial rings that may be up to ten feet in diameter. Usually successive crops appear after each rain and in the same place year after year. These mushrooms are said to be of reviving habit, which simply means that once they have been formed they endure for some time, drying up in dry weather and expanding or reviving again during moist weather. Most old mushroom specimens are likely to be wormy, and so are not attractive for food. *Edibility*—Excellent.

Sulfur Shelf: *Polyporus sulfureus. Time and place of appearance*—Midsummer to late fall, on decaying logs, stumps, and trees. *Description*—fruit bodies shelf-like, usually many shelves overlapping, the upper side of fresh young specimens banded orange and yellow, the under surface consisting of fine pores or tubes, pale yellow to chrome yellow. Flesh is firm and white, or pale yellow. *Edibility*—Excellent. Cut in strips and fried in deep fat, they are superb.

Shaggymane: *Coprinus comatus. Time and place of appearance*—Late spring to fall, along parkways and roadsides, occasionally in gardens, especially where leafmold or horse manure has been worked into the soil. *Description*—plants four to eight inches high, stem cylindrical, white ¼ to ½-inch in diameter; cap cylindrical, one to two inches in diameter, covered with shaggy fibers or scales; gills wide, very close together, first white, then pale pink, finally dissolving from the base of the cap upward and dripping away in a black liquid. *Edibility*—Excellent, pro-

Coprinus Comatus

viding it is gathered while young and firm, before the cap liquefies.

Practically all mushrooms, wild and cultivated, are subject to invasion by the larvae of various fungus flies. When you gather wild mushrooms for eating, cut off each stem above the ground, to avoid getting soil with them. Also split each specimen down through the cap and stem, examine the interior for larval tunnels, and discard those that are infested.

The following literature on mushrooms is available:

Mushroom Collecting for Beginners, by J. Walton Groves. A bulletin which describes and illustrates about a dozen kinds of edible and some kinds of poisonous mushrooms. Available without cost from the Division of Botany, Depart. of Agriculture, Ottawa, Canada.

Mushrooms and Toadstools, by H. T. Gussow and W. S. Odell. Describes 160 kinds, with good illustrations of most. Available from same address as above.

Common Edible Mushrooms, by Clyde M. Christensen. Published by the University of Minnesota Press, Minneapolis 14, Minnesota. Reprint edition by Charles T. Branford Company. Describes and illustrates about 50 species.

Polyporus sulfureus

Morchella (Morel)

Illustrated Keys to the Common Fleshy Fungi, by the same author. Keys and descriptions of 350 kinds of fleshy fungi, with some line drawings. Published by the Burgess Publishing Company, 426 S. 6th St., Minneapolis 14, Minn.

The Mushroom Hunter's Field Guide, by A. H. Smith. University of Michigan Press, Ann Arbor, Michigan. Describes and illustrates over 100 species.

Mushroom in Their Natural Habitats, by the same author. Published by Sawyer, Inc., Portland, Oregon. Descriptive text, plus reels of colored transparencies and a stereoscopic viewer for the reels, of 231 species. ::

Marasmius oreades

Reprinted from HORTICULTURE, November 1960 issue

Reprinted by the Agricultural Extension Service, University of Minnesota.

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HELMINTHOSPORIUM LEAF BLIGHT OF CORN*

A great deal of concern has been expressed the past few weeks regarding Helminthosporium leaf blight of corn. This disease can be more spectacular than damaging.

The disease is caused by a fungus (Helminthosporium turcicum) that remains alive in the corn tissues after they are dead. During the following growing season the fungus will produce spores on the surface of the undecomposed corn tissues. These spores will be carried about by air currents and by chance some will lodge on corn leaves. The spores germinate and establish infection during long periods of dew and moderate temperatures. After the fungus has penetrated into the corn tissues, it grows in all directions but more rapidly up and down the leaf blade than across. This causes elongate lesions that are parallel with the leaf blade. In the early stages of lesion development the dying tissues usually have a dark, water-soaked appearance. As the lesion enlarges and the affected tissues change from a dry-green to dusty-tan color, a concentric ring pattern may develop. This is due to a variable growth rate of the parasite within the tissues. The fungus does not infect the kernels.

After the tissues are killed, the fungus produces numerous spores on the surface of the lesion. These spores are readily distributed by air currents and cause secondary infection if the weather is warm and humid.

Destruction of the functional leaf tissue causes reduction in grain yield. Normally this disease is not conspicuous until sometime after tasseling. This is primarily because of the lack of long dew periods rather than resistance to infection. Naturally, after the corn has reached full foliage development long dew periods are more likely to occur within a corn field.

Natural epidemics of the disease which became severe two to three weeks after fertilization may be expected to decrease yields as much as 50 percent. When the disease does not become severe until four to five weeks after fertilization, losses of 15-25 percent may take place. If the onset of the disease is delayed until mid-September or six to eight weeks after full silk, no significant losses in grain yield are likely to occur.

Resistance to this disease has been incorporated in certain hybrids that were developed for the eastern half of the United States. The amount of yield loss in any particular hybrid is directly related to the number of resistant inbred lines within its parentage. A double cross hybrid which has two of its four inbred parents resistant to the leaf blight will, in an epidemic, lose only half as much as a double cross hybrid whose four inbred parents are all susceptible.

* This is a copy of sheet No. 42 of University of Nebraska Plant Pathology Agricultural Notebook, September 22, 1961, by John L. Weihing, Extension Plant Pathologist.

Helminthosporium leaf blight has never been known to cause an appreciable loss in the 100 years that corn has been grown in Nebraska. It has been occasionally noted late in the growing season in eastern Nebraska. Why it became so much more prevalent in 1961 is not definitely known. One major factor is apparent, however. The humidity was relatively high and this did permit the occurrence of long dew periods. Another factor is that the disease was present, although to a lesser extent, in 1960 and to a still lesser but noticeable extent in 1959. This would mean there has been a gradual build-up of carry-over inoculum. The greater the amount of initial inoculum, the greater are the chances for a disease to reach epidemic proportions. Another factor is that most Nebraska-grown hybrids carry very little if any resistance to this disease. This is no criticism of the breeders of hybrid corn of this region. Why should they have gone to the time and expense of breeding for resistance to a disease that had never been of any economic importance in 100 years of corn production?

Now the question is, "will we continue to have this disease?" The answer is "yes, it will continue to be here, but whether or not it will ever be of economic importance cannot be stated at the moment." The disease agency can exist on certain grass species other than corn and is probably present year in and year out in an inconspicuous amount. The odds are that the disease will not become a major production factor in Nebraska because of one significant feature--weather. The disease cannot increase without warm, humid weather and historically Nebraska can have some very hot, dry weather. One normal dry season will drastically reduce the carryover of inoculum, thus markedly lowering the capacity of the disease to build up rapidly and extensively.

Another question that is being posed is "how much loss has this disease caused in Nebraska in 1961?" Over-all it has caused an insignificant amount. This statement may be rather hard to swallow by the bottomland farmer whose fields were heavily blighted by the first week in September; but his fields are the exception and not the rule. The preponderance of the corn in eastern Nebraska is grown on upland soils and the build-up of infection on this corn was too late to have a significant effect on yield.

A third question that is commonly being asked is "will the plant breeders develop resistant hybrids for eastern Nebraska?" The answer is "certainly they will if the disease continues to remain as a threat."

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PLANT DISEASE SPECIMEN DATA SHEET

Fill out as much of the information below as practical. This will aid us in identifying the problem and will result in better and faster service to you and the grower.

County _____ Date Collected _____

Name and address of grower _____

_____

_____

Name of crop or plant and variety _____

Age and/or size of plant _____

Area of injury (check): roots, tubers, bulbs, corms, stems (trunk), twigs, buds, leaves, flowers, fruits, seeds, other _____

Nature of injury (check): spot, rot, wilt, canker, blight, stunting, galling, dying, abnormal growth, other _____

Prevalence (check): occasional, scattered, small areas, large areas, whole fields, other _____

Severity on affected plants (check): high, intermediate, low, variable

Location in field (check): high ground, low ground, slopes, level, edge, other ____

_____

Exposure (check): north, south, east, west

Other factors that could affect the problem (give kinds and rates where applicable):

Fertilizer: _____

Seed treatment: _____

Dust or spray: _____

Seed source: _____

Soil type: _____

Herbicides on or near crop: _____

Soil moisture: wet _____ moist _____ dry _____

Date last soaking rain: _____

Crop rotation: _____

Windstorm, hail, sand, etc. (date): _____

Raising or lowering of soil level (season and year): _____

Shading: _____

Mushrooms and toadstools: edibility _____ control _____

Have you been bothered with this trouble before (explain)? _____

_____

Remarks: _____

_____

_____

_____

_____

Perhaps by this time you have figured out the trouble. If not or if you want a recommendation for control, send in the form and specimens.

COLLECTING AND PACKAGING SPECIMENS

1. Collect the whole plant if practicable. Top symptoms may result from root trouble.
2. Collect several plants showing various stages of disease and healthy plants if available.
3. If soil nematodes are suspected, about a pint of soil is necessary for a diagnosis.
4. Ship the plants to arrive at the Plant Disease Clinic in the best possible condition. Some specimens arrive as a wet mass or as dust.
   - A. Fleshy plant parts such as mushrooms and fruits should be wrapped in paper like newspaper and then put into a box.
   - B. Put large leaves between layers of heavy paper or cardboard.
   - C. Woody twigs ship well in plastic envelopes or wax paper, but most other specimens ship better if they dry out some rather than remain moist during shipment.
   - D. Place in a container that will prevent crushing.

Mail specimens along with this sheet to:

Plant Disease Clinic
Institute of Agriculture
St. Paul 1, Minnesota

_____
County Agricultural Agent

DEALERS' GUIDE TO INSECTICIDES*

John Lofgren
Extension Entomologist

Regulations on Sale and Uses

The sale and use of insecticides are regulated by two federal acts and by corresponding state laws. The federal regulations cover the interstate phases of insecticide labeling and sales and the interstate movement of treated foods or agricultural products. The state laws cover these areas within the state.

The federal acts are the Federal Insecticide, Fungicide, and Rodenticide Act, with amendments, and the Food, Drug, and Cosmetic Act as amended. The Insecticide, Fungicide, and Rodenticide Act is administrated by the USDA. It provides that all pesticides sold in interstate commerce be approved and labeled according to its provisions.

The Food, Drug, and Cosmetic Act, with amendments, is administered by the Food and Drug Administration. It provides for the establishment of tolerances for pesticides in or on agricultural commodities. This means that the applications of chemicals to crops and livestock must be done in such a way that their residues left in or on the commodities are within the established tolerances. This can be done by following to the letter suggestions as to dosage, time of application, crops or livestock to be treated, waiting periods between treatment and harvest, and other limitations stated in current recommendations and on current labels.

Forms of Insecticides

1. Dusts are dry powders ready for immediate use. They may contain 1/2, 1, 2, 3, 5, 10, or 20 percent of the actual chemical. The rest of the dust is a carrier, such as talc or pyrophyllite. Combination dusts with two or more insecticides or fungicides are available. Dusts should not be used in sprayers because they do not mix properly with water or oil.

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* From Insecticides, Ext. Bul. 263, University of Minnesota Agricultural Extension Service.

2. Wettable powders are dry powders which may be mixed with water to make sprays. Formulations containing 15, 25, 40, 50, and 75 percent of the actual ingredient are available. These powders contain a carrier plus a wetting agent which permits them to form suspensions when mixed with water. This formulation is useful on vegetation because it does not injure foliage as readily as do emulsions or oil solutions. High-volume hydraulic sprayers with mechanical agitators are best suited for handling wettable powders.

3. Soluble powders. Only a few organic insecticides, made of newer materials, dissolve in water. Powders of these chemicals are called soluble powders. They may be mixed with water in the same way as wettable powders and used in the same type of sprayers that handle solutions or emulsions.

4. Emulsifiable concentrates are liquids which contain the insecticide dissolved in a suitable solvent and an emulsifier. This permits the concentrate to mix with water to form an emulsion. These concentrates may contain many different amounts of the active ingredient, but the label will give this information plus the weight of active chemical per gallon. For example: 25-percent DDT emulsifiable concentrate contains 2 pounds actual DDT per gallon; 18.5-percent dieldrin emulsifiable concentrate contains $1\frac{1}{2}$ pounds actual dieldrin per gallon; 57-percent malathion emulsifiable concentrate contains 5 pounds actual malathion per gallon, etc. Emulsions may be used in low-pressure, low volume sprayers without mechanical agitation. Be sure the use on plants is specifically recommended or included on the label as emulsions damage some types of foliage.

5. Oil solutions are solutions, generally ready to use, of the insecticide in a suitable solvent and an oil carrier. Ready-to-use solutions usually contain from $\frac{1}{2}$-to 10-percent active ingredients. Some solution concentrates are available for further dilution with oil or to form oil sprays such as those used by aerial spray equipment, foggers, and mist blowers. Oil solutions should not be used on plants or animals except for special uses with special formulations, such as pyrethrum fly sprays on cattle.

6. Granulated material is a ready-to-use preparation of the insecticide in or on particles of an insect carrier, such as attaclay or bentonite. The particles are usually from 25 to 60 mesh in size or from the consistency of granulated sugar to that of coffee grounds. Granules are particularly useful for controlling soil insects because they sift down through foliage and last longer than other formulations. The granules are also effective for corn borer control because they roll down into the whorl of the plants. They may be applied with fertilizer spreaders, seeders, or special granule applicators, ground or aerial.

7. Aerosol and spray bombs contain one or more insecticides, an oil solvent, and a propellant gas. These bombs produce a very fine mist (an "aerosol") or a coarse spray, depending on the purpose of the bomb. The fine mist aerosols are for the control of flying insects, such as flies and mosquitoes, in a closed room. The coarser spray bombs are used to apply a residual deposit of insecticide. You may use some spray bombs on certain plants, but check the labels carefully beforehand. Large aerosol cylinders are available for use in greenhouses, warehouses, etc.

8. Miscellaneous. In addition to the main insecticides, there are a number of special types. Baits, insecticide-fertilizer mixtures, insecticide -

herbicide mixtures, mothproofing agents, etc. should be used according to recommendations.

Calculating Dosage and Rates of Application

Most recommendations are given in terms of amount of actual insecticide per acre, percent active ingredient in the finished spray, or as recipes using a given formulation in 1, 5, 25, or 100 gallons of water. The following formulas and tables will help you calculate proper dosages. This is extremely important in order to avoid waste, excessive residues, or injury to treated plants or animals.

1. To figure amount of emulsifiable concentrate needed for a required amount of actual chemical to be mixed in a spray tank:

$$\frac{\text{Number of acres to be sprayed per tank} \times \text{pounds actual needed per acre}}{\text{Pounds actual per gallon in concentrate used}}$$

Example:

How many gallons of 25-percent DDT emulsifiable concentrate (2 pounds per gallon) are needed to give 3/4 pound actual DDT per acre, using a sprayer with a 50 gallon tank applying 10 gallons per acre (5 acres per tank)?

$$\frac{5 \times 0.75}{2} = 1.87 \text{ gallons}$$

2. To figure amount of wettable powder needed for a certain amount of actual chemical per acre:

$$\frac{\text{Number of acres per tank} \times \text{pounds actual needed per acre}}{\text{Pounds actual chemical per pound of powder used}}$$

Example:

How many pounds of 50-percent DDT wettable powder are needed to apply 3/4 pound actual DDT per acre, using a sprayer with a 50 gallon tank applying 10 gallons per acre (5 acres per tank)?

$$\frac{5 \times 0.75}{0.5} = 7.5 \text{ pounds of 50-percent DDT in 50 gallons of water}$$

3. To figure amount of wettable powder needed to mix a spray containing a given percent of actual toxicant:

$$\frac{\text{Gallons of spray wanted} \times \text{percent actual toxicant wanted} \times 8}{\text{Percent active ingredient in powder used}}$$

Example:

How many pounds of 25-percent malathion wettable powder are needed to make 100 gallons of a 1-percent malathion spray?

$$\frac{100 \times 1 \times 8}{25} = 32 \text{ pounds}$$

4. To figure the percent actual toxicant in a spray mixture:

$$\frac{\text{Pounds of insecticide used} \times \text{percent active ingredient in insecticide used}}{\text{Gallons of spray} \times 8}$$

Example:

What percent DDT is in a spray in which 8 pounds of 50-percent DDT powder were used in 100 gallons of water?

$$\frac{8 \times 50}{100 \times 8} = 0.5 \text{ percent}$$

5. To figure the gallons of emulsifiable concentrate needed to mix a spray containing a given percent of active ingredient:

$$\frac{\text{Gallons of spray wanted} \times \text{percent active ingredient wanted} \times 8}{\text{Pounds active ingredient per gallon in insecticide used} \times 100}$$

Example:

How much 25-percent DDT emulsion concentrate (2 pounds per gallon) is needed to make 50 gallons of an 0.25-percent DDT spray?

$$\frac{50 \times 0.25 \times 8}{2 \times 100} = 0.5 \text{ gallon}$$

REDUCING TO 1 GALLON OF SPRAY

For small jobs, it is often necessary to figure out how much insecticide to use for 1 gallon of spray. If the recommendation is given in terms of 100 gallons, use the following formulas for 1 gallon.

With wettable powder:

1 level tablespoon per gallon of water = approximately 1 pound per 100 gallons of water

With emulsion:

1 teaspoon per gallon of water = approximately 1 pint per 100 gallons of water

Dilution table - emulsifiable concentrates

Pounds of actual chemical per gallon of concentrate used	Desired pounds per acre of actual chemical						
	0.125 lb. (2 oz.)	0.25 lb. (4 oz.)	0.50 lb. (8 oz.)	0.75 lb. (12 oz.)	1 lb.	2 lbs.	3 lbs.
	pints of emulsion concentrate to apply per acre						
1	1.0	2.0	4.0	6.0	8.0	16.0	24.0
1½	0.67	1.3	2.6	4.0	5.3	10.6	16.0
2	0.50	1.0	2.0	3.0	4.0	8.0	12.0
3	0.34	0.67	1.3	2.0	2.7	5.4	8.0
4	0.25	0.50	1.0	1.5	2.0	4.0	6.0
5	0.20	0.40	0.80	1.2	1.6	3.2	4.8
6	0.17	0.34	0.67	1.0	1.3	2.6	4.0
7	0.14	0.30	0.60	0.90	1.1	2.3	3.4
8	0.125	0.25	0.50	0.75	1.0	2.0	3.0

Dilution table - wettable powders (for sprays)

Percent wettable powder used	Desired pounds per acre of actual chemical							
	0.125 lb. (2 oz.)	0.25 lb. (4 oz.)	0.50 lb. (8 oz.)	0.75 lb. (12 oz.)	1 lb.	2 lbs.	3 lbs.	4 lbs.
	amount of wettable powder to use per acre							
15	13 oz.	1 lb., 12 oz.	3 lbs., 5 oz.	5 lbs.	6½ lbs.	13 lbs.	20 lbs.	26½ lbs.
25	8 oz.	1 lb.	2 lbs.	3 lbs.	4 lbs.	8 lbs.	12 lbs.	16 lbs.
40	5 oz.	10 oz.	1 lb., 4 oz.	1 3/4 lbs.	2½ lbs.	5 lbs.	7½ lbs.	10 lbs.
50	4 oz.	8 oz.	1 lb.	1½ lbs.	2 lbs.	4 lbs.	6 lbs.	8 lbs.
75	3 oz.	6 oz.	12 oz.	1 lb.	1 lb., 5 oz.	2 lbs., 11 oz.	4 lbs.	5 lbs., 3 oz.

Dilution table - to obtain a finished spray containing a desired concentration of actual chemical

Formulation to be used in 100 gallons of water	Desired concentration of finished spray in percent								
	0.01	0.03	0.06	0.1	0.25	0.5	1.0	2.5	5.0
Wettable powders (percent)									
15	½ lb.	1½ lbs.	3 lbs.	5 1/3 lbs.	13½ lbs.	27 lbs.	54 lbs.		
25	1/3 lb.	1 lb.	2 lbs.	3 lbs.	8 lbs.	16 lbs.	32 lbs.		
40	1/5 lb.	3/4 lb.	1½ lbs.	2 lbs.	5 lbs.	10 lbs.	20 lbs.		
50	1/6 lb. (2½ oz.)	½ lb.	1 lb.	1½ lbs.	4 lbs.	8 lbs.	16 lbs.	40 lbs.	
75	1/10 lb. (1½ oz.)	1/3 lb.	2/3 lb.	1 lb.	2½ lbs.	5 lbs.	10 lbs.	25 lbs.	52 lbs.
Emulsifiable concentrate (in pounds per gallon)									
1	1 1/3 c.	1 qt.	½ gal.	3 qts.	2 gals.	4 gals.	8 gals.	20 gals.	40 gals.
1½	3/4 pt.	1/3 gal.	1/3 gal.	½ gal.	1 1/3 gals.	2 2/3 gals.	5 gals.	13½ gals.	27 gals.
2	2/3 c.	1 pt.	1 qt.	3 pts.	1 gal.	2 gals.	4 gals.	10 gals.	20 gals.
4	1/3 c.	½ pt.	1 pt.	1½ pts.	½ gal.	1 gal.	2 gals.	5 gals.	10 gals.
5	2 fluid oz.	6 fluid oz.	3/4 pt.	2 2/3 c.	3 pts.	3 qts.	1 3/4 gals.	4 gals.	8 gals.
6	1 3/4 fluid oz.	2/3 c.	1½ c.	1 pt.	2 2/3 pts.	5 pts.	1½ gals.	3 1/3 gals.	6 2/3 gals.
8	1 fluid oz.	¼ pt.	½ pt.	3/4 pt.	1 qt.	½ gal.	1 gal.	2½ gals.	5 gals.

TABLE OF EQUIVALENTS

1 level tablespoon = 3 level teaspoons
1 fluid ounce = 2 tablespoons
1 cup = 8 fluid ounces
1 pint = 2 cups
1 quart = 2 pints or 32 fluid ounces
1 gallon = 4 quarts or 128 fluid ounces
1 gallon (United States) = 0.83 (approximately 4/5) gallon (British or Imperial)
1 gallon (British or Imperial) = 1.2 gallons (United States)
1 gallon water (United States) weighs 8.345 pounds
1 pound = 16 ounces or 453.59 grams
1 gram = 0.0353 ounces
1 ounce = 28.3 grams
1 kilogram = 35.27 ounces or 2.2 pounds
1 milligram per kilogram = 1 part per million

SAFETY PRECAUTIONS AND FIRST AID

PRECAUTIONS WHEN USING TOXIC PHOSPHATES

Use natural rubber gloves to prevent absorption through the skin. Remove and wash contaminated absorbent clothing.

Avoid breathing any wettable powder dust or contacting an emulsion. If this is unavoidable, use a respirator specifically made for phosphates. A list of respirators can be obtained by writing to the Department of Entomology, University of Minnesota, Institute of Agriculture, St. Paul 1, Minnesota.

PHOSPHATE-POISONING SYMPTOMS AND ANTIDOTE

Many organic phosphate insecticides (TEPP, parathion, methyl parathion, tetraethyl dithiopyrophosphate, EPN, demeton, Guthion, Phosdrin, phorate, Di-Syston, and schradan) are hazardous to man during mixing operations and application. Contact with recently treated plants or surfaces may also be hazardous. Certain organic phosphates have been found which are considerably less toxic, Malathion, Dicapthon, Co-Ral, and ronnel being much less toxic and Diazinon, Dylox, and Delnav being intermediate.

All of the organic phosphates discussed, including the least toxic, produce similar symptoms in human beings. All require the same antidote. The symptoms may be produced by absorption through the skin, inhalation, or swallowing. Signs of poisoning include blurred vision (pinpoint pupils), abdominal cramps, tightness of the chest, digestive upset, sweating and excessive salivation, restlessness, giddiness, headache, and twitching of the facial and eye muscles.

If any of these symptoms occur:

1. Call physician immediately.
2. Remove contaminated clothing and wash skin thoroughly with soap and water.
3. If chemical has been swallowed, induce vomiting.
4. Keep patient quiet and warm.
5. Physician may administer atropine as an antidote.

If you have had these symptoms from organic phosphorous compounds, do not handle the compounds again until your physician determines by a blood analysis that your condition is satisfactory. Persons who often use these compounds should have analyses of the blood made at regular intervals.

CHLORINATED-HYDROCARBON FIRST AID

For Chlorinated Hydrocarbons (such as aldrin, BHC, chlordane, dieldrin, DDT, endrin, heptachlor, lindane, methoxychlor, toxaphene, thiodan):

1. If chemical has been swallowed, call physician immediately. If patient is conscious, induce vomiting with warm, salty water. Continue until vomit fluid is clear.
2. If chemical has been spilled on the skin or clothing, remove clothing and wash skin thoroughly with soap and water. Do not use kerosene, gasoline, or other solvents.
3. Keep patient quiet and warm.
4. Physician may administer sedatives such as phenobarbital or other barbiturates to keep patient calm or to control convulsions.

MINNESOTA POISON INFORMATION CENTERS

These centers have been established by the Minnesota Department of Health. Their purpose is to provide information for physicians about pesticides and common household poisons, their antidotes, and treatments. Most of these centers operate on a 24-hour basis.

City	Address	Telephone
Bemidji	Bemidji Hospital	Pl. 1-5430
Brainerd	St. Joseph's Hospital	2861
Crookston	Bethesda Hospital	At. 1-4682
	St. Francis Hospital	At. 1-2490
Duluth	St. Lukes Hospital 915 E. 1st Street	RAndolph 7-6636
Fergus Falls	Lake Region Hospital	523
Mankato	Immanuel Hospital	MAnkato 8-1605
Marshall	Lewis Weiner Memorial Hospital	2263
Minneapolis	Division of Special Health Services State Health Department	FEderal 9-7751
	Abbott Hospital 110 E. 18th Street	FEderal 9-8414
	Fairview Hospital 2312 S. 6th Street	FEderal 6-6691
	Minneapolis General Hospital 619 S. 5th Street	FEderal 3-1178

	North Memorial Hospital 3220 Lowry Avenue North	JUniper 8-9451
	Northwestern Hospital 810 E. 27th Street	FEderal 2-7266
Morris	Stevens County Memorial Hospital	1191
Rochester	St. Mary's Hospital	AT 9-4581
St. Cloud	St. Cloud Hospital	BL. 1-2700
St. Paul	Ancher Hospital 495 Jefferson Avenue	CApital 2-7341
	Bethesda Hospital 559 Capitol Boulevard	CApital 4-7561
	St. John's Hospital 403 Maria Avenue	PRospect 1-5521
	St. Joseph's Hospital 69 W. Exchange	CApital 2-6321
	St. Luke's Hospital 287 N. Smith Avenue	CApital 2-6644
	Children's Hospital 311 Pleasant Avenue	CApital 7-6521
Virginia	Virginia Municipal Hospital	Harwood 1-3340
Willmar	Rice Memorial Hospital	Belmont 5-4543
Worthington	Worthington Memorial Municipal Hospital	Worthington 2-5601

FIELD CROP INSECTS

Insect	Crop	Insecticide	Dosage (actual toxicant per acre)	Remarks
Aphids (green-bugs, corn leaf aphids, English grain aphids)	Small grains	malathion	1 lb.	At least 7 days before harvest.
		methyl parathion	4 oz.	Not after heads form.
		parathion	4 oz.	At least 15 days before harvest.
Armyworms	Corn	phorate (Thimet)	1 lb. (10 lbs. 10% G)	Apply just before or at the time of tasseling. Direct granules into whorls of plants.
		dieldrin	4 oz.	At least 60 days before harvest or ensiling.
		endrin	3 to 4 oz.	At least 45 days before harvest or ensiling.
		toxaphene	1½ to 2 lbs.	Do not feed or ensile treated stalks, leaves, husks.
	Small grains	dieldrin	4 oz.	At least 7 days before harvest (grain), 30 days for straw.
		endrin	3 to 4 oz.	One application at least 45 days before harvest.
		toxaphene	1½ to 2 lbs.	At least 7 days before harvest (14 days for barley). Do not feed straw.
Beet webworm	Sugar beets	Dylox	½ to 1 lb.	At least 14 days before harvest. Do not feed tops within 28 days of treatment.

*Abbreviations: E. C. --emulsion concentrate; W. P. --wettable powder

Insect	Crop	Insecticide	Dosage (actual toxicant per acre)	Remarks
		endrin	6 oz.	At least 20 days before harvest if tops are not fed; 60 days if tops are fed.
		toxaphene	2 to 3 lbs.	At least 60 days before harvest. Do not feed tops.
	(See Commercial Vegetable Pest Control Guide)			
Corn earworm	Sweet corn	DDT	2 lbs.	As emulsion in at least 25 gallons of water to the ear zone. Repeat at 10 percent, 50 percent, and 90 percent silked. With heavy infestations, late corn may need treatment every 2 or 3 days during silking. Do not feed or ensile treated crop residues (stalks, leaves, husks).
		Sevin	$1\frac{1}{2}$ to 2 lbs.	In at least 25 gallons of spray per acre. Direct spray to ear zone every 2 or 3 days during silking until silks begin to dry. At least 7 days before feeding or ensiling treated plant parts.
Corn rootworms	Corn	aldrin or heptachlor	$\frac{1}{2}$ to 1 lb.	For broadcast application, 1 pound rate; $\frac{1}{2}$ pound rate for band or row treatment. Incorporate into soil surface before or at planting time.
Crickets	Flax	dieldrin	6 to 10 oz.	Apply before swathing to prevent boll clipping.
	Legumes (for seed)	dieldrin	6 to 8 oz.	Do not graze treated field or feed treated plants.

Insect	Crop	Insecticide	Dosage (actual toxicant per acre)	Remarks
Cutworms	Corn	aldrin or heptachlor	1 to 1½ lbs.	Apply before or at planting time as for corn rootworm. Lower rate for row treatment, higher rate for broadcast application.
	Corn, soybeans, flax	DDT	1½ lbs.	Do not feed or ensile treated plants (stalks, leaves, husks)as forage.
		dieldrin	6 to 8 oz.	At least 60 days before harvest(corn)
		endrin	3 to 4 oz.	At least 45 days before harvest.
		toxaphene	2 lbs.	Do not feed or ensile treated crops as forage.
	Small grains	dieldrin	6 to 8 oz.	At least 7 days before harvest (grain), 30 days for straw.
		endrin	4 to 6 oz.	At least 45 days before harvest.
		toxaphene	1½ to 2 lbs.	At least 7 days before harvest (14 days for barley). Only one application after grain has headed.
European corn borer	Corn	DDT	1½ lbs. spray 1 lb. granules	Do not graze, feed, or ensile DDT treated stalks, leaves, and husks.
		endrin	3 to 4 oz. (spray or granules)	At least 45 days before harvest.
		EPN	4 to 8 oz.	At least 14 days before harvest.
		sevin	1 1/2 to 2 lbs.	At least 7 days before harvest for forage or ensiling
		toxaphene	2 lbs. granules	Do not feed treated forage to milk cows or meat animals within 28 days of slaughter.

Insect	Crop	Insecticide	Dosage (actual toxicant per acre)	Remarks
	Note: For first brood treat when 75 percent of the plants show recent larval feeding ("shot holing") in the whorl leaves. For second brood treat when the average egg mass count reaches 100 per 100 plants. On sweet corn treat for second brood when egg hatch starts. One to three treatments may be needed. See "Commercial Vegetable Pest Control Guide."			
Grasshoppers		**Diazinon**	**1/2 lb.**	**At least 7 days before cutting.**
	Alfalfa, clover hay, forage	dieldrin	1 oz.	Only one application. Treat alfalfa before 6 to 8 inches high and clover before 2 inches high. No treatment within 35 days of cutting or harvesting.
		malathion	1 to 1½ lbs.	At least 7 days before cutting or ensiling.
	Corn	aldrin	2 to 4 oz.	At least 21 days (2 ounce rate) or 30 days (4 ounce rate) before harvest or ensiling.
		dieldrin	1 to 2 oz.	At least 40 days before harvest or ensiling.
		malathion	1 to 1½ lbs.	At least 5 days before harvest.
		toxaphene	1 to 1½ lbs.	Do not feed or ensile treated corn forage or stover (stalks, leaves, husks).
	Nonagricultural land (roadsides, fencerows, idle land)	aldrin dieldrin heptachlor malathion toxaphene	2 to 4 oz. 1 to 2 oz. 2 to 4 oz. 1 to 1½ lbs. 1 to 1½ lbs.	Do not graze or cut for feed. Do not allow spray or dust to drift onto adjacent crops or pastures.

Insect	Crop	Insecticide	Dosage (actual toxicant per acre)	Remarks
	Pasture, grass	aldrin	2 to 4 oz.	Do not graze milk cow or meat animals being finished for slaughter.
		heptachlor	2 to 3 oz.	Do not graze milk cows. Do not graze meat animals to be finished for slaughter for 90 days after treatment.
		malathion	1 to 1½ lbs.	At least 7 days before grazing or cutting.
		toxaphene	1 to 1½ lbs.	One application per season. Do not graze milk cows. If meat animals are also treated for control of ectoparasites (flies, lice), remove them from treated pastures at least 6 weeks before slaughter. Do not sell or ship treated grass for feed.
	Small grains	aldrin	2 to 4 oz.	At least 7 days before harvest (grain); 30 days if the straw is used for feed or bedding.
		dieldrin	1 to 2 oz.	At least 7 days (grain) or 30 days (straw) before harvest.
		toxaphene	1 to 1½ lbs.	At least 7 days before harvest (14 days for barley). One application only after grain has headed. Do not pasture treated field. Do not feed treated straw.
	Soybeans(including for hay or ensiling)	aldrin	2 oz.	One application at least 30 days before cutting for hay or ensiling.

Insect	Crop	Insecticide	Dosage (actual toxicant per acre)	Remarks
		dieldrin	1 oz.	One application at least 35 days before cutting for hay or ensiling.
		toxaphene	1 to 1½ lbs.	Do not feed or ensile treated plants.
	Note: There are no restrictions on the use of these materials on the crop to be harvested as beans. The restrictions apply to the use of the plants (leaves, vines, pods) as feed.			
		Diazinon	1/2 lb.	At least 7 days before cutting.
Leafhoppers	Alfalfa hay, forage	methoxychlor	1½ lb.	At least 7 days before cutting.
Pea aphid	Alfalfa, clover	demeton(Systox)	4 oz.	At least 21 days before cutting (aerial application only).
		Diazinon	1/2 lb.	At least 7 days before cutting.
		malathion	1 lb.	At least 7 days before cutting.
		parathion	4 oz.	At least 15 days before cutting (aerial application only).
		Phosdrin	4 oz.	At least 1 day before cutting (aerial application only).
Plant bugs (tarnished, alfalfa, rapid, Lygus)	Alfalfa, clover, trefoil for seed	DDT	1½ to 2 lbs.	Do not graze or harvest for feed. Apply when the crop is in the bud stage or when the bugs average one or more per sweep with a 15-inch net. Do not spray crop in bloom.
		dieldrin	4 to 6 oz.	
		endrin	3 to 4 oz.	
		toxaphene	2 to 3 lbs.	
Sweet clover weevil	Sweet clover, alfalfa new seedings.	aldrin	8 to 10 oz.	Apply in spring at two leaf stage. Later in summer second generation may require another treatment. Do not graze or cut for feed.
		dieldrin	8 oz.	
		toxaphene	2 to 3 lbs.	

Insect	Crop	Insecticide	Dosage (actual toxicant per acre)	Remarks
	Note: For light infestations dieldrin granules mixed with the seed ($\frac{1}{2}$ pound actual in the amount of seed per acre) will protect the stand if seeding is shallow and pressed in.			
Thrips	Barley	parathion (or methyl parathion)	4 to 6 oz.	Aerial application at least 15 days before harvest. Treat just as heads emerge.
White grubs	Corn, soybeans	aldrin	3 lbs.	Preplanting soil treatment.
		dieldrin	3 lbs.	
		heptachlor	3 lbs.	
Wireworms	Corn, beans, small grains	aldrin, dieldrin, heptachlor, or lindane	1 oz. (per bushel)	As seed treater
	Corn	aldrin or heptachlor	1 to $1\frac{1}{2}$ lbs.	Soil treatment before or at planting. Use 1 pound rate for row treatment, $1\frac{1}{2}$ pounds for broadcast.

STORED-GRAIN INSECTS

Note: Market or food grains should not be stored in barns, in buildings where livestock feed is stored, or in other situations where they are near to sources of infestation. Excessive moisture content, dirty or damaged grain, and dirty bins all encourage insect infestation.

Bin sprays — Thoroughly clean bins as soon as they are emptied; spray walls, ceilings, and floors of the empty bin with:

malathion	1 gal. 57 percent premium-grade E.C. in 25 gals. water (1 pt. in 2 to 5 gals. water).
methoxychlor	2 gals. 25 percent E.C. for 25 gals. of spray or ready-to-use methoxychlor bin spray.
	Synergized pyrethrins. Ready to use bin spray.

Grain protectants (applied directly to grain as it comes from combine or as it is binned)

malathion	1 pt. premium-grade E.C. per 2 to 5 gals. water per 1,000 bu.
malathion	1 percent premium-grade wheat flour dust, 60 lbs. per 1,000 bu.
	Synergized pyrethrins. Ready-to-use protectant sprays or dusts, as labeled.

Surface treatments (applied to surface of grain after it is in the bin)

malathion	½ to 1 pint premium-grade E.C. in 2 gals. water per 1,000 sq. ft. of grain surface area.
malathion	1 percent premium-grade wheat flour dust, 30 lbs. per 1,000 sq. ft.
	Synergized pyrethrins Ready to use, 1 gal. per 1,000 sq. ft.

Fumigation (applied to binned grain to stop insect infestation. Does not give a residual preventive treatment.)

There are many commercial fumigants available. Some of the common ones are listed below. Grain to be fumigated should be in a tight bin and leveled to a height no more than within 6 or 8 inches from the top of the side walls of the bin. Fumigate on a calm day when the grain temperature is at least 60°F. Persons applying or handling the fumigant should protect themselves from vapors by using suitable gas masks and protective clothes. More than one person should be present at the job in case of accident. Read and follow all precautions listed on the labels for each different fumigant. Information about other fumigants is available from the Department of Entomology and Economic Zoology, University of Minnesota, St. Paul 1, Minnesota.

Fumigant	Dosage (gal. per 1,000 bu)			
	Small grain		Shelled corn	
	Wooden bins	Metal bins	Wooden bins	Metal bins
Carbon tetrachloride - carbon disulfide, 80-20	4	2	6	5
Carbon tetrachloride - ethylene dibromide, 95-5	4	2	6	5
Carbon tetrachloride - ethylene dichloride, 3-1	6	3	8	6
Carbon tetrachloride - ethylene dichloride-ethylene dibromide, 60-35-5	4	2	6	5
Chloroform - carbon bisulfide, chloroform - ethylene dibromide mixtures as labeled.				
Use other liquid fumigant mixtures as labeled.				
Aluminum phosphide (Phostoxin)	Add 180 tablets per 1,000 bu. as grain is binned or probe tablets into binned grain.			

SUGGESTED STOCK OF INSECTICIDES

1. Basic list for general field crop business:

aldrin	Malathion (and Malathion, premium grade)
DDT	Parathion (or Methyl-Parathion)
Diazinon	Sevin
Dieldrin	Toxaphene
Endrin	Grain fumigants
Heptachlor	Pyrethrins

2. For Livestock business add:

Co-Ral	Methoxychlor
Delnav	Pyrethrins
Korlan	Rotenone
Lindane	Ruelene
Lethane or Thanite	

3. For Fly Control business add:

DDVP
Dibrom
Dipterex
Korlan
Pyrethrins (or allethrins) plus synergist.
Lethane or Thanite

4. For Household business add:

Chlordane
Korlan
Pyrethrins
Lindane
And household grade preparations of DDT, Diazinon, Dieldrin

5. For Commercial Fruit, Vegetable, and Ornamental business add:

Aramite	Kelthane	Systox
Chlorobenzilate	Lead Arsenate	Tedion
Disyston	Lime-Sulfur	Thimet
D.N. 289	Mitox	Thiodan
Dormant oils	Ovex	Trithion
Dylox	Phosdrin	VC-13
Ethion	Phosphamidon	
Guthion	(Dimecron)	

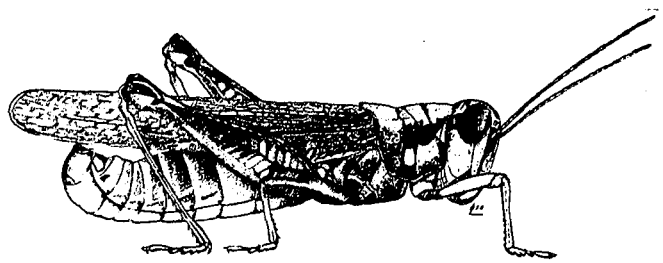
TOMOLOGY
NO. 4

INSECT CONTROL ON FORAGE CROPS

John Lofgren

Insecticide applications to forage crops and pastures must be made with caution in order to avoid excessive chemical residues. These restrictions are necessary because chemical residues on feed may appear in the fat or milk of livestock who eat the treated feed. Such residues on forage and in fat and milk are strictly regulated by the U. S. Food and Drug Administration.

Observe the following limitations carefully when you apply insecticides to forage crops. Be sure to use the rates of application listed for individual insect problems.



Red-legged Grasshopper

Chemical	Limitations
aldrin, dieldrin, heptachlor	Do not feed treated forage to milk cows or to meat animals being finished for slaughter. Do not graze treated pastures or fields.
malathion, methoxychlor	Wait at least 7 days after treatment before cutting or grazing.
parathion	Wait at least 15 days after treatment before cutting or grazing. Application by qualified aerial operator only.
demeton (Systox)	Wait at least 21 days after treatment before cutting. Application by qualified aerial operator only.
toxaphene	Do not feed treated forage to milk cows. Meat animals should be removed from treated feed or pasture at least 6 weeks before slaughter.

RATES OF APPLICATION FOR SPECIFIC PROBLEMS

GRASSHOPPERS

If grasshoppers become numerous shortly before the hay or forage is to be harvested, the best practice is to cut it and leave trap strips of uncut hay in the field. These strips may then be treated with aldrin, dieldrin, heptachlor, or toxaphene. Such treated strips should not be used for feed. Field margins, fence rows, and other waste areas may also be treated with these materials if the treated vegetation is not fed or grazed.

If hay is to be treated before cutting use malathion or parathion and wait the required number of days before cutting. If the forage is to be fed only to meat animals, toxaphene may be used provided the animals are removed from the treated feed at least 6 weeks before slaughter or sale.

Chemical	Rate per acre
aldrin	2 to 4 ozs. actual per A. (2-lb. emulsion concentrate, ½ to 1 pint 4-lb. emulsion concentrate, ¼ to ½ pint)
dieldrin	2 ozs. actual per A. (1.5-lb. emulsion concentrate, 2/3 pint)
heptachlor	2 to 4 ozs. per A. (2-lb. emulsion concentrate, ½ to 1 pint)
toxaphene	1 to 1½ lbs. per A. (6-lb. emulsion concentrate, 1 1/3 to 2 pints)
malathion	1 to 1½ lbs. per A. (5-lb. emulsion concentrate, 1½ to 2 pints)
parathion	¼ lb. per A. (2-lb. emulsion concentrate, 1 pint per A.)

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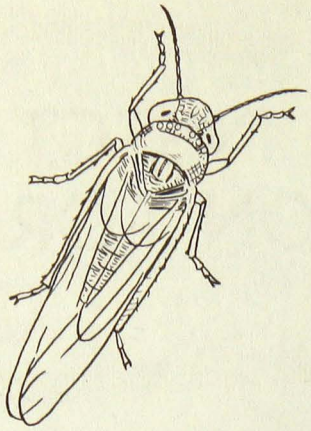
POTATO LEAFHOPPER

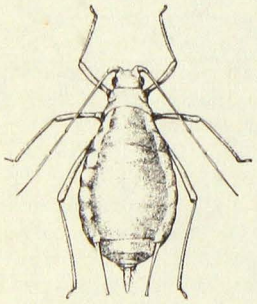


Potato Leafhopper

These tiny sap-sucking insects often become damaging on the regrowth of alfalfa after the first or second cutting. Their feeding causes a yellowing of the foliage and stunting of the plants. Damage is usually most severe on second crop alfalfa hay when the first crop is cut early. Yields and quality of the hay will be increased by cutting the first crop early--when it should be--and treating the second growth when it is 8 to 10 inches high. Use methoxychlor at 1 to 1½ lbs. per acre (2 to 3 qts. of the 25-percent, or 2-lb. emulsion concentrate per acre). Wait at least 7 days before cutting.

PEA APHID

This is the common bright green aphid found in alfalfa. When moisture is adequate alfalfa can tolerate very heavy infestations without much damage. When extremely heavy aphid infestations are present during periods of drought, the plants may yellow and become stunted.



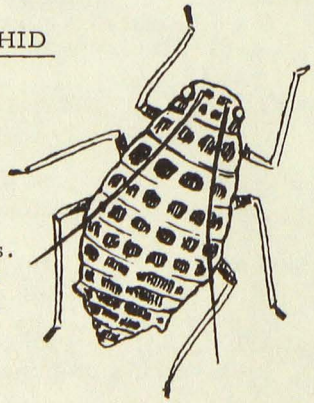
Pea Aphid – wingless female

Pea aphid control on alfalfa hay is of questionable economic value. They may be controlled with one pound of actual malathion per acre, ¼ lb. actual parathion per A., or ¼ lb. actual demeton (Systox) per A. Only malathion should be used with ground sprayers. Parathion or demeton should be applied by qualified aerial operators only.

Waiting periods are: malathion-- 7 days; parathion-- 15 days; demeton-- 21 days.

SPOTTED ALFALFA APHID

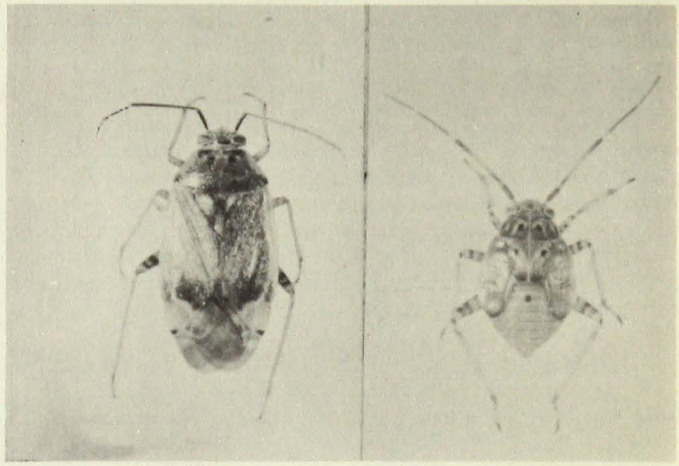
This aphid does not overwinter in Minnesota and has not yet been a serious problem here. Infestations of this aphid are much more severe on alfalfa than are pea aphids. They are smaller than pea aphids, are light in color, and have dark gray spots on the back. They may be controlled by the same materials and rates as those recommended for pea aphid control.



Spotted Alfalfa Aphid

PLANT BUGS

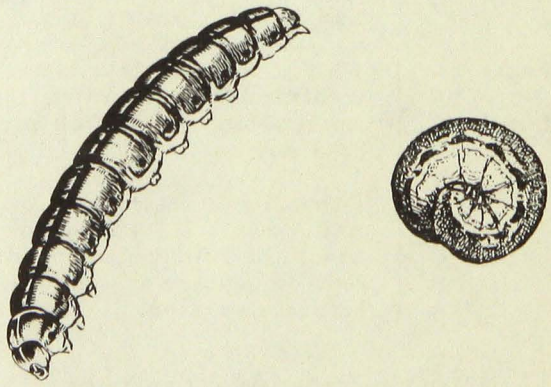
Several kinds of sap-sucking plant bugs may become damaging on alfalfa grown for forage, although they are much more of a problem in legume seed fields. Infestations of over 3 per sweep with an insect net will justify treatment. Methoxychlor at 1 ½ lbs. actual toxicant per acre will give fair control, but a combination of methoxychlor plus 3/4 to 1 lb. actual malathion will give better results. Wait 7 days between treatment and harvest.



Adult Lygus Bug Nymph

CUTWORMS

Occasionally, cutworms and other leafchewing caterpillars become numerous enough to cause damage to forage crops. Cutting usually exposes these pests to natural enemies and other hazards so that the threat is reduced. Methoxychlor or a combination of methoxychlor plus malathion at the rates suggested for plant bugs might give some measure of control. The insecticides which are most effective against these pests cannot be used on forage crops because of the residue problem.



Cutworm

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farm and home

TOMOLOGY
NO. 9

FACT SHEET

INSECTS IN STORED GRAIN

JOHN LOFGREN

PREVENTION AND CONTROL

The increasing amount of grain in storage, some of it in poor keeping condition, has caused the insect problem to become a serious one. Under present food grain regulations, it is illegal to sell contaminated grain or grain that has been stored under unsanitary conditions. The stored grain insects contribute to grain contamination and also cause a direct loss of the grain.

Insects attacking stored grain need favorable food, temperature, and moisture in order to survive and reproduce. When a bin of grain is infested it is an indication that the grain is dirty or damaged, over the safe levels of moisture content, or warm enough for the insects to thrive. Usually a combination of these factors is present in infested grain.

Why Stored Grain Insects?

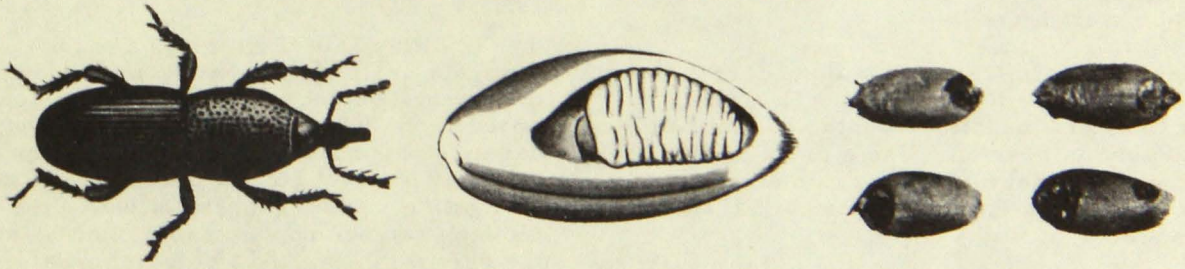
Stored grain insects must have a temperature of at least 60°F. in order to reproduce. Primary infestors, such as the granary weevil, will attack sound, whole grain if the moisture content is above 11 percent and the grain temperature is above 80° F. Infestation by the weevils can take place at even lower temperatures if the moisture content of the grain is greater.

The secondary pests, such as the saw-tooth grain beetle, do not normally attack sound whole kernels except at high temperatures and high moisture content. If the grain is damaged - cracked or broken - or contains much chaff and dust they may breed in it regardless of the moisture content if the temperature is above 70°F.

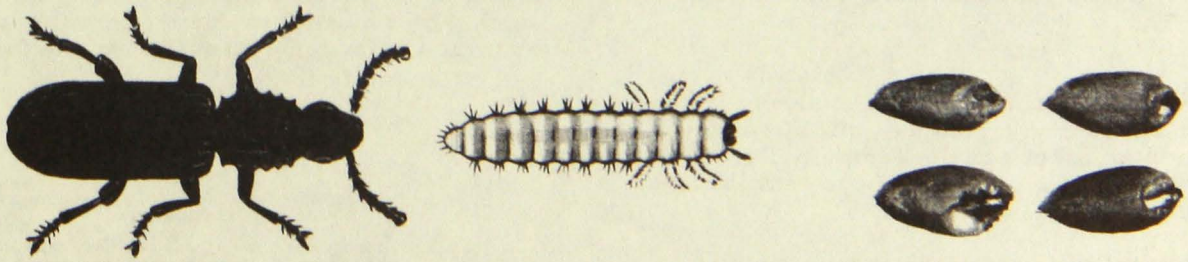
How Does Grain Become Infested?

In Minnesota, grain does not become infested or "weevily" in the field. Some of the bran bugs may be found in the field but if the grain is in good storing condition they will not survive in the bin. Grain becomes infested when it is put into a bin that has held infested grain or which is near infested feed or grain. It is also possible for some of the grain infesting insects to fly or crawl into the bin if the grain is in a condition to attract them. Grain may become infested at any point where it is held on its way through marketing or use channels, but the severity of the infestation will depend on the

GRANARY WEEVIL



SAW-TOOTHED GRAIN BEETLE



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factors of temperature, moisture content, and physical condition of the grain.

Preventing Infestations

1. As soon as bins are empty, clean them thoroughly. Sweep out and destroy old grain, dust, chaff, and webbing.

2. Apply a residual bin spray to the walls, floor, and braces of the bin. Use a $2\frac{1}{2}$ percent methoxychlor or a 1 to $1\frac{1}{2}$ percent malathion (premium grade) spray. One part of 25 percent methoxychlor emulsion concentrate in 10 parts of water will give a $2\frac{1}{2}$ percent spray. Use 1 pint of 50 percent malathion concentrate, premium grade, in 3 to 5 gallons of water. Apply the spray till it runs off.

3. Use a grain protectant. Grain protectants containing either pyrethrins or malathion may be applied directly to the grain before it goes into the bin. Either liquid or dry dust formulations can be used as the grain comes from the combine into the truck or as it is moved into the bin. A surface application after the grain is binned will help prevent surface infestations of insects like the Indian Meal Moth.

4. Check the condition of the grain. Be sure that the moisture content is within the safe limits for storage and that it is free of dirt, chaff, weed seeds, and damaged kernels. The moisture content of grain in the bin is likely to change with outside temperature changes. As the grain cools around the edges of the bin, convection currents in the grain mass may cause "moisture migration." This happens most frequently in large volume storage, especially "flat-storage." The proper installation and use of effective aeration equipment will help correct this problem.

5. Do not store grain that will be used for human food or that will be stored for long periods of time near barns or near livestock feed. Grain stored adjacent to feeds can become infested very easily by the insects living around livestock feeding areas or stored feed.

6. Inspect grain frequently. Don't forget about your grain crop after it's in the bin. Examine it regularly to detect insects, rodents, heating, or molds as early as possible. Use a grain probe or insert a metal rod down into the grain at several locations. By feeling the rod you can tell if the grain is warm.

If You Find Insects.....

Control

Turning the grain or moving it slowly from one bin to another on a cold day will often cool it enough to stop insect activity temporarily. The surest way to stop a stored grain infestation is by proper fumigation.

The object of fumigating grain in a bin is to build up and hold a lethal level of the fumigant gases in all parts of the bin long enough to kill all stages of the insects. Sometimes a "spot fumigation" may be used in a part of a bin but this is usually a temporary measure until it can be remedied more properly.

If you find any of the primary infesting weevil or over five of the secondary "bran bugs" per quart sample of the grain, it should be fumigated.

Requirements For Effective Fumigation

1. Tight Bins Grain fumigants vaporize into heavier than air gases. If the bin is full of cracks and holes the gases will leak out. This may result in under treatment. Use building paper or galvanized sheet metal to close holes and cracks.

2. Level Grain Grain in the bin should be leveled to insure uniform penetration of the fumigants. If the grain is peaked or heaped up, the action of the fumigants is much like that of water on a slope. The bin should not be filled to more than within 6 or 8 inches of the top of the side walls.

3. Proper Grain Temperature The temperature of the grain should be at least 65°F. This is to insure complete vaporization of the fumigant. Fumigate on a calm day, not when it's windy.

4. Even Application of the Fumigant The liquid fumigants should be applied uniformly over the surface of the grain with a sprayer. A coarse droplet spray or solid stream should be used. If a 3-gallon compressed air sprayer is used, remove the nozzle. The spray rod may be flattened out slightly so that a very coarse, fan-shaped spray pattern is obtained.

5. Use Enough Fumigant You cannot expect good results by skimping on the dosage. Use a reliable commercial grain fumigant at the recommended rate. For example, use the common 80-20 mixture of carbon tetrachloride and carbon disulfide at the rate of 4 gallons per 1,000 bushels of small grain or 6 gallons per 1,000 bushels of shelled corn in wooden bins.

6. Play Safe Fumigants are toxic. Do not fumigate grain alone--have someone outside the bin or nearby. Do not breathe fumigant vapors. If exposed to the fumes, wear a gas mask with a fresh cannister approved for the fumigant you are using. Keep everyone out of the bin for 4 or 5 days after fumigating. If fumigant is spilled on the skin or clothing remove contaminated clothing and wash the skin with soap and water immediately. Follow other special precautions printed on the container labels or in instructions. Grain may be fed to livestock 4 or 5 days after fumigation if it is stirred or turned to hasten evaporation of the fumigant.

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ITOMOLOGY
NO. 12

FACT SHEET

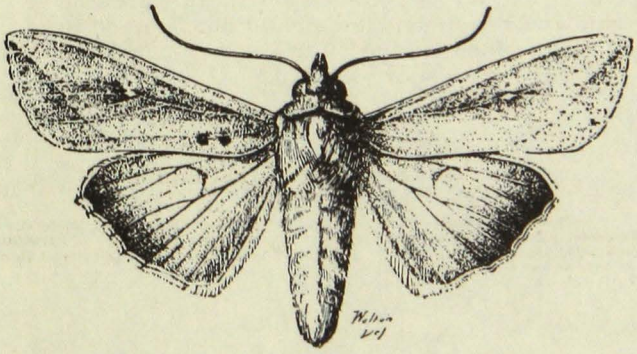
Armyworms

JOHN LOFGREN

WHAT THEY ARE

The term "armyworms" is sometimes incorrectly applied to any large group of caterpillars. However, the true armyworm is a distinct type of insect that belongs to the cutworm family. It is primarily a pest of grasses, small grain, and corn, but will also feed on a wide variety of plants.

The armyworm is the larval stage, or caterpillar, of a moth. The moth is a heavy bodied, light brown "miller" which has a conspicuous white or silvery spot about the size of a pinhead on each front wing.



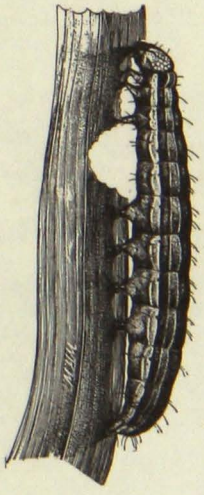
The armyworm moth

The larvae, or armyworms, grow to $1\frac{1}{2}$ - 2 inches long and vary in color from a light gray-green to a dark gray-brown. Along the outer side of each leg, near the middle part of the body, is a dark band. On the body there is a series of longitudinal stripes arranged as follows:

1. A thin, white, broken line down the middle of the back.
2. A wide, dark, mottled stripe halfway down the side.
3. A pale orange stripe with white border.
4. Next, a brownish mottled stripe.
5. Slightly above the legs, another pale orange stripe with a white border.

HOW THEY LIVE

Moths lay eggs in rows on leaves, lodged grasses, and small grain. A favorite place for egg laying is grain or grass that has been flattened by hail or wind. In seven to ten days the eggs hatch into small worms or larvae. These young armyworms feed in the areas where they were hatched until they are full grown or until they run out of food. If the food is all consumed, the worms will often start to move. They may then swarm in huge "armies," eating and destroying other crops as they crawl.



Armyworm feeding on corn

Feeding and moving are done at night or on cloudy days. During daylight, armyworms hide under vegetation, in cracks, or by burrowing into loose soil. As the worms grow larger, they eat more and more food. Infestations, therefore, are often unnoticed until the worms are nearly full grown and are almost ready to stop feeding

When full grown, armyworms burrow into the soil and change to dark reddish-brown pupae. About two weeks later, the adults, or moths, emerge from the pupal cases to mate and lay eggs for the next generation.

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Even though this insect may overwinter in Minnesota, it is believed that our most severe and economic infestations result from moth flights from the south. The moths are very strong fliers. Heavy infestations in the southern states produce large numbers of the moths and these may fly in on southerly winds. If weather, egg laying, and food conditions become favorable here, then outbreaks can result.

HOW TO CONTROL THEM

It is extremely important to control armyworms while they are still small and before extensive damage is done. Killing the worms after they are full grown and the crop is ruined is just a matter of getting revenge. An average of three or four worms per square foot in small grain economically justifies chemical control. It will usually pay to control a 10 percent infestation in corn; that is, when at least 10 percent of the corn plants are infested.

Any one of three insecticides may be used to control armyworms--dieldrin, endrin, or toxaphene. They should be used at the following rates per acre:

dieldrin - 1.5 lb. per gal. emulsion concentrate -- 1 1/3 pts. per acre (4 oz. actual dieldrin per acre)

endrin - 1.6 lb.. per gal. concentrate -- 1 to 1 1/4 pts. per acre (3 to 4 oz. actual endrin per acre)

toxaphene - 6 lb. per gal. concentrate -- 2 to 2 1/2 pts. per acre (1 1/2 to 2 lbs. actual toxaphene per acre)

Sprays can be applied with ground or aerial equipment in such a way that good uniform coverage is made. When the worms are moving from small grain or grass into corn, flax, or soybeans, a couple of swaths should be sprayed ahead of the infestation in the direction of movement in order to form a barrier strip.

Important -- Precautions and Limitations

All insecticides must be handled with caution. Avoid spilling chemicals on the skin or clothing. If insecticides accidently touch the skin, wash immediately with plenty of soap and water. If clothing becomes contaminated, remove it and bathe thoroughly. At the end of a day's spraying, bathe and change to clean clothing. Follow all safety directions on labels.

Minimum Waiting Periods between Treatment and Harvest, Feeding, or Ensiling for Corn and Small Grains

Insecticide	Waiting Periods	
	Small Grain	Corn
dieldrin	7 days (grain) 30 days (straw)	60 days
endrin	45 days	45 days
toxaphene	7 days except 14 days for barley	None for corn grain; do not ensile or feed treated stalks, leaves, and husks.

When crops are treated, excessive chemical residues must not remain at harvest. Do not overtreat -- use the recommended rates. Treated straw and crop residues should not be used for bedding or feed except 30 days after using dieldrin or 45 days after using endrin.

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TOMOLOGY
NO. 14

FACT SHEET

CONTROLLING CORN ROOTWORMS

John Lofgren

You can economically control one of the most significant hazards to efficient corn production in Minnesota. Corn rootworms usually become a serious problem on corn following corn. If you are either growing continuous corn or you observe over 4- or 5-percent rootworm damage in a field, it will pay you to use a soil treatment.

Damage from rootworms is usually first noticed as lodged or "goosenecked" stalks. The feeding of the worms on the roots weakens the roots and usually leads to a rotting of the roots and lower part of the stalks. Lowered yields may appear even before these lodging symptoms develop. It has been found that over a 7-year period yield losses due to rootworms average between 8 and 9 bushels per acre.

Rootworms are produced from eggs laid in the fall by the adults which are small yellowish-green beetles. The beetles sometimes occur in very large numbers on the tassels and silks of corn in August and September. Sometimes the beetles interfere with pollination by feeding on the silks before fertilization of the corn takes place. The eggs hatch in the spring and the worms begin to feed on and in the roots. The worms pupate late in the summer and the beetles emerge by the end of July or eary August.

Either aldrin or heptachlor may be applied in a wide variety of ways; select the method which will fit your needs best. There are two main methods of applying the insecticide--broadcast and band treatments.

BROADCAST APPLICATIONS

If a field is to be treated with a broadcast application of aldrin or heptachlor, use at least 1 pound of the actual insecticide per acre and incorporate or mix the chemical into the soil surface immediately after application. A broadcast application will carry over and give control the second and possibly the third year in most soils.

1. Sprays

A regular weed sprayer may be used. If you

Fig. 1. Evidence of rootworm damage: Root systems of two adjacent rows. Root system at left treated with soil insecticide; right, untreated.

Fig. 2. Evidence of rootworm damage: Left side of field was not treated with soil insecticide, shows lodging. Right side was treated.

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use a tractor-mounted sprayer, then pull a disk and do the job with one trip through the field. You may also mount a spray boom right on the frame of the disk so that the spray is applied just ahead of the harrow. If you use a trailer sprayer, then disk immediately after the sprayer. This incorporation of the insecticide into the soil should be done within one-half day after spraying.

It is possible that aerial sprays would be effective if uniform applications were made and the treatment worked into the soil.

2. Granule Application

Aldrin or heptachlor may be applied to the fields as granules. The limiting factor in using the granules is the equipment needed. Special granule applicators are available or grass seeders may be used if they can be properly calibrated. A recent development is the application of granules broadcast by airplane. Evidently, if this is done during the winter--before mid-March--the freezing and thawing and early rains get the insecticide into the soil surface so that special incorporation with a disk is unnecessary. If granules are applied just before planting or when the temperature is above 60°F., then they must be incorporated just as with the sprays.

3. Fertilizer-Insecticide Mixtures

Fertilizer containing either aldrin or heptachlor may be effective if the proper rate of the insecticide is used. These combinations may be applied in the spring and worked into the soil. Some farmers have successfully applied fertilizer-insecticide combinations as a broadcast plow-down treatment in the fall. There is a chance, however, that such applications will be plowed down too deeply for best results.

Spring, preplant broadcast applications of liquid fertilizer-insecticide mixtures may also be used, but it is very important that the insecticide concentrate used be designed for use with liquid fertilizers. Regular emulsifiable concentrates will not mix with some liquid fertilizers.

BAND OR ROW TREATMENTS

Aldrin or heptachlor may be applied in a band in the row at planting time. This may be accomplished by means of liquid sprays, granules, or fertilizer mixtures. For a row application use at least ½ pound actual aldrin or heptachlor per acre concentrated in the row.

1. Sprays

Special planter-mounted sprayers are available, or a weed sprayer may be modified so that a nozzle is directed behind each planter shoe. The packing wheels on some planters do a satisfactory job of covering the insecticide, but it may be necessary to use a drag harrow behind the planter to adequately mix the chemical into the soil.

2. Granules

Granules may be run into the row just above the seed with a planter attachment. Such a device should give a uniform, metered rate of flow. It is important that an attachment for applying granules be properly calibrated and checked frequently so that a uniform, effective treatment is applied.

3. Fertilizer-Insecticide Mixtures

If you have a split boot type fertilizer attachment for your planter, you may use a mixture of the insecticide in the starter fertilizer. This will place the mixture just above and fairly close to the seed. However, if you use an attachment with a disk opener which places the fertilizer band to the side and below the seed, do not use an insecticide mixture. This applys the insecticide so deeply in the soil that its effectiveness is lost for the job of rootworm control.

WHAT ABOUT SEED TREATMENTS?

A seed treatment or planter box treatment will not do a satisfactory job of controlling rootworms. Such a treatment will protect the seed from damage by wireworms, seed corn maggots, and corn seed beetles but does not protect the root system.

HOW ABOUT OTHER SOIL INSECTS?

There are a number of other insects which may become damaging to the underground parts of the corn plant. This complex of soil pests may be satisfactorily controlled by using higher rates of aldrin or heptachlor. For this broader "insurance" treatment, use either 1 pound actual insecticide in the row or 1½ to 2 pounds as a broadcast treatment (See Ent. F.S. No. 7, Soil Insects of Corn.)

RATES OF APPLICATION PER ACRE FOR ROOTWORM CONTROL

Form	Row	Broadcast
Aldrin or heptachlor emulsion concentrate containing 4 lbs. actual insecticide per gal.	1 pt.	1 qt.
Emulsions containing 2 lbs. actual chemical per gal.	1 qt.	2 qts.
20% granules	2½ lbs.	5 lbs.
10% granules	5 lbs.	10 lbs.
Fertilizer with 10 lbs. actual insecticide per ton	100 lbs. (Split boot only)	200 lbs.

UNIVERSITY OF MINNESOTA, INSTITUTE OF AGRICULTURE
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