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INDEX

DEALERS' GUIDE TO INSECTICIDES

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Regulations On Sale And Uses

The sale and use of insecticides are regulated by two federal acts and corresponding state laws. Federal regulations cover the interstate phases of insecticide labeling and sales and the interstate movement of treated foods or agricultural products. State laws cover these activities 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 USDA. It provides that all pesticides sold in interstate commerce must be registered and labeled according to its provisions.

The Food, Drug, and Cosmetic Act is administered by FDA. It provides for the establishment of tolerances for pesticides in or on agricultural commodities. This means that applications of chemicals to crops and livestock must be done in such a way that residues left in or on the commodities are within established tolerances. Therefore, you must follow 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

* 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. Don't use dusts in sprayers--they do not mix properly with water or oil.

* Wettable powders are dry powders which you may mix with water to make sprays. Formulations containing 15, 25, 40, 50, 75, 80, and 85 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. These formulations are useful on vegetation because they do not injure foliage as readily as do emulsions or oil solutions. High volume hydraulic sprayers with mechanical agitators are best suited for handling most wettable powders.

* Soluble powders. Only a few organic insecticides, made of newer materials, dissolve in water. Powders of these chemicals are called soluble powders. You may mix them with water in the same way as wettable powders and use them in sprayers that handle solutions or emulsions.

* Emulsifiable concentrates are liquids that contain the insecticide dissolved in a suitable solvent and an emulsifier. The concentrates mix with water to form emulsions. These concentrates may contain many different amounts of the active ingredient; the label gives 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 1/2 pounds actual dieldrin per gallon; 57-percent malathion emulsifiable concentrate contains 5 pounds actual malathion per gallon. You may use emulsions in low pressure, low volume sprayers without mechanical agitation. Be sure the use on plants is specifically recommended or included on the label--emulsions damage certain foliage. Some insecticides are available as pastelike "flowable" formulations; handle them in about the same way as emulsions.

* 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 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. Don't use oil solutions on plants or animals except for special uses with special formulations, such as fly sprays on cattle.

* Granulated material is a ready-to-use preparation of the insecticide in or on particles of an inert carrier such as attaclay or bentonite. The particles are usually from 25 to 60 mesh in size, 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. Granules are also effective for corn borer control because they roll down into the whorls of plants. Apply granules with fertilizer spreaders, seeders, or special granule applicators, ground or aerial.

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

* Miscellaneous. In addition to the main insecticides, there are some special types. Use fumigants, baits, insecticide-fertilizer mixtures, insecticide-herbicide mixtures, mothproofing agents, etc. according to recommendations and label directions.

Calculating Dosages And Application Rates

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 and thereby 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 gallons of 25-percent DDT in 50-gallon tank

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

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

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 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:

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

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 pounds

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

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

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 percent

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

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

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 lb.	3 lb.
	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 lb.	3 lb.	4 lb.
	amount of wettable powder to use per acre							
15	13 oz.	1 lb., 12 oz.	3 lb., 5 oz.	5 lb.	6½ lb.	13 lb.	20 lb.	26½ lb.
25	8 oz.	1 lb.	2 lb.	3 lb.	4 lb.	8 lb.	12 lb.	16 lb.
40	5 oz.	10 oz.	1 lb., 4 oz.	1 3/4 lb.	2½ lb.	5 lb.	7½ lb.	10 lb.
50	4 oz.	8 oz.	1 lb.	1½ lb.	2 lb.	4 lb.	6 lb.	8 lb.
75	3 oz.	6 oz.	12 oz.	1 lb.	1 lb., 5 oz.	2 lb., 11 oz.	4 lb.	5 lb., 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	1/2 lb.	1 1/2 lb.	3 lb.	5 1/3 lb.	13 1/2 lb.	27 lb.	54 lb.		
25	1/3 lb.	1 lb.	2 lb.	3 lb.	8 lb.	16 lb.	32 lb.		
40	1/5 lb.	3/4 lb.	1 1/2 lb.	2 lb.	5 lb.	10 lb.	20 lb.		
50	1/6 lb. (2 1/2 oz.)	1/2 lb.	1 lb.	1 1/2 lb.	4 lb.	8 lb.	16 lb.	40 lb.	
75	1/10 lb. (1 1/2 oz.)	1/3 lb.	2/3 lb.	1 lb.	2 1/2 lb.	5 lb.	10 lb.	25 lb.	52 lb.
Emulsifiable concentrate (pounds per gallon)									
1	1 1/3 cup	1 qt.	1/2 gal.	3 qt.	2 gal.	4 gal.	8 gal.	20 gal.	40 gal.
1 1/2	3/4 pt.	1/3 gal.	1/3 gal.	1/2 gal.	1 1/3 gal.	2 2/3 gal.	5 gal.	13 1/2 gal.	27 gal.
2	2/3 cup	1 pt.	1 qt.	3 pt.	1 gal.	2 gal.	4 gal.	10 gal.	20 gal.
4	1/3 cup	1/2 pt.	1 pt.	1 1/2 pt.	1/2 gal.	1 gal.	2 gal.	5 gal.	10 gal.
5	2 fluid oz.	6 fluid oz.	3/4 pt.	2 2/3 cup	3 pt.	3 qt.	1 3/4 gal.	4 gal.	8 gal.
6	1 3/4 fluid oz.	2/3 cup	1 1/2 cup	1 pt.	2 2/3 pt.	5 pt.	1 1/2 gal.	3 1/3 gal.	6 2/3 gal.
8	1 fluid oz.	1/4 pt.	1/2 pt.	3/4 pt.	1 qt.	1/2 gal.	1 gal.	2 1/2 gal.	5 gal.

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, you often must 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

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) = 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

General Precautions For Using Pesticides

1. Always read the label before using sprays or dusts. Note warnings and cautions each time before opening the container.

2. Keep sprays and dusts out of reach of children, pets, and irresponsible people. Store sprays and dusts outside of the home, away from food and feed, and under lock and key.

3. Always keep sprays and dusts in original containers and keep them tightly closed.

4. Never smoke or eat while spraying or dusting.

5. Avoid inhaling sprays or dusts. When directed on the label, wear protective clothing and masks.

6. Do not spill sprays or dusts on the skin or clothing. If they are spilled, remove contaminated clothing immediately and wash thoroughly.

7. Wash hands and face and change to clean clothing after spraying or dusting. Also wash clothing each day before reuse.

8. Cover food and water containers when treating around livestock or pet areas. Do not contaminate fish ponds.

9. Use separate equipment for applying hormone-type herbicides in order to avoid accidental injury to susceptible plants.

10. Always dispose of empty containers so that they create no hazard to humans, animals, or valuable plants.

11. Observe label directions and cautions to keep residues on edible portions of plants within legal limits.

12. If symptoms of illness occur during or shortly after spraying or dusting, call a physician or get the patient to a hospital immediately.

Disposal Of Empty Containers

For all empty containers of all types: Do not reuse the container. Completely empty contents and bury the unused chemical at least 18 inches deep in an isolated location away from water supplies.

Glass containers: Break the container and bury pieces at least 18 inches deep in an isolated location away from water supplies.

Fiber and paper containers: Burn empty containers completely. Exercise extreme caution and stay well away from smoke.

Metal containers: Pour the following mixture into the empty container:

One-gallon cans--1 pint water and 1 tablespoon household detergent.

Five-gallon drums--2 quarts water, ½ cup caustic soda (household lye), and 2 tablespoons detergent.

Thirty-gallon drums--3 gallons water, 1 pound caustic soda (household lye), and ½ cup detergent.

Fifty-five gallon drums--5 gallons water, 2 pounds caustic soda (household lye), and 1 cup detergent.

Handle caustic soda (household lye) with extreme care. Do not get on skin, in eyes, or on clothing. Read and carefully follow the precautions on the package.

Rotate container carefully until all inner surfaces are thoroughly wet. Bury the rinse solution at least 18 inches deep in an isolated area away from water supplies.

Punch holes in the top and bottom of the container, crush the container, and bury deeply in an isolated location.

If you cannot use this rinse method, punch holes in the TOP of the container. Then burn it in a hot fire until all paint is completely burned off the container. Exercise extreme caution to insure that containers are completely empty and that persons stay well away from smoke and fumes.

Do not attempt to burn more than five containers at one time.

Always read and follow directions and precautions on the label of a pesticide container. Handle empty containers as carefully as those that are full.

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, Fisheries, and Wildlife, University of Minnesota, Institute of Agriculture, St. Paul, Minnesota 55101.

Phosphate-Poisoning Symptoms and Antidote

Many organic phosphate insecticides (TEPP, parathion, methyl parathion, tetraethyl dithiopyrophosphate, EPN, demeton, 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 are considerably less toxic: Malathion, Dicapthon, Co-Ral, and ronnel being much less toxic and Diazinon, Dylox, and Delnav being intermediate.

All 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 facial and eye muscles.

If any symptom occurs:

1. Call physician immediately.
2. Remove contaminated clothing and wash skin thoroughly with soap and water.
3. Induce vomiting if chemical has been swallowed.
4. Keep patient quiet and warm.

Physician may administer atropine or 2-PAM 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. If you use these compounds often, have analyses of the blood made at regular intervals.

Chlorinated-Hydrocarbon First Aid

The chlorinated hydrocarbons include aldrin, BHC, chlordane, dieldrin, DDT, endrin, heptachlor, lindane, methoxychlor, toxaphene, and 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. Wash skin thoroughly with soap and water. Do not use kerosene, gasoline, or other solvents.

3. Keep patient quiet and warm.

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 centers operate on a 24-hour basis.

City	Address	Telephone
Bemidji	Bemidji Hospital	751-5430
Brainerd	St. Joseph's Hospital	2861
Crookston	Bethesda Hospital	281-4682
	St. Francis Hospital	281-2490
Duluth	St. Luke's Hospital 915 E. 1st Street	727-6636
Fergus Falls	Lake Region Hospital	736-5475
Mankato	Immanuel Hospital	628-1605
Marshall	Lewis Weiner Memorial Hospital	532-2263
Minneapolis	Division of Special Health Services State Health Department	339-7751 Night: 339-1411
	Abbott Hospital 110 E. 18th Street	339-8414 Extension 226

City	Address	Telephone
Minneapolis	Fairview Hospital 2312 S. 6th Street	332-0282 Extension 331
	Hennepin County General Hospital 619 S. 5th Street	330-3930
	North Memorial Hospital 3220 Lowry Avenue N.	588-9451
	Northwestern Hospital 810 E. 27th Street	332-7266
Morris	Stevens County Memorial Hospital	1191
Rochester	St. Mary's Hospital	282-4425 Extension 591
St. Cloud	St. Cloud Hospital	251-2700
St. Paul	Ancker Hospital 495 Jefferson Avenue	222-7341 Extension 240
	Bethesda Hospital 559 Capitol Boulevard	227-8611
	St. John's Hospital 403 Maria Avenue	776-8595 Extension 531
	St. Joseph's Hospital 69 W. Exchange	222-2861
	St. Luke's Hospital 300 Pleasant Avenue	222-6644
	Children's Hospital 311 Pleasant Avenue	227-6521
Virginia	Virginia Municipal Hospital	741-3340
Willmar	Rice Memorial Hospital	235-4543
Worthington	Worthington Memorial Municipal Hospital	376-4141 Night: 376-4142

Acute oral and dermal LD_{50} values of organic phosphate and chlorinated hydrocarbon insecticides for male and female white rats*

	Oral LD_{50} (MG./KG.)		Dermal LD_{50} (MG./KG.)	
	Males	Females	Males	Females
Organic Phosphates:				
TEPP	1.05	-	2.4	-
Phorate (Thimet)	2.3	1.1	6.2	2.5
Phosdrin	6.1	3.7	4.7	4.2
Di-Syston	6.8	2.3	15.0	6.0
Parathion	13.0	3.6	21.0	6.8
Demeton (Systox)	6.2	2.5	14.0	8.2
Methyl parathion	14.0	24.0	67.0	67.0
Phosphamidon	23.5	23.5	143.0	107.0
Guthion	13.0	11.0	220.0	220.0
Carbophenothion (Trithion)	30.0	10.0	54.0	27.0
EPN	36.0	7.7	230.0	25.0
Ethion	65.0	27.0	245.0	62.0
Co-Ral	41.0	15.5	860.0	-
Delnav	43.0	23.0	235.0	63.0
Dichlorvos (DDVP)	80.0	56.0	107.0	75.0
Methyl Trithion	98.0	120.0	215.0	190.0
Diazinon	108.0	76.0	900.0	455.0
Dimethoate (Cygon)	215.0	-	400.0	-
Fenthion (Baytex)	215.0	245.0	330.0	330.0
Dicapthon	400.0	330.0	790.0	1,250.0
Trichlorfon (Dipterex) (Dylox)	630.0	560.0	2,000.0	2,000.0
Ronnel	1,250.0	2,630.0	-	-
Malathion	1,375.0	1,000.0	4,444.0	4,444.0
Chlorinated Hydrocarbons:				
Endrin	17.8	7.5	-	15.0
Dieldrin	46.0	46.0	90.0	60.0
Aldrin	39.0	60.0	98.0	98.0
Thiodan	43.0	18.0	130.0	74.0
Heptachlor	100.0	162.0	195.0	250.0
Lindane	88.0	91.0	1,000.0	900.0
Toxaphene	90.0	80.0	1,075.0	780.0
Chlordane	335.0	430.0	840.0	690.0
DDT	113.0	118.0	-	2,510.0
Kelthane	1,100.0	1,000.0	1,230.0	1,000.0
Chlorobenzilate	1,040.0	1,220.0	-	-
TDE (DDD)	3,400.0+	-	-	-
Perthane	4,000.0	4,000.0	-	-
Methoxychlor	6,000.0+	-	-	6,000.0

* From Clinical Handbook of Economic Poisons, U. S. Public Health Service.

\+ Sex of the rats not specified.

Summary Of Insecticide Uses

This summary is divided into three parts. In the first part, crops and livestock are listed alphabetically. After each crop or livestock the common insects are listed. In the third column is an alphabetical list of the insecticides presently registered and/or recommended for each use.

In the second part, insecticides are listed alphabetically in the first column with the currently recommended uses in the following columns.

In the third part, the registered and recommended uses are listed with residue tolerances and limitations for the major field crops.

This summary will give you a quick reference to the current uses of insecticides for the control of field crop and livestock pests. Other information on dosage, time of application, restrictions, and limitations is extremely important. You can find this information on container labels and literature supplied by manufacturers and in current University of Minnesota publications (see list of references, page 22).

Part I. By Crop and Livestock

Crop	Insect	Insecticide
Alfalfa, clover	aphids	demeton (Systox) Diazinon malathion mevinphos (Phosdrin) parathion
	grasshoppers	carbaryl (Sevin) Diazinon malathion
	leafhoppers	Diazinon methoxychlor
	plant bugs	DDT (seed crop) dieldrin (seed crop) endrin (seed crop) methoxychlor toxaphene (seed crop)
	sweet clover weevils	toxaphene
Corn (check current limitations for silage or fodder)	armyworms	carbaryl (Sevin) dieldrin } for grain only endrin } for grain only toxaphene } for grain only
	aphids	parathion phorate (Thimet)
	northern corn rootworms	aldrin heptachlor
	western corn rootworms and resistant northern corn rootworms	compound 4072 Diazinon DiSyston parathion (stabilized granules) phorate (Thimet)
	cutworms	aldrin DDT dieldrin
Corn	cutworms	endrin heptachlor toxaphene
	European corn borers	carbaryl (Sevin) DDT endrin EPN toxaphene
	grasshoppers	aldrin carbaryl (Sevin) Diazinon dieldrin malathion toxaphene
	white grubs	aldrin dieldrin heptachlor
	wireworms	aldrin dieldrin heptachlor lindane
Flax	crickets	dieldrin
	cutworms	DDT dieldrin endrin toxaphene
Small grains	aphids	malathion mevinphos (Phosdrin) parathion
	armyworms	dieldrin endrin toxaphene
	cutworms	dieldrin endrin

Crop	Insect	Insecticide
Small grains	cutworms	toxaphene
	grasshoppers	aldrin dieldrin toxaphene
	thrips (barley)	parathion
	wireworms (seed treat)	aldrin dieldrin heptachlor lindane
Soybeans (for beans)	cutworms	DDT dieldrin endrin toxaphene
Potatoes	fleabeetles, leafhoppers	carbaryl (Sevin) DDT Diazinon DiSyston endosulfan (Thiodan) endrin Guthion malathion naled (Dibrom) phorate (Thimet) phosphamidon (Dimecron) toxaphene
	wireworms	chlordane

Infested Building	Insect	Insecticide
Barns, sheds, shelters	flies	Diazinon (except poultry and milkhouses) dichlorvos (DDVP) dimethoate (Cygon) dimetilan (Snip) malathion naled (Dibrom) (except milkhouse) Pyrethrins ronnel (Korlan) trichlorfon (Dipterex)
Barns, other than dairy or poultry or milkhouses	flies	antiresistant DDT fenthion (Baytex)

Livestock	Insect	Insecticide
Beef cattle (and non-lactating dairy cattle)	cattle grubs	coumaphos (Co-Ral) ronnel (Trolene) rotenone Ruelene
	flies	Ciodrin coumaphos (Co-Ral) DDT (in backrubbers) dichlorvos (DDVP) dioxathion (Delnav) malathion methoxychlor Pyrethrins ronnel (Korlan) toxaphene
	lice	coumaphos (Co-Ral) dioxathion (Delnav) lindane malathion methoxychlor ronnel (Korlan) toxaphene
Dairy cattle	cattle grubs	rotenone
	flies	Ciodrin dichlorvos (DDVP) malathion dust methoxychlor dust Pyrethrins thiocyanates
	lice	Pyrethrins rotenone
Poultry	mites, lice	carbaryl (Sevin) coumaphos (Co-Ral) malathion
Sheep	keds ("ticks")	coumaphos (Co-Ral) DDT dioxathion (Delnav) lindane malathion methoxychlor ronnel (Korlan) toxaphene
	wool maggots	screwworm smears coumaphos (Co-Ral) dioxathion (Delnav) lindane ronnel (Korlan)
Swine	mange, lice	lindane

Part 2. By Insecticide

Insecticide	Crop or Livestock	Insect
aldrin	corn	cutworms rootworms white grubs wireworms grasshoppers
	small grains	grasshoppers wireworms
	soybeans	grasshoppers white grubs wireworms
carbaryl (Sevin)	alfalfa, clover	grasshoppers
	corn	earworms European corn borers grasshoppers
	sugar beets	webworms grasshoppers
	potatoes	Colorado potato beetles flea beetles leafhoppers
	poultry	mites lice
chlordane	potatoes	wireworms
Ciodrin	cattle, beef, dairy	flies lice
coumaphos (Co-Ral)	beef cattle	lice flies

Insecticide	Crop or Livestock	Insect
coumaphos (Co-Ral)	beef cattle	screwworms grubs
	poultry	mites lice
	sheep	keds wool maggots
DDT	corn (for grain)	European corn borers earworms cutworms
	alfalfa, clover (for seed)	plant bugs leafhoppers
	potatoes	Colorado potato beetles flea beetles leafhoppers
	beef cattle	hornflies (in backrubbers)
	sheep	keds ("ticks")
demeton (Systox)	alfalfa	aphids leafhoppers
	potatoes	aphids leafhoppers
Diazinon	alfalfa, clover	leafhoppers grasshoppers
	corn	grasshoppers earworms corn rootworms
	potatoes	aphids Colorado potato beetles flea beetles leafhoppers
	barns	flies
dichlorvos (DDVP)	cattle, dairy, beef	flies
	barns	flies
dieldrin	corn (for grain)	armyworms cutworms grasshoppers white grubs wireworms
	small grains	armyworms cutworms grasshoppers wireworms
	soybeans (for beans)	cutworms grasshoppers white grubs
Dimetilan ("Snip")	barns	flies
dioxothion (Delnav)	beef cattle	lice hornflies
dioxothion (Delnav)	sheep	keds wool maggots
DiSyston	potatoes	aphids flea beetles leafhoppers
	corn	corn rootworms
endosulfan (Thiodan)	potatoes	aphids Colorado potato beetles flea beetles leafhoppers
	alfalfa, clover (for seed)	plant bugs grasshoppers
endrin	alfalfa, clover (for seed)	plant bugs leafhoppers
	corn	armyworms cutworms European corn borers
	small grains	armyworms cutworms
	sugar beets	webworms cutworms
	potatoes	aphids cutworms Colorado potato beetles flea beetles leafhoppers
EPN	corn (canning)	European corn borers
Guthion	potatoes	Colorado potato beetles flea beetles leafhoppers
heptachlor (soil treatment)	corn	corn rootworms cutworms wireworms white grubs
	soybeans	white grubs wireworms
lindane	corn, soybeans, small grains (seed treatment)	wireworms
	beef cattle	lice
	sheep	keds wool maggots
	swine	mange lice
malathion	alfalfa, clover	aphids grasshoppers leafhoppers
	corn	grasshoppers
	small grains	aphids grasshoppers
	beef cattle	flies lice

Insecticide	Crop or Livestock	Insect
malathion	dairy cattle	flies (as dust only)
	poultry	mites lice
	sheep	keds ("ticks")
	barns	flies
methoxychlor	alfalfa, clover	leafhoppers
	beef cattle	flies lice
	dairy cattle	flies (as dust only)
	sheep	keds ("ticks")
mevinphos (Phosdrin)	alfalfa, clover, small grains	aphids
naled (Dibrom)	potatoes	Colorado potato beetles flea beetles leafhoppers
	barns	flies
parathion	alfalfa	aphids leafhoppers
	corn	corn rootworms
	small grains	aphids
	barley	thrips aphids
	potatoes	aphids leafhoppers
phorate (Thimet)	potatoes	aphids flea beetles leafhoppers
	corn	corn rootworms aphids

Insecticide	Crop or Livestock	Insect
phosphamidon (Dimecron)	potatoes	aphids Colorado potato beetles flea beetles leafhoppers
ronnel (Korlan, Trolene)	beef cattle	cattle grubs lice flies
	sheep	keds wool maggots
	barns	flies
Ruelene	beef cattle	cattle grubs lice
toxaphene	corn	armyworms cutworms grasshoppers European corn borers
	small grains	grasshoppers armyworms
	potatoes	Colorado potato beetles flea beetles
	beef cattle	lice flies
	sheep	keds ("ticks") scab
trichlorfon (Dipterex)	barns	flies
trichlorfon (Dylox)	sugar beets	webworms
Compound 4072	corn	corn rootworms

Part 3. By Registered And Recommended Insecticide Uses In Cereal, Oil, And Forage Crops

Chemical	Crop	Tolerance (ppm.)[1]	Limitations or minimum days before harvest
aldrin	corn (field, pop, sweet)	0	Soil treatment before or at planting
	corn seed		Seed treatment Do not use for food or feed
	corn	0	21 days (2 oz. per acre) 30 days (4 oz. per acre) Do not use treated stalks, leaves, and husks for forage or ensilage
	small grain seed	--[2]	Do not use for food or feed
	small grains	0.1 (grain) 0.7 (straw)	7 days (grain) Do not feed straw treated within 30 days of harvest to livestock, or ship interstate
	soybeans (beans)	0	30 days, single application Do not feed or ensile treated plants
carbaryl (Sevin)	alfalfa, clover	100	NTL[3]
	corn	25 (forage) 5 (kernels, cobs)	NTL
	small grain	0 (grain) 100 (straw)	Do not apply after boot stage
	sugar beets	100 (tops)	14 days (for tops) NTL for beets

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[1] ppm. = parts per million.

[2] --or NR = registered on "no residue" basis.

[3] NTL = no time limitations.

Chemical	Crop	Tolerance (ppm.)	Limitations or minimum days before harvest
carbaryl (Sevin)	soybeans	5 (beans) 100 (forage, hay)	NTL
	Grass (pasture and hay)	100	NTL
chlordane	flax	--	Do not apply after blossoming
	alfalfa, clover (for seed)	--	Do not feed or graze treated plants or crop residues
DDT	alfalfa, clover (for seed)	--	Do not feed, sell, or ship treated forage
	corn	3.5 (kernels and cobs of sweet corn only)	Do not feed or graze treated forage NTL on grain
	soybeans (beans)	--	Do not feed treated forage
	small grains	--	Do not apply after heads start to form Do not feed treated forage or graze treated fields
demeton (Systox)	alfalfa, clover	5 (fresh)	21 days -- one application per cutting
Diazinon	alfalfa	40 (fresh) 10 (hay)	2 days - grazing 10 days - cutting for hay
	clover	40 (fresh) 10 (hay)	NTL - grazing or feeding fresh or green cut forage 7 days for cutting for hay
	corn (field, sweet)	0.75 (kernels and cob only)	NTL for grain NTL for forage fed to cattle and sheep; 2 days other livestock
	grass (pasture)	60 (40 ppm. 24 hrs. after treatment)	NTL for grazing or feeding fresh forage

Chemical	Crop	Tolerance (ppm.)	Limitations or minimum days before harvest
Diazinon	grass hay	10	21 days (water spray) 30 days (oil spray) Do not spray on or over livestock Do not repeat application within 30 days
dieldrin	corn	0	40 days (2 oz. per acre) 60 days (8 oz. per acre) Do not feed forage
	corn seed		Seed treatment Do not use for food or feed
	soybeans (for beans)	0	35 days (1 oz. per acre)
	small grain seed		Seed treatment Do not use for food or feed
DiSyston	corn (field)	--	Soil treatment only at least 100 days before harvest
endosulfan (Thiodan)	sugar beets	--	Do not feed treated tops
endrin	corn	--	Single application 45 days
	small grains	--	45 days
	sugar beets	0	20 days (no tops) 60 days (for tops)
heptachlor	corn	0	Soil treatment before or at planting
	corn seed	--	Seed treatment Do not use for food or feed
	small grain seed	--	Seed treatment Do not use for food or feed
lindane	corn seed, small grain seed	--	Seed treatment Do not use for food or feed
malathion	alfalfa, clover, grass, pasture, forage, or hay	135	NTL

Chemical	Crop	Tolerance (ppm.)	Limitations or minimum days before harvest
malathion	corn	8 (forage) 2 (ear)	5 days
	small grain	8	7 days or postharvest storage treatment
	soybeans	--	1 day for rates less than 1 3/4 pounds per acre 3 days for rates less than 2 pounds per acre
methoxychlor	alfalfa, clover, grass	100	7 days
mevinphos (Phosdrin)	alfalfa, clover grass	1 --	1 day 1 day (5 days for grass hay to be sold or shipped)
	corn	0.25 (grain) 1.0 (forage)	1 day
	small grains	--	14 days
parathion (and methyl parathion)	alfalfa, clover	1	15 days
	corn	1	12 days or soil treatment
	small grains	1	15 days
phorate (Thimet)	corn	--	Granular formulation soil treatment at planting <u>or</u> application to whorls prior to tasseling Do not apply if previous soil application is used
toxaphene	alfalfa, clover for seed	--	Do not feed, graze, or cut for hay
	corn	7	NTL grain Do not feed treated forage
	small grains	5	NTL grain Do not feed straw or use treated crop for forage

Chemical	Crop	Tolerance (ppm.)	Limitations or minimum days before harvest
toxaphene	sugar beets	--	60 days Do not feed tops
	soybeans	--	NTL beans Do not feed forage
	grass, pasture	7 (in fat of meat animals)	Not more than one application Do not graze milk cows Remove meat animals at least 6 weeks before slaughter Do not apply to grass to be cut for hay
	sweet clover	--	Early spring - two leaf stage Do not pasture or cut for hay or forage
trichlorfon (Dylox)	sugar beets	--	14 days - beets 28 days - tops
4072	corn	--	Soil treatment

References - Insect Control - Insecticides

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Insecticide Recommendations of the Entomology Research Division. Agr. Handbook 120. ARS, USDA, Washington, D. C.

Home Fruit Spray Guide. P. 184, Univ. of Minn., St. Paul, Minn. 55101

Fly Control for Livestock. Ext. F. 192., Univ. of Minn., St. Paul, Minn. 55101

Entomology Fact Sheet Series, Univ. of Minn., St. Paul, Minn. 55101

1. European Corn Borer and Corn Earworm Control
2. European Corn Borer Control with Granular DDT
4. Insect Ccntrol on Forage Crops
5. Controlling Cattle Lice
7. Chemical Control of Soil Insect Pests of Corn
8. Indian Meal Moth Control in Stored Shelled Corn
9. Insects in Stored Grain
11. Controlling Insects in the Home Vegetable Garden
12. Armyworms
14. Controlling Corn Rootworms
17. Insect Pests of Poultry
20. The Apple Maggot
21. Cankerworms
28. Controlling Insect Pests of Trees and Shrubs

THE WESTERN CORN ROOTWORM IN MINNESOTA

John A. Lofgren, extension entomologist

The western corn rootworm is present throughout most of southern Minnesota and is firmly established in the southwest corner of the state (see map). It is expected to spread and increase and eventually become a pest of high economic importance in corn-producing counties. This insect is related to the common northern corn rootworm and has a similar life cycle: eggs are laid in the fall, larvae hatch in June, and adults emerge in July and August.

Concern over the western corn rootworm is due to the fact that crop rotations are not as effective in preventing their infestations as they are for the northern corn rootworm. The western species readily becomes resistant to the commonly used soil insecticides, aldrin and heptachlor. Furthermore, when the western species becomes established in a field or locality, northern rootworms become less abundant and the western evidently becomes dominant. It is apparently more vigorous and damaging than the northern.

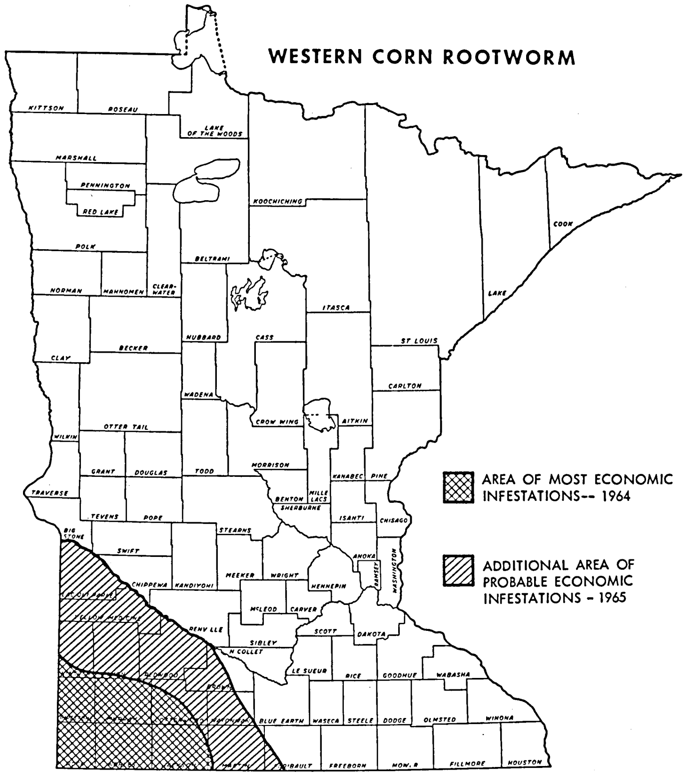
In fields where western rootworms have become damaging, or in those few localized areas where the northern species has become resistant to aldrin or heptachlor, the following suggestions may be helpful in minimizing losses:

1. Wherever practicable, rotate badly infested fields to crops other than corn in the following year.

2. Avoid late planting dates for fields that are probably infested. As a general rule, other factors being equal, late planted corn is more severely damaged than early planted corn.

3. If you apply the chemical properly, use of certain phosphate insecticides may reduce losses when corn is planted in fields likely to be economically infested with western or resistant northern rootworms. Chemicals which have label approval for the control of resistant rootworms are granular Diazinon, phoratc (Thimet), stabilized parathion, compound 4072, and DiSyston.

Aldrin or heptachlor is still recommended for the control of nonresistant populations of rootworms. (See Entomology Fact Sheet 14.)



Rate Of Application Of Organic Phosphates

Apply 1 pound of actual chemical per acre. The commercially available form of phorate, parathion, and 4072 to use for rootworms is the 10-percent granular formulation. Apply granules at 10 pounds per acre. If using Diazinon, apply 14-percent granules at 7 pounds per acre. Amounts should be concentrated over rows.

Placement Of Insecticides

It is extremely important to apply the right amount of chemical in the right place. Use properly calibrated and adjusted granular applicators mounted on the corn planter. The granules should not be placed deep in the furrow with the seed but in a 4- to 6-inch band over the seed and just covered by 1/2 to 1 1/2 inches of soil. To do this, use spreaders on the ends of applicator tubes. Adjust tubes to deliver the insecticide well behind the planter shoes, just ahead of the press wheels.

Postemergence Treatments

Experimental work in some north-central states shows that applications of these phosphate insecticides at 1 pound of actual chemical per acre in the row about the middle of June may give satisfactory control. Apply granules or spray with an applicator mounted on the cultivator, directed at the bases of the plants, and covered with 2 to 3 inches of soil. You can do this with disk hillers on the cultivator. Good results will probably not be obtained if you make the treatment during a droughty period.

Caution!

Some organic phosphate insecticides are highly toxic--use them with extreme care. Avoid exposure to the skin, lungs, and mouth. Wear protective clothing when directed to do so on the label. Do not breathe the dust or vapors; do not eat or smoke while handling the chemicals or until after washing thoroughly. When finished for the day, bathe thoroughly and change clothes. Follow these and other precautions given on the container's label to protect yourself.

GENERAL CHARACTERISTICS OF MINNESOTA SOILS

Lowell D. Hanson, extension soils specialist

Area 1 -- Fayette—Tama Soils

Landscape Pattern and Texture of Soils - This is an area of high yield potential soils because of their high water-holding capacity and favorable climate. Texture is uniform silt loam due to the silty original windblown deposits. Landscape is variable; much of the land is uncultivated because of steep slopes.

Drainage, Tilth, and Erosion Problems - Relatively few drainage problems exist because natural surface drainage is well developed. Erosion is a general problem due to the silt loam texture and slope of the land. Contour tillage and terraces have worked well but erosion still occurs. Leave seedbeds as rough as possible without interfering with seed soil contact - in order to minimize erosion and crusting.

Climate, Rainfall, and Drought - Frost-free days average about 150-- this is high for Minnesota. April-September rainfall is 22 inches. Because these soils usually are well drained, spring soil temperature is higher than in most soils. Use 20,000 corn plants per acre to maximize yields.

Organic Matter and Nitrogen (N) Release - Organic matter (humus) is low on Fayette soils (formerly forested) and higher on Tama (formerly prairie). In alfalfa rotations, soil N is usually adequate for crops except corn. N is available from soil early in the season because of warm soil temperatures.

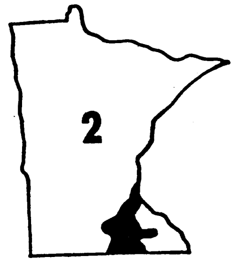
Phosphorus (P) and Potassium (K) Status - Available P is medium to high in surface soil and very high in subsoil on Fayette. K usually limits yields more than does P. K tests often run less than 200 but can be built up quite rapidly with heavy potash fertilization.

Acidity and Need for Lime - About 50 percent of the soils have a pH less than 6.2 and need lime application. Local quarries supply a good quality agricultural limestone high in magnesium (Mg). Some fields had repeated lime applications which were not necessary; other acid fields received very little lime. Check lime needs with test.

Summary - Main shortcomings of this soil area are erosion hazard and deficiencies of lime, N, and K. Soils are responsive to good management on a variety of crops. Corn yield goals of 130 bushels are practical.

Area 2 -- Ostrander-Kenyon and Kasson-Skyberg Soils

Landscape Pattern and Texture of Soils - These are some of Minnesota's oldest soils so some lime and nutrient minerals have leached out of them. Textures vary but are mainly silt loam to clay loam. Kasson-Skyberg soils in western Dodge and Mower are almost level; the rest are gently rolling.



Drainage, Tilth, and Erosion Problems - Poorly drained soils are major problems, especially in western Dodge and Mower Counties. Because of a compact subsoil, tiling is not always effective. Erosion is a problem but can be controlled with simple practices on most soils. Poor soil tilth is common, especially on Kasson-Skyberg where organic matter is low. Production of more soil-returned crop residues is necessary through adequate fertilization.

Climate, Rainfall, and Drought - April-September rainfall averages about 22 inches--as high as any area of the state. In terms of frequency of drought, recent studies showed that 10 days of drought will occur only once in 3 years.

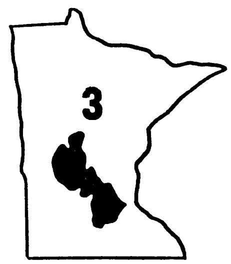
Organic Matter and N Release - N deficiency is most severe on Kasson-Skyberg soils due to both low organic matter and cool soil temperature. Soils have sufficiently heavy textures so rapid loss of N by leaching is not a problem. Reserve of soil N in the area is about exhausted. Therefore, you must supply most of a crop's N requirement by manure or fertilizer.

P and K Status - About 50 percent of the soils test low and medium in P; 75 percent test low and medium in K. Subsoil P and K are usually lower than in soils to the east.

Acidity and Need For Lime - The area has a high lime need because about 70 percent of the soils are below pH 6.2; heavier than average rates of lime are needed to correct acidity of the fine textured soils. Most soils are not suitable for alfalfa without lime and potash applications.

Summary - These soils need several specific management practices before they can produce crops as efficiently as other soil areas. Most important of these are drainage, lime, and substantial corrective applications of phosphate and potash.

Area 3 -- Hayden, Lester, and Sandy Terrace Soils



Landscape Pattern and Texture - This soil group represents a transition between the forested soils to the north and the true prairie soils to the south and west. Most of the area is characterized by rolling topography and sharp changes in relief, texture, and drainage due to the morainic nature of the glacial deposits. Morains are sometimes described as glacial "dumping grounds," so the combination of moving water and ice created a complex of textures ranging from "heavy" clay loams to loamy sands.

Hayden developed under hardwood tree vegetation and on limy clay loam till. Lester is a similar soil but with more organic matter due to some original prairie vegetation. The main sandy soils are Wadena, Hubbard, and Waukegan--all dark colored, usually level, prairie soils.

Drainage, Tilth, and Erosion Problems - The full range of these problems is exhibited on these variable landscapes. Tilth, drainage, and erosion problems are of minor importance on sandy soils, but tilth and erosion are serious on the fine textured rolling Hayden and Lester soils. Many poorly drained areas have not been drained either by ditch or tile. The complex slope pattern often dictates tillage types of erosion control or forage crops rather than conventional contour strips and terraces.

Climate, Rainfall, and Drought - The fine textured soils have a moderately high water-holding capacity (8 to 12 inches); with an annual rainfall of 27 to 29 inches, drought days are normally less than 5 days per year. On sandy soils, assuming a 5-inch water-storage capacity, 10 to 20 drought days can be expected in the normal year.

Growing days are about 135-140, but low potholes are often subject to late spring and early fall frost.

Organic Matter and N Release - The topography and texture pattern is closely related to the organic matter and N release pattern. Most cultivated sections in the hilly areas of Scott, Carver, Wright, and Meeker Counties are quite low in organic matter. Some "deficiency" is due to erosion, but actually these soils never had the high accumulation of organic matter that is typical of prairie soils. Therefore, N deficiency is common; legumes or commercial N must be used. Level and usually poorly drained areas are high in organic matter and N, but much of this land is not in cultivation.

In sandy areas, organic matter is rather uniformly medium to low. These soils warm faster in the spring than do the fine textured soils; N is available early but these soils usually are quite deficient at mid-season.

P and K Status - As with other soil characteristics, P and K status is variable. Soil test summaries show that 30 percent of the samples are medium and low in P and 75 percent are medium and low in K. Subsoil P is considered to be quite high on both fine and coarse textured soils. Starter P would be especially important on fine soils. Substantial amounts of potash are often needed to maintain yields and stands of alfalfa. In view of present test levels, considerable corrective K applications are needed.

Acidity and Need for Lime - Various subareas in this area range in percent of samples showing a need for lime from 38 to 64. Most sandy soils need a regular liming program. Variable till soils often need lime on gently rolling fields more than do the steep eroded fields. Check with soil test.

Summary - This is the so-called "dairy belt" in central Minnesota. The cutup nature of many fields and marginal cropland make forages and pasture appropriate crops on much land. Livestock farms, in general, help maintain fertility so crop yield averages and potentials are relatively high.

Area 4 -- Clarion, Nicollet, and Webster Soils

Landscape Pattern and Texture of Soils - This is the largest area of prairie soils in Minnesota--over 7 million acres. Most land is gently rolling which results in the range of soil types from Glencoe (wet, depressional) to Clarion and Storden (well drained sites at the top of slopes). Clay loam, the main soil texture, has high nutrient and water-holding capacity.

Drainage, Tilth and Erosion Problems - Poor soil tilth accounts for many crop growth problems on these fine textured soils. Many older drainage systems are inadequate because of silting in of outlets and thousands of new acres of drainage. Erosion is a continuing problem, but often terraces and strip cropping are not used due to a complex slope pattern. Planting row crops on a loose, rough seedbed reduces erosion. Artificial drainage is necessary on Glencoe and Webster soils.

Climate, Rainfall, and Drought - Growing season rainfall averages 20 inches and the number of days without killing frost is about 145. Drought occurs more often in this area than further east, with 10 days of drought likely in 5 out of 10 years. However, maintain corn stands at 16,000 to 20,000 plants per acre. A population of this level does not lower yields in a dry year as much as a low population reduces yields during an average year. Cool soil temperatures often limit early crop growth on Webster soils.

Organic Matter and N Release - These dark colored soils were originally high in organic matter but this reserve supply is gradually decreasing with cropping. Some Webster soils, which were recently drained, release substantial amounts of N during July and August but are deficient early in the season when soils are cool. On higher lying Nicollet and Clarion soils, almost all of the crops' N supply must be provided by manure, legumes, crop residues, and fertilizer.

P and K Status - Both P and K availability is variable. Phosphate usually increases corn yields because few fields test very high. However, profitable amounts to use vary from 20 to 80 pounds per acre, depending on the test.

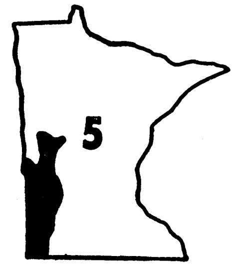
Some sections in this group of soils are more deficient in potash than are other areas. Those particularly deficient are sandy soils near the Mississippi River and a section in eastern Watonwan County. Both P and K tend to be lower in the subsoil than on the surface.

Acidity and Need for Lime - Surface soil acidity is increasing throughout the Clarion-Nicollet-Webster soils. About 35 percent of the soil samples show a need for lime application. Lime is actually applied on only a small fraction of this acreage due partly to less legume acreage and the fact that subsoil lime is usually adequate.

High lime rims or "alkali" spots are a problem on Webster soils. Here lime is concentrated on the surface, resulting in K and P deficiency problems.

Area 5 -- Barnes-Aastad and Moody Soils

Landscape Pattern and Texture of Soils - Western Barnes-Aastad soils are developed from the same fine textured, limy parent material as the Clarion-Nicollet-Webster soils. However, because of less rainfall, the surface soil is higher in lime and K than are similar soils to the east. Much land is level to gently rolling. Moody soils of Rock and Pipestone Counties are different from Barnes-Aastad soils because they are developed from silty windblown materials. Here slopes are long and regular and the texture is almost always a silt loam.



Drainage, Tilth, and Erosion Problems -- These problems are closely related to soil type. Erosion is the main problem in the Moody and Barnes soils. These are well drained soils with slopes of 3 to 6 percent. On level lying, fine textured soils like Flom and Aastad, artificial drainage is necessary and must be well engineered to perform satisfactorily. Tillage of these soils when wet causes severe structure problems and a poor tilth condition.

Climate, Rainfall, and Frequency of Drought - Year in and year out, having adequate moisture is the major problem for farmers. Average growing season rainfall is 17 to 18 inches. Since 100 bushel corn yields require about this amount, water conservation is important. Frequency of drought is high. Longterm records show that a drought of at least 30 days can be expected 1 out of 2 years. Corn following alfalfa is a hazard because of low subsoil moisture after this crop.

Days without killing frost average about 140; this allows use of most high yielding corn and soybean varieties.

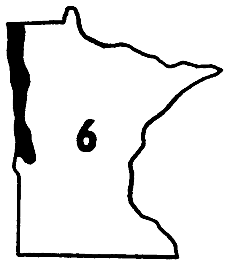
Organic Matter and N Release - Level soils, Flom and Aastad, are higher in organic matter than soils further up the slopes. However, the high organic matter of the level soils does not release N readily early in the season. Small grains and early growth of corn are usually limited by N deficiency on these soils. When these soils become warm in late June and July, considerable N is released. The opposite pattern holds true on well drained Moody and Barnes soils. Here nutrients, particularly N, are relatively more available early in the season than they are in the level wetter soils. N is often deficient late in the season when available supply from organic matter is exhausted.

On all soils, N deficiency develops despite soil organic matter level or soil type when corn is grown intensively.

P and K Status - Barnes-Aastad soils have a history of showing the highest percentage of low soil tests of any area in Minnesota. About 35 percent test in the low category and another 40 percent are medium in available P. Considerable amounts of phosphate were applied in recent years so test levels are gradually building up. However, P is still the most seriously deficient nutrient. K levels, in contrast, are much higher with only 30 percent in the medium and low category; 70 percent are high and very high. Subsoil P levels are even lower than in the surface. K subsoil amounts are slightly lower but are still quite high.

Acidity and Need for Lime - Few soils in the Barnes area will profit from lime application. Most soils have free lime at the surface. The Moody and associated soils in the southwest corner of the state are more acid; their lime need is being investigated. High cost of lime is a deterrent to even trial use. However, if alfalfa stands and growth are a problem after fertilization, lime may be necessary.

Area 6 -- Red River Valley Soils



Landscape Pattern and Texture - This section of Minnesota is part of the largest, nearly level area in the world. Soils are developed from sediments of glacial Lake Aggasiz. The surface usually is very flat with a 1-foot fall per mile quite common. Textures are finer (clays and silty clays) close to the Red River and become more coarse to the east. Fargo and Bearden are the major soil types.

Drainage, Tilth, and Erosion Problems - Tilth, drainage, and temperature are the major physical problems of these soils. Wind erosion also can be serious because wind velocities near the soil are high.

Surface drainage is usually more practical than tile because of outlet problems and a rather impermeable subsoil. Land forming or leveling small differences in the surface has been effective in spreading water and increasing yields.

Method of handling crop residues is important because residues can often lower soil temperature which adversely affects some crops. Surface soil compaction often is a problem when soils with high moisture are worked.

Climate, Rainfall, and Drought - Either too much water or not enough is a common description of the situation. Drought, as defined by days where water supply for crops is inadequate either from rainfall or water stored in soil or both, occurs about 30 days every 2 years. However, because rainwater does not move off the land rapidly, conditions too wet for crops are common.

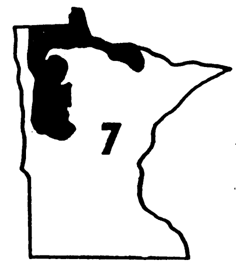
Although the crop season in terms of frost free days is considerably shorter (110-130 days) than in southern Minnesota, the greater number of daylight hours helps equalize the potential for crop growth. Despite some moisture problems, high yields of a wide variety of crops can be grown due to the climate.

Organic Matter and N Release - Organic matter contents of Fargo-Bearden soils commonly are 5 percent and above--higher than most Minnesota soils. However, cool early season conditions cause a slow release of N from this organic matter, so small grains usually show a substantial growth and yield response to this nutrient. Corn, on the other hand, is less likely to respond to N because late season release is substantial. Legumes and fallow contribute N to the following year's crop and reduce the fertilizer N requirement by 40-50 pounds per acre.

P and K Status - About 90 percent of the soils test high and very high in K. This situation, along with the rather small requirement of small grains for K, limits the potash fertilizer need. P, on the other hand, is deficient in 50 percent of the soil samples received from this area. The original parent material was low in this plant nutrient and phosphate deficiencies have always been present. This is particularly true early in the season, as with the N nutrient. Subsoil levels of available P are usually lower than at the surface. Soil tests are recommended as a basis for fertilization.

Acidity and Need for Lime - Only 1 percent of the soil samples tested from this area have been below a pH of 6.3 so no lime is needed to correct acidity.

Area 7 -- Northwestern Minnesota Soils



Landscape Pattern and Texture of Soils - The main agricultural soils of this area are the Rocksbury-Kittson-Peat and the Waukon-Barnes associations. Most soils developed from large glacial lake deposits. But these soils are more variable than the Fargo-Bearden soils of the Red River Valley. The Waukon-Barnes soils, developed from glacial material, are generally quite rolling. Textures range from coarse sands to fine clays, depending on the soil's parent material. Use local individual farm maps for definite soil type information.

Drainage, Tilth, and Erosion Problems - Drainage is the number one physical soil problem; much of the land is quite level and lacks water outlets. Surface drainage through shallow ditches is often practical, and new research on land forming and land leveling appears promising. Soil losses due to wind and water erosion need to be minimized by appropriate practices. Physical soil management, because of the importance of moisture and temperature, is as important as fertility management.

Climate, Rainfall, and Drought - Growing season rainfall of about 16 inches is not high but is more effective than a similar amount in a warmer climate. Drought is still a hazard; a 10 day or more drought should be expected 5 out of 10 years. Growing season ranges from 100 to 110 days.

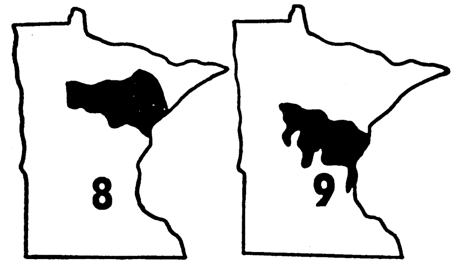
Organic Matter and N Release - Prairie grasses and hardwood trees were originally intermixed in this area. The prairie developed dark colored, high organic matter soils that are still higher in potential N supply than are the light colored forest soils to the east. However, commercial fertilizer N is needed on small grains for efficient production. Rates depend on the crop and past management.

P and K Status - There is a wide variation in soil tests because of the variability in soils. In general, silt loams and finer soils are low to medium in P and medium in K. Sands are generally higher in P and lower in K, but sands near the Red River Valley are usually very low in P.

Acidity and Need for Lime - Almost all soils are alkaline and need no agricultural limestone.

Areas 8 and 9 -- Milaca-Brainerd-Hibbing Soils

Landscape Pattern and Texture of Soils - These central Minnesota soils were built from glacial material. This material was a reddish sandy loam drift with minerals that were low in lime and potash. Consequently, there are some severe lime and potassium deficiencies in this area. Surface textures vary from sands and sandy loams to friable silt loams. Water-holding capacity is fair for most soils except sands. Fields are often cut up and singular because of poorly drained areas or uncleared trees.



Drainage, Tilth, and Erosion Problems - Compared to other Minnesota agricultural areas, erosion problems are not as severe because most slopes are short and forages occupy much of the land. Organic matter is generally quite low, causing some structure and tilth problems. Surface stones have to be removed on many fields.

Climate, Rainfall, and Drought - Milaca and Brainerd soils have a moderate water-holding capacity, intermediate between silt loams and sands. Long season crops like alfalfa and corn are usually subject to 10 days drought on the average.

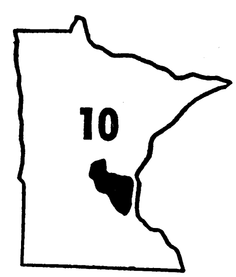
Hibbing soil, with a clay texture, can hold more water and therefore is subject to less drought.

P and K Status - Soil test summaries show that 92 percent of the samples from this area are either low or medium in potash. Therefore, if you have not applied a heavy rate of potash recently, be sure to include this in corn and alfalfa fertilizer next spring. Use grades such as 0-10-30, 4-12-36, or 0-0-60.

P status is much higher with only 18 percent of the samples in the low and medium categories. However, with acid soils, P availability is lower than tests indicate. So apply some starter fertilizer phosphate for corn even though tests are high.

Acidity and Need for Lime - Acid soils are the rule in this part of the state. Soil tests show that 72 percent of the soils are below the pH required for alfalfa. Interest in liming has been increasing but many farmers have disappointing results with alfalfa even after liming. In cases where farmers limed and applied adequate potash before seeding, good alfalfa stands and yields resulted.

Area 10 - Zimmerman-Isanti-Peat and Wadena-Hubbard Soils



Landscape Pattern and Texture of Soils - The most extensive area of these sandy soils is immediately north and west of the Twin Cities, an area often called the Anoka sand plain. This sand was laid down by glacial meltwater streams which moved through this section about 12,000 years ago. These are mainly Zimmerman and Isanti soils which usually are a loamy sand texture. However, some have lenses of silt and clay that improve water-holding capacity.

Wadena-Hubbard soils are also coarse textured, particularly in the subsoil, and are located in several scattered locations in central Minnesota. Counties with significant acreages of these soils are Sherburne, Benton, Stearns, Pope, Wadena, Otter Tail, and Swift.

Drainage, Tilth, and Erosion - For most of the soils, excessive drainage and low water-holding capacity are problems rather than restricted drainage. However, peat and depressional soils are poorly drained, and ditches are necessary for production. Tilth is not a serious problem except that organic matter is usually low on sands and a dry seedbed is a hazard. Wind erosion is a common problem, requiring shelterbelts and rough tillage.

Climate, Rainfall, and Drought - A 3- to 6-inch water-holding capacity in 5 feet is a chief shortcoming of Zimmerman, Hubbard, and Wadena soils. Days of moisture shortage for crops are much more likely on these soils than on heavier soils. The calculated number of drought days per growing season is 30, 1 out of 2 years in the Anoka sand plain area. In the western part of the state, probability of drought days is about 40-50 on Wadena-Hubbard soils.

Try to evaluate moisture each spring on different soils when deciding on crop selection and level of fertilization.

Organic Matter and N Release - Organic matter contents are quite low on Zimmerman soils and only medium on Wadena and Hubbard soils. However, these soils warm up quickly in the spring so N is released from organic matter early in the season. Corn and small grains consistently respond to N when not preceded by a legume or manure.

P and K Status - P tests average higher on these sandy soils than anywhere in the state. Because of acidity, some of this "tested" P is not available. N and K are more critically needed than is P. Potash is deficient on about 90 percent of the samples received from this region. Correctional potash applications are needed on most fields, especially where corn and legumes are to be grown.

Acidity and Need for Lime - Eastern Minnesota sandy soils have a higher lime requirement than soils in the west. Usually, Zimmerman soils are quite acid but do not require heavy rates of lime per acre because sands are relatively easy to neutralize. Soil tests are always the best way to check lime needs.

FERTILIZING MAJOR CROPS IN MINNESOTA'S SOIL AREAS

C. J. Overdahl, extension soils specialist

We continually strive to bring crops to their most efficient productive levels. But attainment of these levels is affected by many factors including weed, insect, and disease control; seed selection; weather; and proper use of fertilizers as a supplement to soil management. The latter factor is the subject for this article.

Specific fertilizer recommendations cannot be made without a soil test. However, general fertilizer ratio and rate patterns tend to follow soil areas. We have divided the state into 10 areas according to general soil type (for soil characteristics, see the accompanying article by Lowell Hanson).

Area 1

Corn - Since phosphorus (P) in subsoils is high and high efficiency from row-applied potassium (K) has been demonstrated, broadcast P and K are not as necessary here as in most areas. Fertilizers with ratios of 1:4:4 or 1:3:9, such as 6-24-24 or 4-12-36, applied with the planter meet most P and K needs. Rates range from about 150 to 200 pounds per acre. Little, if any, additional nitrogen (N) is needed when corn follows a good stand of legumes. Corn in an N-depleting sequence needs 80-100 pounds of N, preferably sidedressed after crop emerges.

Table 1. Average yield increases per acre of corn on four experimental plots, Fayette soils, 1961

Treatment per acre*	Average corn yield increase per acre
100 lb. N	21 bushels
40 lb. P_2O_5 (row)	3 bushels
20 lb. (row) + 100 lb. (broadcast) K_2O	18 bushels

* Other nutrients were adequately applied in addition to each nutrient under study.
Data by Grava and Hanson.

Table 1 gives average yield increases on four experimental plots. Soil tests ranged from 16 to 23 pounds (medium high) of P and from 93 to 145 pounds (medium low) of K. No manure or legumes immediately preceded corn. Other plots in this area showed as high a K response from 30 pounds of potash in the row.

Alfalfa - If you grow alfalfa regularly in the rotation, K application must be quite high. You can apply K any place in the rotation. If you apply P and K only in the row for corn, a 0:1:3 fertilizer such as 0-12-36 broadcast at about 300 pounds per acre, worked in before seeding, is profitable. If stands are good, annual topdressings of 0-12-36 or 0-0-60 are necessary for most efficient production.

Oats - Oats are generally grown as a nurse crop. Emphasize fertilization of the legume. Where lodging is not a serious problem, a mixed fertilizer containing N, such as 4-12-36, may be best for oats and legume.

Area 2

Corn - Because of soil characteristics, starter fertilizer is a must for most profitable production. It is often desirable to use rates of 200-250 pounds of a 1:4:4 fertilizer such as 6-24-24, or 1:3:6 as is in 4-12-24. In addition to starter, broadcast applications are usually necessary as a corrective measure at least every 3 years.

Data in tables 2 and 3 illustrate what fertilizer responses can be obtained. Profits from fertilizer on these farms were extremely high. On the Dakota County plot the best treatment (40+30+30) gave a 43-bushel increase above check from $9.70 worth of fertilizer. The best treatment on the Mower County plot (80+30+120) cost about $20 and increased yield 66 bushels over the check. Results from 1 year are not conclusive as to what will happen every year. But these data indicate the great potential for profit increase through fertilizer.

Table 2. Average yields of corn from N, P, and K treatments on one farm, Dakota County, 1961*

Treatment per acre	Total nutrients per acre	Average yield (bushels per acre)	Average increase (bushels per acre)
N response:			due to N
150 lb. 10-20-20 row	15 + 30 + 30	108	--
150 lb. 10-20-20 row + 25 lb. N sidedressed	40 + 30 + 30	120	12
150 lb. 10-20-20 row + 65 lb. N sidedressed	80 + 30 + 30	118	10
P response:			due to P
150 lb. 10-0-20 row (special mix) + 65 lb. N sidedressed	80 + 0 + 30	90	--
150 lb. 10-20-20 + 65 lb. N sidedressed	80 + 30 + 30	118	28
250 lb. 6-24-12 row + 65 lb. N sidedressed	80 + 60 + 30	113	23
K response:			due to K
150 lb. 10-20-0 + 65 lb. N sidedressed	80 + 30 + 0	68	--
150 lb. 10-20-20 + 65 lb. N sidedressed	80 + 30 + 30	118	50
250 lb. 6-12-24 + 65 lb. N sidedressed	80 + 30 + 60	120	52

* Soils tested: pH, 6.6; organic matter, high; P, 25, high; K, 30, very low; texture, clay loam. Unfertilized check plot yielded 77 bushels per acre.

Table 3. Average yields of corn from N, P, and K treatments on one farm, Mower County, 1961*

Treatment per acre	Total nutrients per acre	Average yield (bushels per acre)	Average increase (bushels per acre)
N response:			due to N
150 lb. 10-20-20 starter + 100 lb. 0-0-60 broadcast	15 + 30 + 120	46	--
plus 25 lb. N sidedressed	40 + 30 + 120	70	24
plus 65 lb. N sidedressed	80 + 30 + 120	95	49
P response:			due to P
150 lb. 10-0-20 row (special mix) + 65 lb. N sidedressed	80 + 0 + 30	75	--
250 lb. 6-24-12 + 65 lb. N sidedressed	80 + 60 + 30	85	10

Table 3 (continued)

Treatment per acre	Total nutrients per acre	Average yield (bushels per acre)	Average increase (bushels per acre)
K response:			due to K
150 lb. 10-20-0 row + 65 lb. N sidedressed	80 + 30 + 0	67	--
250 lb. 6-12-24 row + 65 lb. N sidedressed	80 + 30 + 60	76	9
250 lb. 6-12-24 row + 65 lb. N sidedressed + 100 lb. 0-0-60 broadcast	80 + 30 + 120	95	28

* Soils tested: pH, 6.9; organic matter, low-medium; P, 30, high; K, 100, medium-low; texture, silt loam. Unfertilized check plot yielded 31 bushels per acre.

Alfalfa - Lime applications are important; soil testing is the simplest way to determine rates. Sometimes, alfalfa responds to N. However, if soils are limed properly and seed is inoculated, N fertilization is usually not necessary.

High K-containing fertilizer such as 0-12-36 applied at seeding time and annual topdressings are necessary for best yields.

Soybeans - Except with a split boot attachment on the planter, you can use 0-12-36 or 0-20-20 fertilizer in the row at 100-150 pounds per acre. Lime applications to correct soil acidity are beneficial.

Area 3

Handle the fine textured soils in the same way as described in Area 4; coarse textured soils, the same as Area 10.

Area 4

Corn - N rates of 80-100 pounds are needed when no manure, legume, or high N fertilization was used during the 2 preceding years. More moderate rates, such as 50-70 pounds, are probably most profitable when corn is in the 2nd year following heavy manuring or a good stand of alfalfa. When corn follows soybeans or a green manure, follow the same recommendations as for 2nd year corn. Only the amount of N included in the starter is recommended when corn follows alfalfa.

Table 4. Corn yield averages according to P tests from several fertilizer treatments, Area 4, 1961 and 1962

Treatments per acre	Total nutrients per acre	Yield (bushels per acre)		
		1961	1962	
		medium	medium	low
None	0 + 0 + 0	95	84	81
200 lb. 5-20-20 row	10 + 40 + 40	105	100	101
200 lb. 5-20-20 + 70 lb. N sidedressed	80 + 40 + 40	116	119	111
200 lb. 5-20-20 + 70 lb. N sidedressed + 90 lb. 0-45-0 broadcast	80 + 80 + 40	117	120	117
Number of field sites		6	7	5

Data from Profit Possibility Plots.

Table 4 gives data on corn yield averages according to P tests. No plots in this area tested low in P in 1961. Although nine plots tested high, results were nearly the same as for medium tests.

In 1962, check plot yields were slightly lower and starter response was higher. There was more rain in 1962 and soil temperatures were probably lower than in 1961. Moreover, on soils testing medium, no apparent benefit was obtained in either year from broadcast P in addition to that in the starter. However, there was evidence of a profitable response on soils testing low, especially if there was further benefit from carryover on the broadcast application.

Results from potash use were of equal interest. From 40 pounds of potash in the row, average yield increases in bushels per acre were as follows:

Year	K test	
	medium	high
1961	8 (5) *	1 (10)
1962	12 (8)	4 (4)

* Numbers in parenthesis indicate number of plots in each category.

Alfalfa - Fertilization of small grains and alfalfa is done primarily for the benefit of alfalfa.

Table 5. Alfalfa yield averages from P and K treatments and the combination of both, Brown County, 1960

Treatment per acre	Total nutrients per acre	Yield (tons per acre) *
none	0 + 0 + 0	1.2
220 lb. 0-45-0	0 + 100 + 0	3.4
+ 330 lb. 0-0-60	0 + 100 + 200	3.8

* Soils tested: pH, 7.0; organic matter, medium; P, 4, very low; K, 145, medium; texture, loam.

Data from soil test correlation plots on alfalfa.

Area 5

Corn - In an N-depleting system, N needs are high. However, corn following a legume seldom needs N. Corn grown the 2nd year after a legume, immediately after soybeans, or in a year after heavy applications of manure, returns only small profits at best.

Results with N in a rotation of corn, corn, soybeans, flax, and alfalfa plus a series of plots with continuous corn are shown in table 6.

Table 6. Average corn yield increases per acre from N at the Morris Experiment Station*

Year	1st year after legume, 40 lb. N	2nd year after legume, 80 lb. N	Continuous corn, 160 lb. N
1957	10	46	51
1958	1	1	19
1959	-3	-7	8
1960	-4	-3	19
1961	-8	-8	23
1962	5	7	39
1963	-6	6	21
1964	-2	-9	0
8 year average	-1	4	23
8 year average check yield	63	67	54

*Adequate P and K on all plots; data by Evans, Thompson, and Caldwell.

Average corn yields, 2 years after alfalfa, showed little if any response to N. County agents as well as soils agents had similar experience in this area. Large nitrate buildups in subsoil where rainfall is low have been reported in Nebraska. An N-depleting cropping system, such as a corn and small grains rotation, occasionally interrupted with an alfalfa crop or with heavy manuring, makes supplemental N needs low.

The variable corn yield increases due to P treatments in table 7 are difficult to explain. If hot dry weather occurs when the somewhat earlier maturing fertilizer plots are pollinating, but rains and cool weather occur when untreated plots pollinate, more barren stalks possibly will result. This nullifies the advantage of fertilizer.

There is evidence of P-induced zinc (Zn) deficiencies that result in yield decreases. However, this is more likely to occur on soils testing high in P. Experiments in the area on corn showed yield increases up to 25 bushels per acre from Zn. Carryover 2 years after the Zn application was also very striking.

Alfalfa - P gives large yield increases on alfalfa compared to the variable results on corn. In table 7, average yield increases of alfalfa from phosphate are shown in comparison to results obtained on corn in adjoining plots. These data are from the same experiment as table 6 data.

Table 7. Average yield increases per acre from 80 pounds of P_2O_5 on alfalfa and corn, Morris Experiment Station *

Year	Yield increase of alfalfa (tons per acre)	Yield increase of corn (bushels per acre)
1957	1.2	3
1958	1.3	17
1959	1.7	-1
1960	1.2	0
1961	0.4	0
1962	1.1	8
1963	2.0	16
1964	1.3	0
8 year average	1.3	5

*Soils tested: pH, 7.2; P, 9, low; K, 230, high; texture, loam.

Returns of $3 per $1 invested in P on alfalfa are common. There was no apparent K response in these experiments.

Area 6

N Needs - Soils in this area are high in organic matter, "heavy" fine textured, and slow to warm up. N release from organic matter is usually too slow for small grains. In recent years, less fallow and fewer acres of legumes have increased the need for N fertilization. Plots often show that 60 or 80 pounds of N are profitable on wheat. Response varies with soil temperature and available moisture; when these conditions are ideal there is less response from N fertilizer.

Table 8 shows a summary of wheat yields and their response to N over a 3-year period in the Red River Valley.

Table 8. Average yields of wheat at four N levels in the Red River Valley from five experiments

Nitrogen* (pounds per acre)	Average yield (bushels per acre)	Yield increase (bushels per acre)
0	21	--
20	32	11
40	36	15
80	40	19

*Adequate P was applied. Wheat was preceded by a nonlegume.

P Needs - For small grains, P is most efficiently used when applied near or with the seed. If broadcast, rates should at least be doubled. The average effect of row versus broadcast P applications on wheat yields in six experiments at the North Dakota Experiment Station were as follows:

	Row placed				Broadcast
Pounds P_2O_5 per acre	0	12	24	47	47
Yield	12.6	16.4	17.6	18.1	15.8

These yields are low but they are evidence that a 1:1:0 or 2:1:0 ratio applied in the row can possibly supply all needed nutrients. The first 20 pounds of phosphate apparently are very effective on most soils. Effectiveness of higher rates depends on soil tests.

Fertilization of P and K on flax showed little if any benefits. Rates above 20 pounds of phosphate lowered stands when row applied. Flax is also sensitive to damage from N if N contacts seed. However, if weeds are controlled, flax responds well to N when broadcast or properly placed beside the seed. Rates from 30 to 40 pounds of N on mineral soils could be profitable if flax does not follow a legume or fallow.

Corn responds well to P. Study of a 4-year rotation at the Crookston Experiment Station showed that the average yield increase due to P was 17 bushels from 40 pounds of P_2O_5. Since the preceding crop was alfalfa, 40 pounds of N increased yields only 4 bushels. K application had no effect on yield. Apparently, a 1:4:0 or similar ratio of fertilizer used as a starter is profitable on corn. Supplemental N should be effective where no legumes, fallow, or manure were used.

Soybean yields averaged from 1 to 3 bushels more where P was applied. These small yield increases make direct fertilization of this crop questionable.

As in Area 5, alfalfa responds well from P fertilization. A 3-year average at the Crookston Experiment Station showed 1.6 more tons of alfalfa per acre from just 40 pounds of phosphate. Higher rates may be even more profitable.

Potatoes have a high requirement for mineral nutrients. Data indicate that this plant is a "weak feeder" on both soil and fertilizer P. Data from a 3-year study at the University potato research farm show that 200-240 pounds of P_2O_5 per acre were the most economical rates.

Data from the North Dakota Experiment Station indicate that 60 pounds of N are profitable when soils are cropped by a nonlegume the preceding year:

Nitrogen (pounds per acre)	Marketable yield (cwt. per acre)
0	139
30	168
60	180
90	179

Response from K is irregular. However, potatoes on soils testing other than very high usually respond profitably to some K in the row.

Area 7

A wide variety of soils exist in this area, ranging from very fine to coarse textured. Results on fine textured soils would be similar to results in Area 6. Sandy loam soils test considerably lower in K than do finer textured soils.

Legumes - Heavy fertilization of P and K on legume seed production can give highly profitable results in this area. Table 9 data concern alsike seed production from fertilizer treatments when used along with insect control and proper bee pollination.

Table 9. Yield of alsike clover seed from P alone or with K the 1st year as well as the 6th year following treatments, Roseau County

Treatment per acre	Total plant nutrients per acre	Pounds of alsike clover seed per acre	
		1st year	6th year
None	0 + 0 + 0	154	145
500 lb. 0-20-0	0 + 100 + 0	570	267
500 lb. 0-20-20	0 + 100 + 100	641	264
500 lb. 0-20-40	0 + 100 + 200	614	278
1,000 lb. 0-20-0	0 + 200 + 0	620	330
1,000 lb. 0-20-20	0 + 200 + 200	657	381
1,000 lb. 0-20-40	0 + 200 + 400	691	352

These data show that P gave the largest increase but profitable returns also resulted from K. Note the big increases in seed production obtained even after the 6th year. Such treatment would perhaps similarly affect legumes used as hay.

Some soils are too acid for good growth of legumes. Lime needs can be determined best by a soil test. In this area, excess lime is probably more common, particularly in the western portion.

Sulfur (S) deficiencies in the eastern section can seriously limit yield. Since there is no soil test for S, trial strips with gypsum or other S-containing material are necessary to determine need. However, be sure that adequate P, K, and lime are applied to make a valid check. See discussions for Areas 8, 9, and 10 for data on S trials.

Potatoes - A University experiment in Lake of the Woods County in 1961 demonstrated large differences in potato yield from all three major nutrients.

The P rate of 120 pounds per acre of P_2O_5 increased yield by 24 cwt. (40 bushels per acre). Forty pounds of N increased yield by 12 cwt. (20 bushels per acre); the 80-pound N treatment did not further increase yield beyond the 40-pound rate. Yields increased with increasing rates of K up to 120 pounds per acre; the highest increase was 47 cwt. (78 bushels per acre). This was a dry year with February-August precipitation only 8 1/2 inches, 7 inches below normal.

Areas 8, 9, and 10

Liming Needs - Soils are usually too acid and low in K for most profitable alfalfa production. Symptoms of acid soils are thin stands and lack of root nodules. Rates and frequency of liming must be determined by soil test. Several reasons why soils in this area continue to be acid are:

1. Limed fields gradually become acid again but the change is not abrupt enough to be easily observed. As a result, reliming is seldom done soon enough to prevent loss of highly valuable legume forages. Sandy soils need reliming more frequently than do other soils.

2. Lime responses are not as immediate or spectacular as with some fertilizers.

3. Topdressing established stands of legumes is generally ineffective for the immediate crop.

4. Liming receives less publicity than many other farming practices. Nevertheless, it is the most important step in soil improvement in this area.

K Needs - Plot work indicates that K applications must be considerably higher than the amounts now applied by most farmers, especially when K tests are low. Low K levels are made even lower by crop removal. When yields are 3 to 4 tons per acre, alfalfa removes 150-180 pounds per acre of potash. This is over 250 pounds per acre when expressed as 0-0-60 or over 650 pounds of 0-12-36.

To insure adequate return of this nutrient, even higher rates may be needed annually; utilization of added fertilizer is never 100 percent. Manure contains about 10 pounds of potash per ton. Therefore, supplying K by spreading manure is a highly recommended practice. However, crops are often shortchanged if you depend only on manure because it usually comes from on-the-farm produced feeds.

P Needs - Soils in this area usually test high in P. However, the P soil test is subject to some error on acid soils. Acid conditions dissolve iron and aluminum, which in turn react with P. Although this P is unavailable to plants, the soil test probably measures some of it. Therefore, on acid soils, even when light applications of lime were made recently, most crops need some fertilizer P--even with high tests.

Boron (B) Needs - B deficiencies on alfalfa are common when rainfall is normal or below. Alfalfa on coarse textured soils, low in organic matter, are B deficient sometime during every growing season.

Half of a ton of hay may be lost on most alfalfa fields in this area--a loss that could easily be eliminated by including about a dollar's worth of B per acre in the fertilizer. Corn and small grains need considerably less B than does alfalfa.

Sulfur (S) Needs - Three years' data from S applications on a University experimental plot near Park Rapids are shown in table 10. Rainfall limited yields during most of this time.

Corn - Results with corn depend largely on the timing of rains. In 1964, experiments in Benton and Anoka Counties failed due to drought. Results in table 11 are on sandy loam soils at nine locations in 1961 which are probably typical of what happens when rainfall is about adequate.

Alfalfa -- Effects are additive (see table 12). For example, 2.5 tons per acre of lime, 30 pounds per acre of P_2O_5, and 240 pounds of K_2O increased yields 0.24 + 0.30 + 0.71 for a total of 1.25 tons. Some treatments are beneficial for several years, so the 1.25-ton yield increase is only part of the benefits that will probably be obtained.

Table 10. Average alfalfa yields per acre by S treatments and years, Park Rapids

Material	Sulfur rate (pounds per acre)	Yields (tons per acre) 1962	1963	1964	3-year total
Annual applications:					
None	0	0.9	0.5	0.7	2.1
S	25	1.1	1.0	2.4	4.5
S	50	1.1	1.2	2.5	4.8
S	100	1.2	1.3	2.4	4.9
Gypsum	50	1.2	1.1	2.3	4.6
Residual, from one application 1962:					
None	0	0.9	0.5	0.8	2.2
S	25	1.1	1.0	2.1	3.2
S	50	1.1	1.1	2.2	4.4
S	100	1.2	1.3	2.5	5.0
Gypsum	50	1.2	1.2	2.5	4.9
Gypsum	1,000	1.0	1.0	2.4	4.4

Table 11. Corn yields per acre according to various fertilizer treatments on sandy loam soils, east-central Minnesota, nine fields, 1961*

Treatment per acre	Total nutrients per acre	Yield bushels per acre	Increase per acre yield	profit
Check	0 + 0 + 0	54	--	--
150 lb. 10-20-20 row	15 + 30 + 30	63	9	$2.50
plus 65 lb. N sidedressed	80 + 30 + 30	80	26	$11.00
plus 100 lb. 0-0-60 broadcast	80 + 30 + 90	88	34	$16.00

*Soils tested: P, high; K, low. All crops followed nonlegume.

Table 12. Alfalfa yield increases per acre due to lime and fertilizer rates, Pierz, Minnesota, Morrison County, 1964*

Treatment per acre	Alfalfa yield increase (tons per acre) +
Lime 2.5 tons per acre	0.24
Lime 5.0 tons per acre	0.39
40 lb. N	0.02
P: 30 lb. P_2O_5	0.30
60 lb. P_2O_5	0.45
K: 60 lb. K_2O	0.41
120 lb. K_2O	0.47
180 lb. K_2O	0.39
240 lb. K_2O	0.71

* Soils tested: pH, 6.4; P, 19, medium; K, 70, low; texture, sandy loam.

\+ Check yield was 1.42 tons per acre.

CROP VARIETIES FOR 1965

Harley J. Otto, extension agronomist

For further information on field crop varieties (including variety descriptions and detailed performance data), see Miscellaneous Report 24, Varietal Trials of Farm Crops.

For 1965, Garland oats and A-100 and Chippewa-64 soybeans were added to the recommended variety list. Kindred and Traill barley; Ajax, Andrew, and Burnett oats; and Comet and Norchief soybeans were dropped.

Barley -- Larker and Trophy, varieties released by the North Dakota Agricultural Experiment Station, have been produced by growers long enough to have thorough evaluation by malting and brewing industries. These industries appear satisfied with their quality.

University of Minnesota tests, conducted in the main barley-growing areas of the state, showed both Larker and Trophy to be at least equal to Traill in yield and standability and considerably superior to Kindred in both characteristics. In percent of plump kernels, both Larker and Trophy are superior to Kindred and Traill. Larker produces a higher percentage of plump kernels than does Trophy.

Parkland, a variety with blue aleurone color, is recommended for planting only in Minnesota's northwest counties. It is similar to Trophy in yield, standability, and percent of plump kernels.

Oats -- In 3 years of testing, Garland produced higher yields than did any other variety of the same maturity. It is medium early in maturity, heading about 3 days later than Minhafer and 4 days earlier than Garry. Its straw strength is acceptable.

Garland has as good resistance to stem rust as any variety, is only moderately susceptible to crown rust, and is resistant to smut. Since no commercial variety is completely resistant to crown rust, Garland is a good variety in this respect.

Andrew, Ajax, and Burnett are no longer on the recommended list because they do not perform as well as some of the more recently developed varieties of similar maturity.

Seed of several new oat varieties developed in other states has been increased for distribution in Minnesota in 1965. These are: Brave from Illinois and Clintland-64 and Tippecanoe from Indiana. Brave is early to medium early in maturity. In 2 years of testing, it headed about 2 days later than Minhafer. It is fair in standability and yield, resistant to prevalent races of stem rusts and smut, and susceptible to crown rust.

Clintland-64 has been tested only 1 year. So far it appears to be of the same maturity as Garland, stands slightly better, does not yield as well, has approximately the same degree resistance to stem rust, and is slightly better in resistance to crown rust.

Tippecanoe also has been tested only 1 year. In 1964, it had the best standing ability of any variety tested. Its maturity, yield, and disease resistance were about the same as Minhafer.

Lodi, a variety developed in Wisconsin, continued to look good in 1964 tests. Seed was distributed to Minnesota growers in 1964. It is a late maturing, high yielding variety with good disease resistance. It has better standing ability than any variety of the same maturity.

Further testing of Brave, Clintland-64, Tippecanoe, and Lodi is required before a decision regarding recommendation can be made.

Winter Rye -- Seed of the variety Von Lochow was distributed to growers in fall, 1964. This variety produces high yields in the absence of winterkilling but is less winter hardy than recommended varieties. It had better standing ability than any other variety in recent tests.

Flax -- No changes were made in the list of recommended varieties for 1965. However, flax rust continues to threaten the crop. So it is still highly recommended that susceptible varieties not be grown.

A flax variety survey conducted by the Minnesota Crop and Livestock Reporting Service in 1964 indicated that approximately 11 percent of the state's acreage was seeded to rust susceptible varieties. Production of susceptible varieties not only endangers the acreage on which they are grown but may allow development of new rust races which could attack presently immune varieties.

Soybeans -- Varieties A-100 and Chippewa-64 were added to the recommended list for 1965.

A-100 is slightly earlier in maturity than are Harosoy and Lindarin. Its yield potential is equal to these varieties but it has better standability and higher oil content. It is recommended only for the southern corn maturity zone.

Chippewa-64 performs the same as Chippewa except that it is resistant to Phytophthora root rot. This disease has not been definitely identified in Minnesota. Chippewa-64 offers insurance against this disease if it should become prevalent. Therefore, Chippewa-64 probably will replace Chippewa as seed supplies become available.

Certified Seed Assures Varietal Purity

Recommended varieties demonstrated superior performance compared to other varieties tested. If a farmer is to obtain the benefits of these varieties, he must plant seed of known varietal purity. This assurance is best obtained by planting certified seed.

Certified seed is no more than three generations removed from foundation seed maintained by the University of Minnesota and known to be pure for variety. Production and processing of certified seed are supervised by the Minnesota Crop Improvement Association through field and laboratory inspections.

A test of bacterial wilt resistance of several seed lots of Vernal alfalfa was recently conducted at the University. Test results illustrate the importance of planting seed with known varietal purity. Two lots of certified Vernal alfalfa seed produced plants that did not differ significantly in wilt resistance from a check lot known to be Vernal. Two of the six uncertified lots had the same degree of wilt resistance as the check lot. Four lots of uncertified seed, which were represented as Vernal, produced plants that were only 15-36 percent as wilt resistant as the Vernal check lot.

In earlier tests of many seed lots represented as Ranger alfalfa, only 54 percent of the uncertified lots performed like Ranger with respect to plant growth type. Winter-hardy alfalfa varieties such as Ranger produce a low growing rosette type of regrowth in the fall following clipping. Nonhardy types produce a tall erect growth following similar treatment. So, only lots with plant growth types like Ranger could be expected to have the same degree of winter hardiness as Ranger.

In these tests, only 45 percent of the uncertified lots had the degree of wilt resistance found in Ranger. If a farmer buys from one of these lots of uncertified seed, he would have only a 50-50 chance of obtaining alfalfa performance he should expect with Ranger.

In addition to varietal purity, certified seed must meet high standards for freedom from weeds, other crop seeds, and inert material. It also must be high in germination. Within certified seed, a tolerance for these factors is allowed. For example, the minimum germination allowed in small grains is 85 percent. Individual lots may have considerably higher germination so some certified seed lots may be better than others. Study the analysis tag for this information.

Seed cost represents only a small fraction of the total cost of producing a crop. A crop producer cannot afford to take a chance on planting poor seed. It is a wise policy to plant certified seed purchased from a reliable seedsman.

Varieties Recommended For Planting In 1965

Barley:	Larker, Parkland (for northwest counties only), Trophy	
Oats:	Early:	Minhafer
	Medium early:	Dodge, Garland, Goodfield (where lodging is a serious problem)
	Medium late:	Portage, Garry, Rodney
Wheat:	Hard red spring:	Crim, Justin, Pembina, Selkirk
	Durum:	Lakota, Wells
	Hard red winter:	Minter
Flax:	B-5128, Bolley, Redwood, Summit, Windom	
Soybeans:	A-100, Acme, Chippewa, Chippewa-64, Flambeau, Grant, Harosoy, Lindarin, Merit, Ottawa Mandarin	

Sunflowers:	Arrowhead, Mingren
Field Peas:	Chancellor, Stral
Millet:	Proso: Turghai Foxtail: Empire, White Wonder
Alfalfa:	Ranger, Vernal
Birdsfoot Trefoil:	Empire
Red Clover:	Dollard, Lakeland
Sweet Clover:	Evergreen, Goldtop, Madrid
Kentucky Bluegrass:	Park
Bromegrass:	Achenbach, Fischer, Lincoln
Sudangrass:	Piper
Timothy:	Climax, Itasca, Lorain

CROP VARIETY SURVEYS

Harley J. Otto, extension agronomist

In 1964 the Minnesota Crop and Livestock Reporting Service conducted variety surveys in wheat, barley, and flax. Results were as follows:

Wheat

Wheat variety surveys are regularly conducted at 5-year intervals.

For hard red spring wheat, three varieties (Selkirk, Justin, and Pembina) accounted for 97 percent of the total acreage grown. Selkirk was grown on 58 percent of the hard red spring wheat acreage, Justin on 28 percent, and Pembina on 11 percent. Selkirk was first reported in the 1954 survey; at that time only 0.5 percent of the acreage was planted to this variety. By 1959 it was grown on 96 percent of the spring wheat acreage.

The newer varieties, Justin and Pembina, have replaced a great deal of the Selkirk. The variety Crim, released by the Minnesota Experiment Station in 1963, was grown on about 1 percent of the hard red spring wheat acreage in 1964.

For durum wheat, Lakota was seeded on 53 percent, Wells on 45 percent, and Langdon on 2 percent of the acreage.

Minter has been the leading winter wheat variety for the past 10 years. In 1964, it was seeded on 78 percent of Minnesota's winter wheat acreage.

Of the three market classes of wheat, 91 percent of the state's acreage was seeded to hard red spring, 8 percent to durum, and 1 percent to winter wheat.

Barley

Larker and Trophy, with 42 and 41 percent of the acreage, respectively, were the leading barley varieties in Minnesota. Their popularity has increased rapidly with their combined acreage rising from less than 2 percent of the total in 1962 to about 83 percent in 1964. The combined acreage of Kindred and Traill dropped from 88 percent in 1962 to 13 percent in 1964.

The acreage reported for each variety, by crop reporting districts, is shown in table 1.

Table 1. Minnesota barley varieties by selected crop reporting districts, 1964

District	Planted acreage of barley	Percent of acreage seeded to each variety					
		Larker	Trophy	Traill	Kindred	Park-land	Others and unknown
	thousand acres						
Northwest	474	46	40	3	5	5	1
West central	132	30	45	14	10	*	*
All other	21	8	22	66	4	-	-
State total	627	42	41	7	6	4	*

* Less than 1 percent.

The state acreage seeded to each of several varieties by years is shown in table 2.

Table 2. Barley varieties: percent of acreage seeded to each variety, Minnesota, several years

Variety	1964	1963	1962	1960	1959	1958	1956
Larker +/	42	5	*	-	-	-	-
Trophy +/	41	32	1	-	-	-	-
Traill #/	7	31	57	50	48	30	*
Kindred	6	22	31	36	31	47	97
Parkland	4	9	9	4	4	4	-
Forrest	-	*	-	8	17	16	-
Other and unknown	*	1	2	2	*	3	2

* Less than 1 percent.
\+ First seed distributed in 1962.
\# First seed distributed in 1956.

Flax

Bolley, grown on 45 percent of the state's flax acreage, was the most popular variety grown in 1964. This was followed by B-5128 with 27 percent, Redwood with 10 percent, and Windom with 8 percent.

Acreage distribution, by crop reporting districts, is shown in table 3.

Table 3. Minnesota flax varieties by selected crop reporting districts, 1964

District	1964 seeded acreage	Percent of district and state acreage seeded to each variety								
		Bolley	B-5128	Redwood	Windom	Arny	Marine	Marine-62	Others *	Total
	thousands									
Northwest	178	78	1	7	8	-	3	1	2	100
West central	197	29	35	11	6	10	1	1	7	100
Southwest	91	8	52	18	6	12	-	-	4	100
All other	15	76	10	7	-	2	-	1	4	100
State	481	45	25	11	7	6	1	1	4	100
Percent of farms reporting +		40	27	10	8	9	1	1	5	---

* Other varieties include Bison, Buda, Sheyenne, Crystal, Linda, Norland, Redwing, Summit, Victory, and unknown varieties.

\+ Total exceeds 100 percent because some farmers seed more than one variety.

These data show that over 11 percent of the acreage was seeded to rust susceptible varieties (Arny, Marine, and Marine-62). These varieties should not be grown because they may contribute to the development of new rust races which could attack presently immune varieties.

A comparison of 1964 results with those of 1960 is in table 4.

Table 4. Minnesota flax varieties: percent of acreage planted to each variety, 1960 and 1964

Year	Bolley	B-5128	Redwood	Windom	Arny	Marine	Marine-62	Norland	Linda	Others and unkown	Total
1960	11	38	16	*	9	17	*	2	2	5	100
1964	45	25	11	7	6	1	1	+	+	4	100

* First released in 1962.

\+ Less than 1 percent, included in others and unknown.

In addition to information on variety usage, data on seeding dates, source of seed, and chemicals for weed control were obtained in this survey.

Minnesota farmers seeded the majority of the 1964 flax crop during May. The state's average date of seeding was May 13. Planting dates varied with areas. The average date of planting was: northwest district, May 29; west-central district, May 8; and southwest district, April 29.

Table 5. Sources of seed for the 1964 flax crop, by selected crop reporting districts, Minnesota

District	Percent of flaxseed obtained from: Homegrown	Local elevator	Neighbor	Other *	Total
Northwest	32	56	7	5	100
West central	54	24	15	7	100
Southwest	36	55	4	5	100
Others	21	66	11	2	100
State	42	42	10	6	100

* Includes seed companies, seed houses, farm stores, and creameries.

Chemicals were used on 56 percent of the flax acreage reported in the survey. Table 6 shows the breakdown of chemical use by crop reporting district.

Table 6. Chemical weed control on 1964 flax acreage, by selected crop reporting districts, Minnesota

District	Percent of total flax acreage treated	Percent of reported treated acres sprayed with each chemical: MCPA	MCPA and Dalapon	2,4-D	Dalapon	2,4-D and Dalapon	Unknown and others	Total
Northwest	33	66	8	13	-	-	13	100
West central	69	42	40	7	7	1	3	100
Southwest	77	54	20	4	11	4	7	100
Others	13	29	71	-	-	-	-	100
State	56	50	28	8	6	2	6	100

CORN EAR DROPPAGE

Harley J. Otto, extension agronomist

Preharvest losses of corn ears in Minnesota fields in 1964 were worse than they have been in many years. Some reports from southern Minnesota indicated that up to 30 bushels per acre were on the ground at harvesttime in some fields.

While exact causes are unknown, several factors--both environmental and genetic--are believed to influence ear droppage. Unusually dry hot weather in many areas throughout the growing season and the high incidence of strong winds after corn matured were two climatic factors that probably contributed to the problem. In a few cases, stalk and ear rot and corn borers may have been factors.

Hybrids differed greatly in amount of ear droppage. In recent years, most corn breeding programs put some emphasis on picking ease in corn hybrids. This, together with adverse weather conditions, was largely responsible for the ear loss.

Reports indicate that some single crosses had serious losses. But observations of many single crosses in experimental trials indicated that several of them held their ears. So this should not be the basis for condemning all single crosses. It is important to study individual hybrids since there are undoubtedly good as well as poor single crosses just as there are good and poor double crosses.

Farmers should consider this factor when selecting hybrids for planting in 1965. The 1964 season produced unusually severe conditions which may not be repeated for several years. Ear loss is only one factor to take into account when choosing hybrids. Such things as yielding ability, standability, and maturity are also important and should not be sacrificed.

SUDANGRASS AND SORGHUM - SUDANGRASS HYBRIDS

James R. Justin, extension agronomist

Sudangrass has been part of American agriculture for many years, and some varieties have been recommended for use in Minnesota for a long time. Within the past few years sorghum-sudangrass hybrids have appeared, raising many questions for the farmer.

Sudangrass is a form of sorghum. It is normally tall growing with thinner stems and leaves and smaller seeds than either grain or forage sorghums. Sorghum-sudan hybrids are, as the name implies, hybrids between sudangrass and either grain or forage sorghums. They normally grow taller and have heavier stems and leaves than does sudan. They more nearly approach the forage sorghums (sorgos, sweet sorghums, or canes) in size and growth characteristics.

University of Minnesota tests compared Piper sudan with several sorghum-sudan hybrids in the grazing stage. These tests showed no real yield advantage for hybrids over Piper in two cuttings. Protein content was slightly lower in stems but higher in leaves of Piper as compared with the hybrids. Protein in total plants of both Piper and hybrids was lower than would be expected in good alfalfa hay. A few hybrids were as low in fiber as Piper but most were slightly higher.

Tests at other locations indicated little difference between Piper and hybrids when all were harvested at a grazing stage. The hybrids exhibited hybrid vigor when grown to a silage stage (seed in the dough stage) and outyielded Piper. Silage yields can be expected to be greater from hybrids than from Piper.

In grazing trials at St. Paul, cattle were given a free choice between Piper and 15 hybrids. Piper and one sudan-sudan hybrid were grazed almost completely before sorghum-sudan hybrids were well utilized, even though all had been "tasted" by the cattle. If cattle are allowed only one hybrid, they would undoubtedly graze it with no refusal.

Farmers are concerned about prussic acid (hydrocyanic acid or HCN) poisoning from feeding sudan or sorghum-sudan hybrids. Loss of livestock is a potential threat from feeding these crops but proper crop management can reduce the danger considerably. Sorghums (including sudangrass) contain a substance called dhurrin. Cutting, bruising, wilting, freezing, or eating sorghum does not increase the amount of dhurrin in the plant, but does cause its conversion to poisonous prussic acid.

Dhurrin is found in greatest concentrations in young plants and actively growing plant parts. Stems are lower in dhurrin content than are leaves. The presence of carbohydrate, particularly glucose, in an animal's digestive tract normally reduces chances of poisoning. Allowing plants to grow beyond a young stage also reduces the possibility of poisoning.

Never graze sudan and sorghum-sudan hybrids before they are 18-20 inches tall. During drought or any growth-disrupting conditions, delay grazing until more growth has been made. Curing these crops for hay or ensiling them allows the prussic acid to volatilize and escape, thereby reducing the danger of poisoning.

Prussic acid works quickly in the digestive tract of livestock. Only about 50 grams HCN per 100 pounds of body weight can kill livestock. When a lethal amount of prussic acid is consumed, livestock may die in a matter of minutes. This material reacts with the oxygen-carrying portion of the blood, resulting in suffocation of the animal.

In Minnesota tests, sorghum-sudan hybrids contained at least twice as much prussic acid on a percentage basis as did Piper sudan. Some contained five times as much HCN as Piper. Piper can be poisonous, but hybrids require more careful management to prevent livestock poisoning.

As stated previously, do not graze sudans and hybrids before they are 18-20 inches tall. In poor growing years and particularly in dry years, allow another foot of growth. Never let livestock graze new shoots from plant bases.

These crops make fine supplementary pastures in the heat of summer when other pastures may not produce well. Their use also lets you "rest" permanent pastures to allow recovery. Moreover, these crops are fine for green chop. Cutting from late grazing stage until heading should work well. Because wilting increases poison danger, plants should grow beyond the earliest limits for grazing. Don't let chopped material wilt on wagons after chopping and before feeding.

For silage, cut these crops when seed are in the dough stage although only one cutting can be obtained then. But carbohydrate content is then high and will help in silage preservation, and moisture will be best for good preservation. Earlier harvesting produces poorer quality silage and can likely result in excess seepage.

Sudans and hybrids frosted in fall do not lose their poisonous properties until they have dried. Freezing does not increase these properties but does release dhurrin to be converted to prussic acid. Frosted material can be utilized in the same way as if unfrosted. Follow the same precautions. Once the plants are dry, no danger from poisoning should exist, but new growth from the bottom of the plant is very dangerous.

CHEMICALS FOR WEED CONTROL IN 1965

Harley J. Otto and Gerald Miller, extension agronomists

For more information on weed control in field crops, see University of Minnesota Extension Folder 212, Cultural and Chemical Weed Control in Field Crops.

The University of Minnesota Agricultural Experiment Station continually evaluates promising new chemicals developed by manufacturing companies. Each year new chemicals are compared with older ones to determine their relative effectiveness for controlling weeds in specific crops.

Time Of Application

Application time of chemicals can be grouped into these classes:

* Preplowing -- Apply chemical to soil and/or plant foliage before plowing.

* Preplanting -- Apply chemical to soil before planting crop. Usually, the chemical is incorporated into the soil by one or more tillage operations.

* Preemergence or postplanting -- Apply chemical to the soil after planting crop but before it comes up, usually at planting time.

* Postemergence -- Apply chemical to crop and weeds after they are up.

* Postemergence directed spray -- Apply chemical to base of crop plant and to weeds. Use special devices to raise crop plant leaves to avoid contact with the chemical. This method presently is used only on corn. However, the corn plant is not highly resistant to chemicals used so take care to avoid crop injury.

Research results indicate that early season weed competition can seriously reduce corn yields. Chemicals applied as postemergence directed sprays do not eliminate the early competition. So, they may not increase crop yields as much as preemergence chemical application.

Many chemicals, developed in recent years, are used in preemergence applications. When chemicals are applied at this time, their effectiveness greatly depends on soil type, rainfall after application, and other environmental factors. So they are often less reliable than are chemicals applied after crop and weeds emerge. But preemergence applications have certain advantages:

1. You can apply the chemical at planting, saving a trip over the field.

2. Early season competition can be reduced. Research indicates that early competition between crop and weeds may be more injurious to crop yields than later competition.

3. You can often delay the first cultivation, allowing more time for putting up high quality hay if you have both row crops and hay.

4. Number of cultivations may be reduced.

5. You can more nearly control weeds in the row than where cultivation is your only means of weed control.

Preemergence herbicides often give better results on well prepared seedbeds than on poorly prepared seedbeds.

Granular Versus Spray Form For Herbicides

Farmers show great interest in granular herbicides. The advantages and disadvantages of granular herbicides compared to the spray form are:

Advantages:

1. Granular herbicides are ready to use as they come from the package. They do not need to be mixed with water.

2. You do 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 usually need both the granular applicator and sprayer.

3. Granular materials require more storage space per pound of active ingredient than do spray materials because they usually contain a lower percentage of active ingredient.

4. Some granular applicators give poorer distribution of the herbicide than do sprayers.

Comparisons of granular and spray materials were made in research and county demonstration trials during the past 5 years. CDAA (Randox) and CDAA-T (Randox-T) gave consistently better results in the granular than in the liquid form.

Granular applicators are more likely to apply materials uniformly on smooth seedbeds than on rough seedbeds. You must calibrate the applicator to be certain of the amount of chemical being applied. Devices now on the market aid accurate calibration.

Safety Precautions

* Always follow carefully the label precautions in order to protect yourself, avoid crop injury, and prevent harmful residues in food and feed crops.

* Use herbicides only on crops for which they are specifically approved and recommended.

* Use only recommended amounts. Applying too much of a herbicide may damage the crop, may be unsafe if the crop is to be used for food or feed, and is costly.

* Apply herbicides only at times specified on the label. Observe recommended intervals between treatments and pasturing or harvesting.

* Wear goggles, rubber gloves, and other protective clothing as recommended on the label.

* Guard against possible injury to nearby susceptible plants.

Chemicals

Some herbicides now sold in Minnesota are listed below with comments about them. Rate of application refers to pounds of active ingredient per acre on a broadcast basis. The information given is not intended to replace label instructions; follow label instructions closely.

CDAA (Randox):

Use - annual grass control in corn, soybeans, and sorghum.

Rate of application - 4-5 pounds per acre.

Time of application - preemergence.

Remarks - irritating to skin and eyes. Handle with extreme caution.

CDAA-T (Randox-T):

Use - control of annual grasses and broadleaved weeds in corn.

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).

Time of application - preemergence.

Remarks - irritating to skin and eyes. Avoid use on soybeans. A few cases of soil residue carryover and damage to soybeans following corn were reported.

Simazine:

Use - control of grasses and broadleaved weeds in corn.

Rate of application - 2-4 pounds per acre. Use heavier rate on fine textured soils or soils with high organic matter content.

Time of application - preemergence.

Remarks - residue in soil has damaged susceptible crops in rotation following corn. It has not given as good weed control results as has atrazine in Minnesota.

Atrazine:

Use - weed control in corn and sorghum and quackgrass control. Experiments in Minnesota and Wisconsin showed 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.

Rate of application - (1) weed control in corn: 2-4 pounds per acre. Use higher rate on fine textured soils or soils with high organic matter content. (2) weed control in sorghum: 2-3 pounds per acre. (3) quackgrass control: 3-4 pounds per acre.

Time of application for weed control in corn and sorghum - preemergence in corn and postemergence in corn and sorghum. You can apply chemical up to 3 weeks after planting. Apply it before weeds are 1 1/2 inches tall.

Remarks - susceptible crops have been injured in rotation following treated crop. To minimize injury to susceptible crops following corn, use the lowest rate possible consistent with good weed control, use band applications rather than broadcast applications, and have thorough soil tillage before planting susceptible crops. Granular formulation is no longer available for use on corn. Do not graze or feed treated sorghum forage.

Amiben:

Use - control of annual grasses and broadleaved weeds in soybeans.

Rate of application - 3 pounds per acre.

Time of application - preemergence.

Remarks - early stunting of soybeans was observed under some conditions but crop usually outgrows injury. Amiben is now cleared for use on corn at 2 pounds per acre. Limited experiment station tests have shown a definite injury potential to corn and erratic weed control at this rate.

Linuron (Lorox):

Use - weed control in corn and soybeans.

Rate of application - (1) corn: 1/2-2 1/2 pounds per acre preemergence; 1 1/2 pounds per acre with wetting agent in postemergence directed spray applications. (2) soybeans: 1/2-2 1/2 pounds per acre.

Time of application - (1) corn: preemergence or directed spray postemergence when corn is at least 12-18 inches tall and weeds are 8 inches or less in height. (2) soybeans: preemergence.