SHORT COURSE

COMBINED SOILS, FERTILIZER & AGRICULTURAL PESTICIDES

December 14-16, 1971 Minneapolis Auditorium

Agricultural Extension Service
UNIVERSITY OF MINNESOTA
Office of Special Programs
Institute of Agriculture

COMBINED SOILS, FERTILIZER AND AGRICULTURAL PESTICIDES SHORT COURSE

PROCEEDINGS

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sponsored by the
University's
Agricultural Experiment Station and
College of Agriculture
in cooperation with
Minnesota Plant Food Association
Minnesota Agricultural Chemical Association
Minnesota Agricultural Aircraft Association
Minnesota Department of Agriculture
Minnesota Department of Aeronautics

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NITROGEN USE ON SOYBEANS

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Soybean plants are legumes and can live in mutual cooperation with certain bacteria (rhizobia) which form nodules on the soybean roots. The bacteria and the soybean plant working together can utilize gaseous nitrogen from the atmosphere. Independently, neither the soybean plant nor the nodule bacteria can utilize nitrogen from the air. The soybean plant furnishes food and a home for the nodule-forming bacteria; the rhizobia in the nodule convert the gaseous nitrogen (N_2), which makes up 80% of the air, into a usable form for soybean plant growth. The process of converting atmospheric nitrogen into a usable form is called "nitrogen fixation".

Well nodulated soybean plants are needed for most efficient seed production. With medium soil nitrogen and good nodulation in Minnesota, about 40 percent of the nitrogen needed for a 40-bushel yield comes nitrogen fixed in the nodules. Two isolines of soybeans genetically alike in characters other than their ability or inability to nodulate have been used to measure symbiotic N fixation in the field. Using these plants, a well nodulated crop of soybeans will convert 60 to 65 pounds of atmospheric nitrogen into a form usable by the plants. About 180 to 195 pounds of N as fertilizer would be required as fertilizer to replace what the nodules add (540-585 pounds of ammonium nitrate, 33-0-0).

Many legume species utilize nitrogen from the atmosphere if they are adequately nodulated. Successful nodulation depends upon proper matching of legume with rhizobia since several kinds of nodule bacteria exist. Soybean plants require one kind of rhizobia and alfalfa plants another and they cannot be interchanged.

Inoculation of soybeans has been very successful in the past. Soybean rhizobia are not native to the soils of the U.S. In the early years of soybean production in this country, rhizobia were introduced in soil from Japan and China. Rhizobia in soil of the current soybean growing areas were introduced in commercial inoculants. Rhizobia surviving in the soil from previous inoculation are referred to as "naturalized rhizobia".

Many different strains of soybean rhizobia exist and some are better nitrogen fixers than others. The differences among strains of rhizobia are comparable to the differences among varieties of a crop. The difference in nitrogen fixing ability among rhizobia strains can affect soybean seed yield as shown in Table 1.

Today we are faced with a new opportunity; inoculation techniques must be developed which will establish superior strains of rhizobia in nodules when naturalized rhizobia are present. Present inoculation techniques are inadequate for the job. The percentage nodules produced by strains of R. japonicum applied at the standard rate of inoculation is very low (runs about 5 percent on the average.) Increasing the amount of inoculum applied increases the percentage of nodules produced by some strains but had little effect on others.

Such results from standard inoculation procedures clearly indicate that improved techniques are needed to introduce new and more efficient strains of rhizobia into the nodules of the plants. Soybean seed yields probably could be increased substantially if a higher percentage of the nodules were formed by more effective strains.

Field measurement of symbiotic N_2 fixation by soybeans is difficult because nodulated legumes use both soil and atmospheric N_2 (nodule nitrogen.) Furthermore, under frequent culture of soybeans, nodulation commonly occurs without seed inoculation. Laboratory and greenhouse studies have shown that N fertilizer was utilized preferentially over symbiotically fixed N and that N_2 was fixed only when inadequate amounts of combined N was present.

Many experiments have demonstrated that the response of soybeans to fertilizer nitrogen is not economical. The history of increased yields from N fertilization of non-legume crops and the very high nitrogen content of soybean seed suggest the key to increased soybean yields may be nitrogen nutrition. Evidence to date indicates that well nodulated soybeans do not respond to nitrogen fertilizer consistently (Tables 2 and 3). Since attempts to increase yields through nitrogen fertilizer have been negative, the logical approach to improved nitrogen nutrition appears to be the nodulation process. Nodulation and nitrogen fixation are decreased by high levels of soil nitrogen indicating that nodule nitrogen must compete with soil and fertilizer nitrogen to supply the plant with nitrogen.

Table 1. Influence of different soybean rhizobia strains on seed yields of Altona soybeans on a "rhizobia-free" soil at Crookston (1971).

Strains	Seed yield bu/acre	Strains	Seed yield bu/acre
Check	15	E	22
A	18	F	23
B	19	G	24
C	20	H	25
D	21	I	27

Table 2. Effect of row nitrogen fertilizer on soybean seed yield (1971).

Nitrogen rate lbs/acre	Morris		Lamberton		Waseca	
	Merit	Clay	Merit	Corsoy	Merit	Corsoy
0	26	33	36	37	31	35
5[a]	29	32	34	38	31	35
10[a]	27	32	37	38	32	35
15[a]	29	30	35	38	27	36
25[b]	29	32	36	38	32	37
50[b]	30	32	36	37	33	39

[a]Fertilizer placed with seed
[b]Fertilizer banded 2 inches to side, 2 inches below seed

Table 3. Effect of broadcast fertilizer on soybean seed yields (1971).

Location	Variety	No broadcast N rate #/ac. 0	50	100	Broadcast P & K N rate #/ac. 0	50	100
Morris	Clay	24	26	26	27	31	25
Lamberton	Corsoy	25	26	26	27	30	31
Waseca	Corsoy	34	34	37	36	38	36

Broadcast P & K Rates: Morris (0 + 60 + 30); Lamberton (0 + 60 + 30); Waseca (0 + 100 + 150).

PASTURE IMPROVEMENT THROUGH FERTILIZATION AND WEED CONTROL

(Results of Trials in Minnesota Red River Basin - 1971)

Charles Simkins, Oliver Strand, Marlin Johnson and Paul Groneberg

Minnesota has more than 2 million acres of unimproved grasslands. Sods of cool season grasses, including mixtures of Kentucky bluegrass, timothy, brome, orchard and quack grass serve as major sources of forage on many farms in Minnesota.

Land which is unsuited for cultivated crops is left in permanent stands of grass. To a lesser extent, some land which could be used as cultivated land is also devoted to permanent grass pasture or hayland. In numerous instances, without fertilization and management, this land provides forage for only a very short period of the year (6 to 8 weeks).

The yield response of such grasses has been the subject of repeated investigations. Research in New York, Maine, Wisconsin, Pennsylvania and Minnesota (4)(1)(7)(5)(3) has shown that yield increases of forage equal to 1.4 to 2.0 tons of dry matter per acre can be obtained from the use of 100 pounds of nitrogen per acre. These increases with nitrogen applications are obtained only when sufficient phosphorus and potassium are also available.

Numerous studies (6) indicate that a fertilizer program which supplies an annual equivalent of 50 pounds of P_2O_5 per acre can provide adequate phosphorus for intensive grass production on soils low to medium in available phosphorus.

The critical percentage of potassium in most grasses at harvest time is considered to be about 1 percent K on a dry matter basis. Grava, et al. (2) in Minnesota found an average of 2.19 percent K in Kentucky bluegrass and 2.6 percent K in timothy collected from 50 fields in northwest Minnesota.

Under general farm conditions in Minnesota, the use of fertilizer on grass pastures or haylands is characterized by an excessive use of phosphorus and potassium in relation to the nitrogen. The economical use of fertilizer on grass pastures must be based on (1) the plant food needs of the crop and its responses to nitrogen, phosphorus and potassium; equally important is (2) the management and harvest of the grassland crop.

Interest in beef cow-calf operations in northern Minnesota has stimulated many questions concerning the fertilization and management of existing grass pastures. Investigations on pasture fertilization and weed control were planned and carried out as a result of discussions and cooperation between

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The authors should like to express appreciation for the materials and assistance provided by the University of Minnesota Agricultural Experiment Station, Crookston, Minnesota. This cooperation, so generously extended, made the project possible.

farmers, University of Minnesota Extension Agents of the Red River Valley and Extension Specialists in Soils and Crops.

These studies were planned with several objectives in mind:

1. To determine the yield response of grass pasture or hayland to varying levels of fertilizer application. Specifically to compare the fertilizer rate common in farm use with a rate of fertilizer known to more nearly meet the needs of good grass growth.

2. To study the influence of weed control on the yield of grass pastures.

3. To determine the influence of fertilizer applications on the protein content of grass pasture.

4. To determine the influence of additions of phosphorus and potassium on yield of grass pastures in northwest Minnesota.

5. The trials were further intended to be used for the dual purposes of (a) collection of data which could help answer the above questions and (b) serve as demonstrations to farmers of the area.

METHODS

County agents in Marshall, Pennington, Roseau, East Polk, West Polk, Norman and Mahnomen counties selected typical pasture areas, assisted in the placement of tests and fencing of the trials. Eleven trials were placed in the seven counties.

Treatments as shown in Table 1 were broadcast on the surface of selected areas in April, 1971.

The trials were fenced to control livestock grazing. In May 1971, 2-4-D low volatile ester at the rate of 1 pound per acre was applied to those plots on which weed control was to be studied. Perennial weeds at this time were 3-4 inches in height. Principal weeds were Canadian thistle, dandelion, goldenrod, and common milkweed. Each trial consisted of 8 treatments replicated 2 times. Each plot was 1/100 acre in size.

During the past season, two cuttings and grazings have been made at all locations. An area equal to 1/2000 of an acre was harvested from each plot. A third has been taken at one location. It is anticipated that a third cutting will be taken at the other locations during the last week of October 1971. The first cutting on most locations was made during the week of June 7, 1971. Second cuttings were taken the last week of July 1971.

DISCUSSION OF RESULTS

The yields of hay obtained from the various treatments from the two cuttings are shown in Table 1. Yields are given for those locations which were predominantly mixed grasses, (quack, timothy, orchard, brome, Kentucky bluegrass) and for those locations which were predominantly Kentucky bluegrass.

These results confirm earlier findings in regard to use of fertilizers in the production of grass hay or pasture. The following conclusions have been interpreted from the data and are further supported by observations and data accumulated by previous research in Minnesota.

1. Pastures with mixed grasses, particularly those containing considerable timothy and quack grass species, produced higher average yields with or without fertilizer use than those pastures which were predominantly Kentucky bluegrass.

2. Fertilizer applications containing an equivalent of 150 pounds of nitrogen, 50 pounds of P_2O_5 and 50 pounds of K_2O resulted in increases in yield of hay of more than 2 tons per acre in two cuttings.

   Yields with the above fertilizer applications were nearly 3 times those obtained from no fertilizer application.

3. The application of 30 pounds of nitrogen per acre in combination with 15 pounds of P_2O_5 and 15 pounds of K_2O resulted in significant increases in yield in the first cuttings, but did not significantly increase yields in subsequent cuttings.

4. Nitrogen applied at the rate of 100 pounds of N per acre in the absence of additions of phosphorus and potassium fertilizer resulted in significant increases in yields. These increases, however, were not of the magnitude obtained when the equivalent quantity of nitrogen was applied in combination with phosphorus and potassium fertilizer. Future work in this area should include specific trials to determine phosphorus and/or potassium needs. It is likely that the response to additions of phosphorus and potassium fertilizer was largely due to the presence of additional phosphorus.

   Soil test results from the various locations as shown in Table 2 indicate a relatively low phosphorus content in many of the soils, while the potassium levels are medium or higher.

   Soil tests below 10 pounds per acre of P indicate low available phosphorus. A soil test of less than 100 pounds per acre of K indicates a low potassium level.

5. Under conditions of these trials, no significant increases in yields were obtained from the application of weed control materials.

Data from these trials show that the application of 2-4-D effectively controlled most of the broad leaf weeds. Under the relatively good moisture and growing conditions experienced during this season, grass yields from plots not receiving weed control materials were similar to those in which weeds were controlled. Normally, weed control is an essential part of good pasture management and often can be as effective in increasing yields as fertilizer treatment. These trials will be conducted for several more years in order to more fully study the influence of weed control and fertilizer treatment on the change of species.

6. Samples of hay obtained from the check plots, weed control plots, and those plots receiving 100 pounds of nitrogen plus 50 pounds each of P_2O_5 and K_2O per acre were analyzed for protein content. These data are shown in Table 3. Increases in protein content, as influenced by nitrogen fertilizer applications, often exceeded 5 percent. There was little difference in the protein content of the mixed grasses as compared with the stands which were predominantly Kentucky bluegrass. In the first cutting, those plots receiving applications of 2-4-D for weed control were generally lower in protein. This was likely due to the reduction in the population of legume plants in the weed control plots.

7. The average protein yield per acre obtained from the two cuttings on both the mixed grass and predominantly Kentucky bluegrass pasture sites was significantly increased by fertilizer applications, as shown in Table 4. The yield of protein per acre on the fertilized plots was more than 3 times that obtained on non-fertilized areas.

Less than 15 percent of the hay and pasture land in Minnesota is fertilized. Farmers as yet have not been motivated to try to shoot for high levels of forage production. While there are many reasons, perhaps one of the most important in northern Minnesota is that farmers feel they do not need additional forage because they keep only sufficient livestock to utilize the forages they normally produce. To be profitable, forages must be fed to livestock. Forages are not easily marketed and, during years of surplus production, the market price is often quite low. There were many instances of under utilization of hay and pastures in Minnesota this past growing season.

Farmers must have sufficient livestock to utilize the additional forages produced as a result of increased fertilization. If forages are not fed or grazed, forage fertilization may not be a paying proposition.

When one compares the production of T.D.N. and protein from grasses with that of corn, we realize that forages properly fertilized and harvested either as forage or pasture can be valuable. Table 5 shows a comparison of the production obtained in the trials with an equivalent production of corn.

The possibility of producing 77 bushels of corn per acre in northern Minnesota on land now being used for pasture and hayland is rather unlikely. However, a yield of 3.5 tons of hay per acre from this land is a reality when proper fertilizer, weed control and management is employed.

Table 1. Hay yields - pasture fertilizer - weed control trials. Red River Basin - Minnesota - 1971.

Treatment ($N + P_2O_5 + K_2O$)	Hay Yields tons/acre: *Mixed Grasses 1st Cut	*Mixed Grasses 2nd Cut	K. Bluegrass 1st Cut	K. Bluegrass 2nd Cut
0 + 0 + 0	.55	.83	.39	.40
0 + 0 + 0 + weed control	.43	.71	.35	.35
30 + 15 + 15	.70	1.10	.49	.43
30 + 15 + 15 + weed control	.73	.84	.57	.43
100 + 50 + 50**	1.75	1.81	1.08	.96
100 + 50 + 50** + weed control	1.75	1.71	1.21	.92
100 + 0 + 0	1.02	1.06	.61	.50
100 + 0 + 0 + weed control	1.13	.90	.69	.52
	5 sites	5 sites	6 sites	4 sites

* Mixed grasses - includes quack, timothy, orchard, brome and Kentucky bluegrass

** Received 50 pounds nitrogen after first cutting

Table 2. Phosphorus and potassium soil test levels - pasture fertilizer - weed control trials.
Red River Basin - Minnesota - 1971.

Location County	Soil Test Level P	K
	lbs/A	
Marshall	5	170
Red Lake	8	600
Pennington	5	200
West Polk	7	160
West Polk	6	170
East Polk	5	160
East Polk	13	140
Roseau	27	340
Norman	18	170
Norman	45	470
Mahnomen	35	560

Table 3. Protein percent - pasture fertilizer - weed control trials.
Red River Basin - Minnesota - 1971.

Treatment	% Protein			
	*Mixed Grasses		K. Bluegrass	
($N + P_2O_5 + K_2O$)	1st Cut	2nd Cut	1st Cut	2nd Cut
0 + 0 + 0	11.7	11.3	11.9	10.3
0 + 0 + 0 + weed control	10.7	10.9	11.5	10.3
150 + 50 + 50** + weed control	16.8	15.0	15.2	15.5

* Mixed grasses - includes quack, timothy, brome, orchard, Kentucky bluegrass mixtures

** 50 pounds nitrogen applied after first cutting

Table 4. Protein pounds per acre - pasture fertilizer - weed control trials. Red River Basin - Minnesota - 1971.

Treatment $(N + P_2O_5 + K_2O)$	*Mixed Grasses 1st Cut	*Mixed Grasses 2nd Cut	*Mixed Grasses Total	K. Bluegrass 1st Cut	K. Bluegrass 2nd Cut	K. Bluegrass Total
0 + 0 + 0	151	187	338	93	82	175
0 + 0 + 0 + weed control	92	155	247	80	72	152
150 + 50 + 50** + weed control	588	513	1001	367	285	652

(Protein pounds per acre)

* Mixed grasses - includes quack, timothy, orchard, brome and Kentucky bluegrass

** Received 50 pounds nitrogen after first cutting

Table 5. Production of T.D.N. and protein from grass pasture compared to corn.

	Ton Hay/Acre	Pounds T.D.N./Acre	Pounds Protein/Acre
Permanent Bluegrass no fertilizer	.8	800	160
Permanent Bluegrass + fertilizer	2.0	2000	600
Mixed Grasses + fertilizer	3.5	3500	1000
Corn (bu.)	18	800	90*
Corn (bu.)	45	2000	227*
Corn (bu.)	78	3500	393*

* Based on 9 percent protein in corn.

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WILL FUTURE FERTILIZER USE BE RESTRICTED

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The use of fertilizer has increased during the same period that pollution abatement has become a national movement. Despite much scientific evidence to the contrary large numbers of our urban voting population are being convinced that nitrogen and phosphorus, supplied by farm fertilizers is a major cause of water pollution, and if allowed to continue could cause a calamity within a decade. Nitrogen and phosphorus are the two essential elements required by plants that are blamed for most water pollution. Nitrates--if converted to nitrites can cause methemoglobinemia in infants. Both nitrogen and phosphate levels in water are considered as critical in the growth of aquatic plants, and eventually an excess can cause eutrophication in streams and lakes. Most other elements required for plant growth are naturally present in adequate concentration and will not limit the growth of water plants in most streams and lakes of the mid-continent area. The impact of publicity on possible detrimental effects of nitrates and phosphates on water quality is probably strongest in the corn belt states. This is the region where most of the meat and grain are produced and where a major portion of fertilizers is applied.

For some years agricultural research administrators and soil fertility specialists have largely ignored the statements of alarmists regarding the hazards of losses of nitrogen and phosphorus from fertilizers or animal manures to water, as not being worthy of rebuttal. Food is critical and the benefits of these soil amendments far outweigh any undesirable effect. In the current period of surplus grains, high incomes and adequate meat supplies, the environmentalists (and there is frequently some question of motives) have largely ignored the role of nutrients in food production. Many erroneous statements of these untrained people made in early news stories regarding soil and plant chemistry have been corrected in their recent writings. (In fact agronomists have aided in this change by pointing out errors in the early presentations by the ecologists.) Apparently articles condemning the use of fertilizers in food production continue in demand by news media outside of the agricultural press, and are apparently eagerly read and accepted by many who take their food supply for granted.

On November 2, the U.S. Senate passed a bill (86-0) that sets a 1985 goal for ending all pollution to streams and lakes for factories and municipal waste-treatment plants. This legislation has not been considered by the House. Also, newspaper stories indicate this legislation, as written will be opposed by the administration. There are reports there will be "stormy" deliberations. However, this Senate action indicates strong public sentiment for clean streams and shows little concern for the increased cost of consumer goods when waste water must be treated to remove all pollutants, or where plants must be relocated to have sufficient space for treatment facilities.

Fertilizers and agriculture are not prominently mentioned in the press coverage of this new Senate action. However, where pollution could come either from municipal sewage plants or from cultivated land, agricultural pollution will not go unnoticed. When or if removal of all urban and industrial pollutants does not have appreciable effects on the aquatic growth of plants or eliminate nitrate and phosphate from the water fertilizers, farm manures and runoff or crop residues will receive attention. The statement has been made that regardless of the treatment given sewage by Kansas City or St. Louis that no difference in water quality can be noted 50 miles below these cities. Pollution from agriculture will mask much urban treatment. Is there really any difference in principle in nitrogen from city sewage entering a body of water, and a substantial amount of nitrate in a header tile line draining a fertile cornbelt soil that has been fertilized to produce a yield of 150-200 bushels of corn per acre?

There is ample evidence that erosion from some sloping land can add substantial amounts of phosphorus to surface water supplies. Where nitrogen fertilizers are added in excess of crop removal, and where denitrification rates are low there can be losses of nitrates through tile drains or through leaching to groundwater on sandy soils. Under our periodic dry conditions in Missouri a substantial addition of nitrogen to corn in amounts in excess of 100 pounds per acre, except on sandy soils, will over a period of years result in the accumulation of nitrates.

There have been discussions in a number of states, on penalties for permitting soil to erode or to impose restrictions on the amount and time of some fertilizer applications. This interest and effort on the fate of nitrogen fertilizers has been strongest in Illinois. A series of hearings have been conducted this fall. Standards that have been prepared by Dr. Sam Aldrich of the Agronomy Department, University of Illinois (also member of the Illinois Pollution Control Board) have been thoroughly discussed in a series of meetings. Most testimony has been opposed to the establishment of standards. In my opinion the levels of application that Dr. Aldrich has included in this proposal are most realistic and higher than more than 90 percent of Missouri farmers use. I feel the fertilizer industry owes Dr. Aldrich a debt of gratitude for his effort. Although I have had conversation with some who have been critical of his activities, farmers and the industry are fortunate in having an individual to take the lead who is one of the most knowledgeable in the country in the field of applied soil fertility and plant nutrition.

What the future holds as a result of these hearings and the influence in other states must now necessarily be opinion. As long as the quantity of our food supply is ample and grain prices are depressed because of surpluses little argument can be made for fertilizer treatments that will provide more than 90 percent of maximum yield, if significant amounts of the applied nitrogen or phosphorus will enter surface or underground water supplies. Arguments that a reduction in fertilizer use will work an economic hardship on crop farmers or the fertilizer industry will not only be ineffective but can have a negative effect on the conservation minded citizen or the urban voter. The agricultural segment of our country does not have the numbers or influence to stop regulations that could be imposed by sentiments of some ecologist and their influence on the voting public.

At this time it is my opinion--and this has been formed largely from contact with midwestern people who understand food production--that the mechanism and problems for administering a program of restrictive fertilizer use are too great for it to be adopted at this time. However, if Congress votes to cease all water pollution, I would expect agriculture to be treated like any other business enterprise when sources of pollution are extablished. Certainly a program of this kind, to be effective, would need to be adopted nationwide. The farmers in a single state where such restrictions might be put in effect would be at a serious economic disadvantage. If we were to have federal restrictions I would expect food shortages, an increase in food imports and a rapid return to "free enterprise" in crop production.

I believe it is a mistake to attempt to refute arguments and discredit data regarding the amount of fertilizer nitrogen and phosphorus lost from land. Instead both farmers and industry should stress the positive side of fertilizer use to the consumer and the beneficial effects of a good soil fertility and management program on the environment and the health of people. The industry should consider methods of getting the crop production story to the same people the alarmists have been courting. The agricultural segment certainly has enough evidence that "talking to each other" is not effective.

Certainly fertility programs should be followed that apply only the amount of nutrients, and at a time they will be efficiently utilized by crops. I am hopeful that any adjustments in fertilizer use in Missouri can be based on facts rather than emotion and can be administered by self compliance and educational programs.

COMPARISON TRIALS OF FERTILIZERS AND RELATED MATERIALS

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Quite frequently Extension personnel are asked for their opinion about various products sold for use in producing crops. Claims may be made for one or more benefits such as increased yields, higher protein content of grain, improved soil tilth, lower moisture content at harvest time, less problems with disease and insects, etc.

In the spring of 1971, field trials were established at the West Central Experiment Station, Morris, and the Southwest Experiment Station, Lamberton, to compare some of the products with a conventional fertilizer program. Because it is not feasible to test all products which may be purchased as fertilizers or related materials, a soil conditioner, an organic soil builder and a liquid fertilizer (advertised for both foliar and soil applications) were selected.

TREATMENTS (Acre basis rate)

1. Check. (0+0+0 total applied)

2. Liquid 10-20-10: Seed plus foliar. (52+20+10 total applied)
   *4 gal. with seed plus 4 gal. on foliage (2 applic. at 2 gal. rate)
   200 lbs. 21-0-0 broadcast and worked in.

3. Liquid 10-20-10: Seed. (47+10+5 total applied)
   Same as treatment 2 except no foliage applications.

4. Soil Conditioner. (0+0+0 total applied)
   250 lbs. broadcast and worked in.

5. Organic Soil Builder. (30+10+5 total applied)
   300 lbs. broadcast and worked in.
   200 lbs. to the side and below seed.

6. Conventional Fertilizer.
   Southwest Exp. Station: (114+43+22 total applied)
   300 lbs. 33.5-0-0 broadcast and worked in.
   180 lbs. 8-24-12 to the side and below seed.

   West Central Exp. Station (120+61+30 total applied)
   313 lbs. 33.5-0-0 broadcast and worked in.
   190 lbs. 8-32-16 to the side and below seed.

**7. Soil Conditioner plus Pesticides. (0+0+0 total applied)
   Same treatment as 4, plus insecticide and herbicide.

**8. Organic Soil Builder plus Pesticides. (30+10+5 total applied)
Same as treatment 5 plus insecticide and herbicide.

**9. Conventional fertilizer plus liquid 7-21-7 with seed. (124+73+34 total applied).
Same as treatment 6 plus 5 gal. 7-21-7 with seed.

**10. High Rate Conventional fertilizer (220+61+130 total applied).
613 lbs. 33.5-0-0 and 167 lbs. 0-0-60 broadcast and worked in.
190 lbs. 8-32-16 to the side and below seed.

*5 gal. with seed at West Central Exp. Station.
**These treatments were only at West Central Exp. Station.

ALL treatments were replicated four times with and four times without broadcast applications of phosphate and potash. The purpose of this is to have comparisons under medium to high fertility soil conditions as well as under low fertility soil conditions. The rates applied were 0+90+45 at Lamberton and 0+80+0 at Morris.

Weed and insect control: Except for treatments 4 and 5, all plots received herbicide and insecticide. At Lamberton, Ramrod and Bux were used; at Morris, Lasso and Furadan. All plots were cultivated two times.

Soil tests show both sites to be low in phosphorus and medium in organic matter. The potassium level is medium to high at Lamberton and high at Morris. The pH was 5.6 at Lamberton and 7.6 at Morris.

RESULTS:

Statistical analyses have not been completed at the time this summarization is being prepared. Therefore, with only one year results, data figures are not being included.

Data for treatments 1 through 6 at both stations show the conventional fertilizer treatment producing the highest yield under both low and high fertility conditions. Following in decreasing yield were the liquid fertilizer treatments, check, organic soil builder and soil conditioner.

There was no apparent yield increase from the foliar applications of liquid fertilizer.

The yield advantage of the check treatment over the organic soil builder and the soil conditioner treatments was due to weed and insect control. At Morris, treatment 7 (soil conditioner plus pesticides) yielded the same as the check, while treatment 8 (organic soil builder plus pesticides) yielded higher than the check treatment.

Yields for treatments 9 and 10 were similar to that for the conventional treatment so there was no yield response to the additional nutrients.

Moisture content of the grain at harvest was lowest in the conventional fertilizer and the liquid treatments with little difference among the three. Grain moisture content was highest with the soil conditioner, organic soil builder and check treatments. There was little difference among these three at the Southwest Station while the corn was substantially drier on the check treatment at the West Central Station. Where pesticides were applied with the soil conditioner (treatment 7) and the organic soil builder (treatment 8), the grain moisture content was reduced.

In mid-June there was a height advantage and the corn was darker green on the conventional and liquid treatment plots. Tasseling under these treatments was several days ahead of that for the other treatments.

Mineral analyses of leaf samples taken at tasseling and of the grain at harvest have not been completed.

FUTURE:

The trials will be conducted a minimum of three to five years. In addition to yield, data is being collected for moisture, growth, tasseling, mineral and protein content, barren stalks and pest problems.

This project is being conducted with the assistance of University of Minnesota staff members: Dr. Samuel Evans, Dr. William Fenster, Orville Gunderson, Dr. Wallace Nelson and Dr. Curtis Overdahl.

FIELD TRIALS WITH HEAVY APPLICATIONS OF SOLID AND LIQUID ANIMAL MANURES

Samuel D. Evans, Soil Scientist,
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Morris, Minnesota

In recent years many changes have taken place in livestock production. These changes have resulted in confinement feeding and a greater concentration of livestock. With more livestock at a specific site, it is necessary to dispose of increased amounts of manure. With the recent interest in pollution control in all phases of our society, it is essential that the manure from these operations not contribute to air and water pollution.

A year and a half ago a group from the University of Minnesota in cooperation with the Agricultural Research Service of the USDA met to discuss the need for work in animal waste management. In this report work now underway in Minnesota will be briefly discussed. The various types of experiments underway are summarized in Table 1.

In many of the experiments mentioned in Table 1, soil samples were taken to depths of 10 feet or more prior to manure application. These samples have been analyzed for conductivity, nitrate nitrogen, nitrite nitrogen, chlorides, sulfate sulfur, and pH. Each year soil samples will be taken from the plots and analyzed. These results will be compared against those from the original samples.

Complete results are not in at the time this report was prepared. However, some general observations have been made on the past year's work.

1. It is possible to incorporate large amounts of manure into the soil. There were application problems, but these were not insurmountable. The effect of the applications on subsequent crops is not known.

2. It is possible to grow corn after one application of fairly high rates of liquid and solid manures. At some locations there were some detrimental effects of these applications. At Morris the high salt content of liquid beef manure caused some corn stunting.

3. Where liquid manure was applied to alfalfa at Crookston, yields were slightly depressed.

Table 1. Summary of Animal Waste Management Experiments at the University of Minnesota Branch Experiment Stations and by ARS, Morris.

	Location				
Type of Experimental Work	Agricultural Research Service, Morris	Crookston	Grand Rapids	Morris	Waseca
Application of high rates of liquid and/or solid manures to the soil yearly. Cropped to corn.		x	x	x	
Application of one type of manure at various rates. Cropped to corn.					x
Application to and incorporation into the soil periodically during the period the soil is not frozen. No crop.		x	x		x
Application to alfalfa prior to growth and between cuttings.		x			
Application to corn, oats, and alfalfa during growth and after harvest and subsequent runoff measurements.	x				
Application to frozen soil and/or snow and subsequent runoff measurements.	x	x			
Transfer of manures to the field thru an irrigation system.				x	

Biographical Sketch

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Birth Place - Lafayette, Indiana

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EFFECT OF SOIL PH ON THE AVAILABILITY OF MANGANESE TO SOYBEANS

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Manganese (Mn) deficiencies have been observed on various crops throughout the U. S. for a number of years. However, with an increasing acreage of soybeans and greater efforts being employed toward the maximization of yields, Mn deficiency of soybeans could become more prevalent. Scott and Aldrich (6) state that a shortage of Mn is the most common micronutrient deficiency of soybeans.

Soils which are low in available Mn are characteristically those with a pH greater than 6.5 and with relatively high amounts of organic matter. However, these factors are modified somewhat by soil texture. Under these conditions, the total amount of Mn may be relatively high, but most of the Mn may be present as higher oxides (MnO_2) and/or chelated very strongly. Either form would not be readily available to the plants. Consequently, manganese deficiency would result, especially on those crops that have high Mn requirements, e.g., oats, onions, soybeans and wheat.

EFFECT OF SOIL PH

In general, there is an inverse relationship between soil pH and plant available Mn. With a low soil pH the Mn available for plant growth is usually abundant and at times may be excessive, resulting in Mn toxicity. Conversely, Mn deficiencies occur more commonly on neutral to calcareous soils.

Raising the soil pH by liming or lowering the pH via acid-forming fertilizers has a very pronounced effect on the Mn supplying power of the soil. Liming of strongly acid soils ($pH < 5$) may reduce or eliminate Mn toxicity; however, lime applied to slightly acid soils may induce Mn deficiency. On the other hand, acidification reactions may release soil Mn, causing Mn toxicity on strongly acid soils and relieving Mn deficiency problems on neutral soils.

EFFECT OF LIMING

The effects of liming a soil are numerous and are interrelated. Conditions for microbial activity, which may affect plant growth, are altered. In addition, the availability of some essential elements such as P and Mo is increased; whereas, the availability of other elements is decreased, e.g., manganese and iron.

Graven et al. (2) state that Mn toxicity appears to be the major factor responsible for poor growth of alfalfa on many acid soils. Moreover, water-logging of soils for short periods of time may accentuate the Mn toxicity, especially to highly sensitive plants such as alfalfa. In a greenhouse experiment they found Mn uptake by alfalfa to be very high from acid soils (Table 1). When coupled with short periods of flooding, toxic amounts of Mn were released by the soils, resulting in greatly reduced alfalfa yields. Liming not only increased yields and reduced the severity of Mn toxicity by decreasing the plant Mn content, but also caused a rapid decline in exchangeable soil Mn.

Table 1. Effect of liming and flooding an acid soil on the yield and Mn content of alfalfa grown in pots on a Kellner loamy sand.

Treatment				
Dolomitic limestone	Period flooded	Soil pH	Yield	Mn content
T/A	days		g/pot	ppm
0	0	4.7	3.1	426
0	3	---	1.2	6070
0.75	0	5.9	4.3	256
0.75	3	---	1.7	5340
2.50	0	7.3	5.7	99
2.50	3	---	3.0	957

Soybeans and cotton grown on some of the strongly acid soils of the Southeastern U. S. sometimes suffer from a disease called "crinkle leaf". This abnormality has been shown to be caused by high levels of Mn. Parker et al. (5) in a pot experiment using an acid soil showed the effect of dolomitic limestone and fertilizer Mn on the soybean leaf Mn (Table 2). Soybean plants from the check and Mn sulfate treatments showed crinkle leaf symptoms along with delayed nodulation, reduced pod size and fewer seeds per pod. Lime reduced leaf Mn, eliminated abnormal growth symptoms and increased pod size.

Table 2. Influence of lime on leaf Mn of soybeans grown on an acid Georgia soil (pH 4.6).

Treatment	Rate	Leaf Mn
	lbs/A	ppm
Check	---	400
Dolomitic limestone	6000	210
Mn sulfate	400	1790

The effect of lime on the availability of Mn has been shown on a Webster sicl at Lamberton, Minnesota. This soil has a moderately acid surface with the subsoil being alkaline at a depth of 24 inches. Results obtained by Grava et al. (1) show that liming did not increase the alfalfa yield but significantly did lower plant Mn to concentrations approaching the critical level of 15 ppm (Table 3). In this soil further reduction of available Mn by liming may induce Mn deficiency in sensitive crops.

Table 3. Effect of lime on soil pH, yield and Mn content of alfalfa grown on a Webster sicl at Lamberton, 1970.

			Plant Mn		
			cutting		
Rate	Soil pH	Total yield	1st	2nd	3rd
T/A		T/A	-----------	ppm	----------
0	5.7	3.9a 2/	24b	27b	31b
7 1/	6.1	4.1a	16a	17a	20a
16 1/	6.8	4.0a	18a	16a	19a

1/ 3 and 6 tons of lime were applied in 1965 with the additional 4 and 10 tons, respectively, being applied in 1968.

2/ Mean values followed by the same letter are not significantly different at the 99% level.

EFFECT OF FERTILIZER ACIDIFICATION

The effect of chemical fertilizers on the pH of the soil has been shown to depend largely on the chemical forms, rates and application methods of nutrients applied. Isensee and Walsh (4), in an incubation experiment conducted on a Wisconsin soil, studied the effect of several fertilizer carriers on soil pH around the fertilizer band (Table 4). Soil pH change during the incubation was highly dependent upon the N source. At the 20 lb/A rate (elemental basis) the greatest acidification was produced by diammonium phosphate (DAP) or a combination of monocalcium phosphate (MCP) and either NH_4NO_3 or urea. This was due primarily to the nitrification of NH_4^+ from the carriers. The inclusion of KCl with the N and P carriers generally moderated the pH change by 0.1 - 0.2 unit. When applying the nutrients at the 60 lb/A rate only NH_4NO_3 and MCP lowered the soil pH sharply. Moreover, urea or DAP resulted in a higher soil pH than when applied at the lower rate. This may have been due to the high concentration of salt and NH_4^+ in the band which inhibited nitrification over the 32-day period.

Based on the data in Table 4 it appears that on soils low in available Mn starter fertilizer containing N and P applied at moderate rates in the row could cause sufficient acidification to release adequate amounts of Mn to soybeans. After noticing the apparent effects of starter fertilizer in reducing the Mn deficiency symptoms of soybeans in 1970, an experiment involving starter fertilizer treatments was conducted on a Mn deficient Sebawa silt loam in 1971. Two forms of phosphorus (monoammonium phosphate (MAP)and diammonium phosphate (DAP) were applied at two rates (15 and 30 lbs P/A) as row treatments in conjunction with a Mn row treatment. Supplemental N as NH_4NO_3 and K as KCl were added to balance the rates of N and K. Amsoy beans were planted on May 17 in 30" rows at a rate of 8.3 beans per foot. Weeds were controlled chemically with 2 qts. Amiben and 2 qts. Lasso broadcast per acre plus one cultivation. Upper, fully-mature, trifoliate leaves were taken from each plot at three growth stages (pre-blossom, early blossom, and early pod set) and were analyzed for plant nutrient uptake. Yields, plant weights and leaf composition data are shown in Table 5.

Table 4. Influence of several carriers of N, P and K on the soil pH within a 1-4 cm area around the fertilizer band after a 32-day incubation period.

Nutrient	Fertilizer Carrier	Application Rate 20 lbs/A	60 lbs/A
		-------- soil pH ------	
Check		6.00	6.35
N	NH_4NO_3	5.65	5.70
	Urea	5.70	6.50
P	MCP 1/	5.80	5.60
K	KCl	6.00	6.25
N + P	DAP 2/	5.30	6.05
	NH_4NO_3 + MCP	5.40	5.50
	Urea + MCP	5.45	6.25
N + K	NH_4NO_3 + KCl	5.80	5.90
	Urea + KCl	5.90	6.85
P + K	MCP + KCl	5.90	5.85
N + P + K	DAP + KCl	5.40	6.10
	NH_4NO_3+MCP + KCl	5.40	5.65
	Urea + MCP + KCl	5.55	6.30

1/ MCP = monocalcium phosphate -- $Ca(H_2PO_4)_2$

2/ DAP = diammonium phosphate -- $(NH_4)_2HPO_4$

Soybean yield, plant weight and leaf Mn were increased significantly over the check by the Mn and starter P treatments. However, the seed yields obtained from the starter P treatments were not improved over that from the Mn treatment. Also, yield, plant weight and leaf Mn differences were not significant between rates or forms of starter P. The leaf composition with the exception of Mn was not increased significantly by any of the treatments. Since leaf N, P and K were not increased by the starter treatments, it is quite possible that secondary fertilizer acidification reactions accounted for the release of soil Mn to the plant, relieving Mn deficiency and resulting in plant weight and seed yield increases.

Table 5. Effect of rates and forms of starter P on the yield, plant weight and leaf composition of soybeans.

Treatment No.	Description	Yield	Plant Wt.	Leaf content 2/ N	P	K	Mn	Fe	Zn	Cu
		bu/A	g/10	----- %		-----	------	ppm		-------
1	Check	33.0a	52a	5.86	.44	2.05	11a	114	40	8.0
2	20# Mn/A as $MnSO_4$(row)	61.6b	96b	5.73	.44	1.87	15ab	112	39	7.3
3	15# P/A as MAP	58.4b	115b	5.75	.43	2.02	19bc	113	37	5.9
4	30# P/A as MAP	64.2b	115b	5.81	.44	1.88	26c	115	32	6.1
5	15# P/A as DAP	57.9b	111b	5.88	.44	2.10	24c	116	37	6.4
6	30# P/A as DAP	61.2b	116b	5.82	.43	1.89	28c	115	35	5.5
	Statistical significance:	**	**	ns	ns	*	**	ns	*	ns

1/ Treatments 3, 4, 5, and 6 received a total of 27# N and 30# K/A

2/ Upper, fully-mature, trifoliate leaves at early blossom stage

3/ MAP = $NH_4H_2PO_4$ -- 11-48-0
DAP = $(NH_4)_2HPO_4$ -- 18-46-0

4/ ns = not significant
* = 95% level
** = 99% level

In trying to pinpoint the fertilizer nutrient responsible for the release of soil Mn, we must look at the properties of the individual components. The MAP is more acidic than the DAP (saturated solution pH of 4.0 vs. 9.0, respectively) because of the presence of the $H_2PO_4^-$ ion. However, since neither form nor rate of P affected soil Mn release, the initial pH of the fertilizer apparently did not have a long term soil acidification effect. Consequently, nitrification of the NH_4^+ contained in the MAP and DAP plus the supplemental NH_4NO_3 appears to have been the major acidification reaction responsible for release of soil Mn.

CORRECTION OF MN DEFICIENCY WITH MN FERTILIZERS

During 1970 and 1971 two experiments were conducted to determine the effect of rates, forms and application methods of Mn fertilizers on various soybean production parameters. The experiments were located on a Sebawa silt loam of pH 6.2; organic matter, 10%; extractable P, 80 lbs/A; and exchangeable K, 175 lbs/A. Sixteen soil and foliar treatments were applied each year; however, some rates were modified in 1971 to gain more meaningful information (Table 6 and 7). The broadcast treatments were disked in about 10 days before planting. Row treatments were applied at planting time with the starter fertilizer. Foliar treatments were applied six to eight weeks later, during the pre- and early blossom stages. Each year all plots received 8+15+28 pounds per acre, N, P and K, respectively. In 1970 nine pounds of Zn/A as $ZnSO_4$ was added to the row fertilizer with an additional 125 lbs K/A broadcast and disked in. Amsoy beans were planted in 30" rows at the rate of 8.5 beans per foot. Weeds were controlled with Amiben and Lasso plus one cultivation. Upper, fully-mature, trifoliate leaves and whole plant samples were taken at various growth stages during the season and were analyzed for Mn, Fe, Zn and Cu. The data in Tables 6 and 7 show the effects of the Mn treatments on certain soybean parameters for 1970 and 1971, respectively.

Significant differences in plant weight, leaf Mn content, yield and bean weight were found among the treatments in both years. Comparing the soil treatments the best yields were obtained with the $MnSO_4$ form applied at the highest broadcast rates or with 20 lbs Mn/A applied in the row. The leaf Mn content increased with increasing rates of $MnSO_4$.

Table 6. The effect of Mn soil and foliar treatments on plant weight, Mn content, yield, bean size, and number of soybeans in 1970. (V. Drendel Farm, Rock Co., Wisconsin)

Treatment	Plant Wt. 1/	Leaf Mn 1/	Yield	Bean Wt.	No. beans per acre
lbs Mn/A	g/10 plants	ppm	bu/A	mg/bean	(x 1,000)
Control	114bc 2/	18abc	56.1ab	163ab	8,113
$MnSO_4$					
15, Bdct.	124c	19bcd	62.7bc	168abc	8,792
30, Bdct.	118bc	20bcd	63.2bc	174bc	8,537
60, Bdct	130c	24de	66.6c	176c	8,918
5, Row	126c	20bcd	64.8c	171bc	8,907
10, Row	130c	22cd	61.8bc	173bc	8,440
20, Row	130c	28e	65.6c	172bc	9,028
0.5, Foliar	121c	22cd	64.7c	170bc	8,959
1.0, Foliar	134c	22cd	62.1bc	174bc	8,425
4.0, Foliar	122c	23cd	60.4abc	167abc	8,545
MnEDTA					
0.5, Row	85a	15ab	54.6a	157a	8,212
1.0, Row	93ab	13a	54.1a	158a	8,024
4.0, Row	119bc	15ab	54.6a	165abc	7,777
0.15, Foliar	118bc	22cd	59.8abc	167abc	8,478
0.30, Foliar	121c	21cd	60.4abc	169bc	8,420
0.45, Foliar	107abc	19bcd	62.2bc	166abc	8,827
Statistical significance: 3/	**	**	**	*	ns

1/ At early pod set, July 31, four weeks after applying the foliar treatments.

2/ Values followed by the same letter are not significantly different

3/ ns = not significant
* = 95% level
** = 99% level

Table 7. The effect of Mn soil and foliar treatments on plant weight, Mn content, yield, bean size, and number of soybeans in 1971 (V. Drendel farm, Rock Co., Wisconsin).

Treatment	Plant wt. 1/	Leaf Mn 1/	Yield	Bean wt.	No. beans per acre
lbs Mn/A	g/10 plants	ppm	bu/A	mg/bean	(x 1,000)
Control	87	14	44.5	185	5,784
$MnSO_4$					
25, Bdct.	102	16	58.3	203	6,934
50, Bdct	88	21	59.8	211	6,839
100, Bdct.	88	26	64.6	206	7,552
10, Row	90	26	60.8	206	7,111
20, Row	95	32	62.4	210	7,149
40, Row	101	52	62.5	205	7,341
0.5, Foliar(2X)	89	24	58.9	200	7,132
1.0, Foliar(2X)	94	27	59.9	206	7,006
2.0, Foliar(2X)	80	32	57.4	199	6,959
MnEDTA					
0.15, Row	73	10	40.0	175	5,446
0.50, Row	68	10	35.8	176	4,930
1.00, Row	60	10	37.0	175	5,060
0.15, Foliar(2X)	88	19	58.7	206	6,862
0.30, Foliar(2X)	78	23	55.6	193	6,952
0.45, Foliar(2X)	80	25	56.6	197	6,944

1/ At early blossom stage, July 15, two weeks after applying the first foliar treatments.

The MnEDTA applied to the soil decreased the plant weight and leaf Mn and produced somewhat lower yields and bean weights than the control. In addition, the plants in these three treatments showed striking Mn deficiency symptoms, were more chlorotic, had smaller roots, and appeared to have less root nodulation than the control plants. The application of MnEDTA to the soil may have strongly chelated the small amount of soil Mn, thus intensifying the Mn deficiency.

Application of Mn by spraying the foliage once with small amounts of $MnSO_4$ or MnEDTA increased the yields over the control but generally resulted in lower yields than from the soil applied $MnSO_4$. The highest yield obtained with these foliar applications was with the low rates of $MnSO_4$. The 2.0 and 4.0 pound rates of $MnSO_4$ caused some leaf burn and leaf drop, resulting in a slight yield depression.

Cost and return values for the Mn treatments applied in 1970 are presented in Table 8. All treatments except the row MnEDTA resulted in increased net return over the control. The highest net return per acre was obtained with the row $MnSO_4$ treatments and the 0.5 pound foliar $MnSO_4$ treatment.

Table 8. The effect of Mn soil and foliar treatments on the economics of soybean production 1/ (V. Drendel Farm, Rock Co., Wisconsin, 1970).

Treatment	Yield	Increase Over Control	Gross return Over Control	Trt. Cost	Applc'n Cost	Total Cost	Net return over control
lbs Mn/A	bu/A	bu/A	$/A	$/A	$/A	$/A	$/A
Control	56.1	---	---	0	0	0	---
$MnSO_4$							
15, Bdct.	62.7	6.6	18.20	3.20	0	3.20	15.00
30, Bdct.	63.2	7.1	19.50	6.40	0	6.40	13.10
60, Bdct.	66.6	10.5	28.90	12.80	0	12.80	16.10
5, Row	64.8	8.7	23.90	1.10	0	1.10	22.80
10, Row	61.8	5.7	15.70	2.20	0	2.20	13.50
20, Row	65.6	9.5	26.10	4.40	0	4.40	21.70
0.5, Foliar	64.7	8.6	23.60	0.85	1.75	2.60	21.00
1.0, Foliar	62.1	6.0	16.50	1.00	1.75	2.75	13.75
4.0, Foliar	60.4	4.3	11.80	1.90	1.75	3.65	8.15
MnEDTA							
0.5, Row	54.6	-1.5	-4.10	4.20	0	4.20	-8.30
1.0, Row	54.1	-2.0	-5.50	8.40	0	8.40	-13.90
4.0, Row	54.6	-1.5	-4.10	33.60	0	33.60	-37.70
0.15, Foliar	59.8	3.7	10.20	1.95	1.75	3.70	6.50
0.30, Foliar	61.2	5.1	14.00	3.20	1.75	4.95	9.05
0.45, Foliar	62.2	6.1	16.80	4.45	1.75	6.20	10.60

1/ Assumptions: soybeans, $2.75/bu; $MnSO_4$ (soil), $6.00/100 lbs; $MnSO_4$ (spray grade), $8.00/100 lbs; MnEDTA, $1.00/lb; sufactant, $0.70/A; application cost, $1.75/A.

In an attempt to obtain information on the date and number of applications of foliar applied Mn needed to maximize soybean yields, an additional experiment was established each year. Management practices were approximately the same as those outlined in the preceding discussion. A foliar rate of 0.15 pound Mn/A as MnEDTA was then applied once at three different dates during the growing season and also in duplicate and triplicate applications to the same plots.

Yields, leaf Mn contents and net return values are shown in Table 9. Spraying the foliage once increased the yields both years. However, in 1970 under ideal growing conditions, the single application at the early date was not as effective as the applications at the later dates when the plants were larger, thereby intercepting more of the Mn spray. Applying the Mn in two or three weekly or bi-weekly applications increased the yields another 2 to 5 bushels in both years.

Table 9. Effect of date and number of applications of foliar-applied MnEDTA on the Mn content and yield of soybeans.

		1970 (Sebawa silt loam)				1971 (Dickman sandy loam)			
Rates	Times	Dates	Leaf[1/] Mn	Yield	Net return over Control	Dates	Leaf[1/] Mn	Yield	Net return over Control[2/]
lbs Mn/A			ppm	bu/A	$/A		ppm	bu/A	$/A
Control		---	14a	56.5a	---	---	9a	21.9a	---
0.15	1	6-19	16ab	62.7ab	13.35	7-9	12ab	26.4b	8.65
0.15	1	7-2	18b	66.1bc	22.70	7-16	12ab	26.4b	8.65
0.15	1	7-17	22c	66.5bc	23.80	7-23	16cd	26.1b	7.85
0.15	2	6-19,7-2	18b	68.6bc	25.90	7-9,7-16	14bc	28.8c	11.55
0.15	3	6-19,7-2,7-17	23c	71.4c	29.90	7-9,7-16, 7-23	17d	29.6c	10.10
Statistical significance:			**	+			**	**	

1/ Prices used are found in the footnote to Table 8.
2/ Two weeks after the final foliar application.
3/ + = 90% level
** = 99% level

Yields obtained at the 1971 experimental site were severely limited by the lack of rainfall on this shallow sandy loam. Because only small amounts of rain fell after mid-July, the soybeans prematurely dropped their leaves and consequently, were harvested on September 24. It is difficult, therefore, to interpret the effect of the later foliar applications.

Ham and Frazier (3) studied the effect of various micronutrients on the yield of Chippewa-64 soybeans grown at Waseca, Minnesota in 1969 and 1970. Soil treatments were broadcast applied and disked in prior to planting. Foliar treatments were applied when the plants were beginning to flower. Yields and leaf Mn from the Mn treatments are shown in Table 10.

Table 10. Effect of soil and foliar applied Mn on the yield and leaf Mn content of Chippewa-64 soybeans grown at Waseca, 1969 and 1970.

Treatment			Yield		Leaf Mn[1/]
Form	Method	Rate	1969	1970	1970
		lbs Mn/A	------ bu/A -----		ppm
Check	---	---	39.4	32.3	50
Mn sulfate	Foliar	3	35.9	30.5	64
Mn chelate	Bdct.	3	40.4	30.6	44
Mn chelate	Foliar	0.6	39.7	31.4	52
Mn silviplex	Foliar	0.6	39.1	28.9	78 [2/]
Statistical significance:			ns	ns	

1/ The last, fully-mature, trifoliate leaf.
2/ Significantly greater than the check at the .01 level.

Leaf Mn content from the check was well above the critical level of 15 ppm which would indicate that this soil was capable of supplying sufficient Mn to the plant. As a result, no significant yield increase was noted in either year. Only the Mn silviplex treatment significantly increased leaf Mn. In 1969 the foliar $MnSO_4$ treatment may have caused a slight burning of the leaves, thereby lowering the yield slightly but not significantly.

CONCLUSIONS

1) Soil pH does strongly influence the availability of Mn to plants. Raising the soil pH by liming may be beneficial on those soils on which Mn toxicity is suspected; however, increasing the pH of some slightly acid soils may in time induce Mn deficiency. On the other hand, release of soil Mn through fertilizer induced acidification processes, mainly nitrification, can relieve Mn deficiency symptoms of plants grown on neutral soils.

2. Correction of Mn deficiency of soybeans is not extremely costly. A row applied rate of about 20 lbs/A of Mn as $MnSO_4$ appears to be the best soil treatment when applied with starter fertilizer. Two or three foliar treatments of 0.15 to 0.30 lbs Mn/A as MnEDTA or 0.5 to 1.0 lbs Mn/A as $MnSO_4$ applied in 7 to 14-day intervals also corrected the deficiency sufficiently. The application of MnEDTA to the soil as a soil treatment stunted the plants, lowered yields slightly, and consequently, should not be recommended.

3) Additional work, including a survey of the micronutrient availability of various soils, perhaps should be conducted before evaluating the Mn situation in Minnesota.

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TILLAGE TRIALS WITH CORN

James B. Swan

Tillage methods for corn have been developed which effectively reduce runoff and erosion. Several of these methods were evaluated in studies at Waseca in 1970 and 1971 and at Lancaster, Wisconsin from 1967 to 1971.

Replicated trials at Waseca were conducted on a moderately well to somewhat poorly drained LeSueur clay loam. The primary tillage practices were chisel, plow, and no primary tillage. The secondary tillage practices were disk, disk-drag, field cultivate, and no secondary tillage. Corn yields averaged 160 Bu/A in 1970 and 104 Bu/A in 1971. The decreased yield in 1971 reflected the severe July-August drought. Yield differences between tillage treatments were relatively small in both years, even though sizeable differences were measured in early growth and average daily 4-inch soil temperatures in May and June. Soil moisture measurements in 1971 indicated the presence of free water at the 3 to 4 foot depth in mid-July. The work at Waseca was conducted in cooperation with William Lueschen, Agronomist, and John True, Agricultural Engineer.

At Lancaster, the tillage practices included conventional seedbed preparation (plow-disk-plant), wheeltrack plant, no-till coulter plant in untilled ground, and no-till coulter plant following a spring chisel treatment. The study was run on ground previously in corn. Average yields have ranged from 107 Bu/A in 1969 to 126 Bu/A in 1968. Yields of conventional planting, wheeltrack planting, and planting following a chisel treatment were similar. Yields for no-till coulter planting were significantly lower in two years. The work at Lancaster was conducted in cooperation with William Paulson, Superintendent, Lancaster Experimental Farm and Arthur Peterson, University of Wisconsin.

PHOSPHORUS AND POTASSIUM NEEDS FOR HIGH CORN YIELDS

C. J. Overdahl and W. E. Fenster

To study rates of P and K broadcast or in the row sounds like repetition of corn fertility research done during the past 50 years. Advances in research with corn hybrids, weed control and insect control, however, causes fertilizer research to become out of date rapidly.

In the fall of 1969, we established trials in Martin and Waseca counties to determine broadcast needs of P and K when corn yields are in the range of 150 to 200 bushels per acre. Earlier work of this nature was carried out where yields were in the range of 80 to 100 bushels. The question is whether increased rates of fertilizer should be in proportion to the higher yield goals, or perhaps much higher, and how high should a soil test be before no more broadcast fertilizer is needed.

Broadcast phosphorus applications were made annually at 0, 50, 100, 150 and 200 pounds per acre of P_2O_5 with a blanket treatment of about 200+0+300+20 Zn each year. The annual broadcast potassium applications were made at 0, 50, 100, 200 and 400 pounds per acre of K_2O with a blanket treatment of 200+150+0+20 Zn.

Farmer cooperators were selected on the basis of ability to produce 200 bushels per acre on occasion where great attention is paid to details of tillage and controlling insects and weeds, plus early planting with good hybrids.

The soils were fine textured, high in organic matter, high in P and K, and had reasonably good drainage. Tables 1 through 4 show yields, along with related soil and tissue tests. They also show details about pH, zinc levels in soil and leaves, as well as nitrogen in leaves.

In 1970, there were no significant increases from either broadcast P or K, but significant responses were obtained from starter fertilizer. In 1971 in Martin county, there was a significant response to broadcast phosphate when the soil phosphorus test was 37 pounds of P in the check plot. Phosphorus in the leaf opposite and below the ear sampled July 21 during silking was increased from .28 to .30 percent by the application of 100 pounds of P_2O_5. Results in 1972 and perhaps 1973 will be necessary before one could safely say that 37 pounds of soil P and .28 percent P in the leaves was not high enough. To complicate our thinking, Waseca county results show that raising leaf P from .28 to .30 percent and soil P from 27 to 45 pounds per acre gave no yield increase in 1971. Rainfall was more limiting in August at this site and yields were about 15 bushels per acre less than in Martin county. We need yields close to 200 bushels per acre before we can learn about yield differences when soil tests are this high.

Some surprises were encountered. Originally, the zinc levels were moderately low on the Martin county trial, so 20 pounds of actual zinc as zinc sulfate were incorporated for the 1970 crop and again for 1971. Table 1 shows that zinc in the leaves is below 20 ppm, but that zinc soil tests are very high. Zinc research by Dr. MacGregor of the Soil Science Department at the University, shows that zinc applications increase leaf zinc, but often maximum corn yields were reached when leaf content was still below 20 ppm. We are quite sure that 20 pounds of zinc per acre two consecutive years prevented zinc from being a limiting factor in these trials.

Another surprise was the small increase of P and K in plant tissue from broadcast or row applications. Other observations showed that nitrogen applications of 200 pounds produced an average of 2.8 percent N in the leaves, while in an adjacent nitrogen study, 400 pounds of N increased this slightly. It appears difficult to raise the nutrients to very high levels in the plant tissue.

Table 1. 1970 and 1971 corn yields, plant analyses and soil tests in Martin county according to broadcast phosphorus treatment. (200+0+300+20 Zn applied over all phosphorus plots)

P_2O_5 lbs/acre	Yields bu/acre 1970	Yields bu/acre 1971	% P leaves 1970	% P leaves 1971	Soil Test P lbs/acre 1970	Soil Test P lbs/acre 1971
0	155	137 a	.26	.28	46	37
50	151	137 a	.26	.27	36	39
100	162	156 b	.27	.30	56	55
150	146	146 ab	.28	.30	65	63
200	145	154 ab	.28	.30	64	55

	1970	1971
Avg. starter response	4*	2
Avg. % N in leaves	-	2.7
Avg. K soil test	268	352
Avg. % K in leaves	1.70	1.88
Avg. soil pH	7.7	7.2
Avg. Zn leaves ppm	19 low	17 low
Avg. Zn soil ppm	-	5.3 high

Table 2. 1970 and 1971 corn yields, plant analyses and soil tests in Waseca county according to broadcast phosphorus treatment. (200+0+200 applied over all phosphorus plots)

P_2O_5 lbs/acre	Yields bu/acre 1970	Yields bu/acre 1971	% P leaves 1970	% P leaves 1971	Soil Test P lbs/acre 1970	Soil Test P lbs/acre 1971
0	133	139	.31	.28	34	27
50	136	133	.30	.27	31	33
100	132	132	.28	.27	31	40
150	136	135	.29	.30	40	44
200	138	130	.29	.30	53	45

	1970	1971
Avg. starter response	13*	4
Avg. % N in leaves	-	2.8
Avg. K soil test	307	276
Avg. % K in leaves	1.68	1.82
Avg. soil pH	6.4	6.1
Avg. Zn leaves ppm	26	16
Avg. Zn soil ppm	-	2.6 high

Table 3. 1970 and 1971 corn yields, plant analyses and soil tests in Martin county according to broadcast potassium treatment. (200+150+0+20 Zn applied over all potassium plots)

K_2O lbs/acre	Yields bu/acre 1970	1971	% K leaves 1970	1971	Soil Test K lbs/acre 1970	1971
0	156	148	1.7	1.8	202	230
50	147	154	1.7	1.8	212	258
100	152	149	1.6	2.1	222	278
200	147	143	1.8	2.1	270	328
400	160	149	1.8	1.9	243	320

	1970	1971
Avg. starter response	16*	3
Avg. % N in leaves	-	2.8
Avg. P soil test	50	62
Avg. % P in leaves	.25	.29
Avg. soil pH	6.4	6.1
Avg. Zn leaves ppm	22	22
Avg. Zn soil ppm	-	8.4 high

Table 4. 1970 and 1971 corn yields, plant analyses and soil tests in Waseca county according to broadcast potassium treatment. (200+150+0 applied over all potassium plots)

K_2O lbs/acre	Yields bu/acre 1970	1971	% K leaves 1970	1971	Soil Test K lbs/acre 1970	1971
0	134	123	1.6	1.4	260	210
50	129	120	1.7	1.7	275	213
100	139	131	1.7	1.7	260	220
200	132	116	1.8	1.8	262	223
400	134	120	2.2	1.9	312	310

	1970	1971
Avg. starter response	10*	7*
Avg. % N in leaves	-	2.7
Avg. P soil test	53	52
Avg. % P in leaves	.27	.31
Avg. soil pH	6.4	6.0
Avg. Zn leaves ppm	26	14
Avg. Zn soil ppm	-	3.0 high

NITROGEN EXPERIMENTS WITH CORN

W. E. Fenster and C. J. Overdahl

In the fall of 1969, nitrogen experiments were established to determine the rates of nitrogen that would result in the highest economic yields of corn on highly productive land. The soils on which the experiments were conducted are fine textured, high in organic matter, high in P and K, and have reasonably good drainage. Another dimension has been added to these experiments whereby the nitrate-nitrogen in the soil is being monitored to ascertain the downward movement with time as it relates to the rate of application of nitrogen.

Table 1. Corn yields as influenced by nitrogen treatments (3 locations- 8 replications).

N (lbs/A) annually	Martin Co. Continuous corn 1970	Martin Co. Continuous corn 1971	Martin Co. Virgin soil 1971	Waseca Co. Continuous corn 1970	Waseca Co. Continuous corn 1971
			yield (bu/A)		
0	120 a	130 a	179 a	82 a	43 a
50	128 ab	142 b	190 bc	109 b	63 b
100	140 c	151 b	187 bc	143 c	93 c
150	132 bc	144 b	183 b	153 cd	131 d
200	131 abc	147 b	194 c	163 d	144 e
400	135 bc	153 b	190 bc	169 d	151 f

Where letters differ at each location, yields are statistically different at the 10% level.

All plots received a basic treatment of 0+150+200+20 Zn annually.

The soils were classified as Webster silty clay loams.

Table 2. Percentage nitrogen in tissue* (July) as related to fertilizer nitrogen application.

N (lbs/A)	Martin Co. Continuous corn 1971 %	Martin Co. Virgin soil 1971 %	Waseca Co. Continuous corn 1970 %	Waseca Co. Continuous corn 1971 %
0	2.5	2.8	1.9	1.5
50	2.7	2.7	2.2	1.7
100	2.6	2.8	2.5	2.2
150	2.9	2.8	2.7	2.6
200	2.9	2.8	2.8	2.9
400	2.9	2.9	3.0	3.0

* sixth leaf at tasseling

In order to determine the amount of nitrate-nitrogen in the soil profile, soil cores were taken to a depth of 6 feet in Martin county and 5 feet in Waseca county. It is our intent to monitor these nitrates and their movement in the soil for at least 5 years. Preliminary data on the soil nitrate regimes are given in the following tables:

Table 3. Amount of nitrate-nitrogen in the soil profile* on continuous corn in Martin county (average of 4 replicates).

Soil Depth (ft.)	Parts per million (ppm) Nitrate-Nitrogen (NO_3-N), Treatment - lbs N/A applied annually: 0		50		100		150		200		400	
	1970	1971	1970	1971	1970	1971	1970	1971	1970	1971	1970	1971
0-1	8	9	7	9	6	9	8	12	9	23	12	60
1-2	6	5	5	5	6	8	6	17	6	23	9	45
2-3	6	5	9	13	7	13	13	43	7	26	19	30
3-4	12	6	17	15	9	15	44	30	22	20	28	20
4-5	12	7	21	14	11	14	29	28	24	17	18	18
5-6	7	10	20	13	13	14	24	23	17	17	14	18

* soils sampled after corn harvested

Table 4. Amount of nitrate-nitrogen in the soil profile on virgin soil planted to corn in Martin county (average of 4 replicates).

Soil Depth (ft.)	Virgin soil fall 1970	ppm NO_3-N Treatment - lbs N/A applied - 1971					
		0	50	100	150	200	400
0-1	6	17	19	24	15	31	40
1-2	4	10	23	32	29	47	32
2-3	5	7	9	8	14	14	11
3-4	3	3	5	4	5	4	5
4-5	3	3	3	4	5	6	3
5-6	3	4	3	4	4	6	4

Table 5. Amount of nitrate-nitrogen in the soil profile on continuous corn in Waseca county (average of 4 replicates).

Soil Depth (ft.)	ppm NO_3-N Treatment - lbs N/A applied - 1971					
	0	50	100	150	200	400
0-1	4	4	6	6	5	17
1-2	2	2	3	4	3	12
2-3	3	3	3	3	3	27
3-4	2	2	2	3	3	17
4-5	3	2	3	4	4	10

OBSERVATIONS AND SUMMARY

1. In Martin county on continuous corn in 1970 and 1971, significant yield increases were not realized where rates of nitrogen greater than 100 pounds of N/acre were applied.

2. In Martin county on the virgin soil in 1971, the 50 pound N rate was adequate to produce a significant increase in corn yields. Higher rates of N produced no additional increases in corn yields.

3. In Waseca county, the highest significant increases in corn yields were obtained in 1970 with 150 pounds of N/acre and in 1971 with 400 pounds of N/acre. The University still recommends between 150 and 200 pounds of N/acre, however, as the farmer realizes his highest economic yield at these rates.

4. The percentage N in the sixth leaf at tasseling stage correlated very well with amounts of N/acre applied and the corn yields. In general, when 2.7 percent or greater was noted in the plant tissue, yield increases were not realized from additional N applications.

5. The soil nitrates at the three plot sites varied markedly. In general, however, the highest nitrate levels were found in the top 2 to 3 feet of soil at all locations. The highest levels of NO_3-N were observed in Martin county on the continuous corn plots receiving an annual application of 400 pounds of N/acre.

6. At the Martin county location, nitrogen applications in excess of 100 pounds of N/acre on continuous corn appears to result in NO_3-N levels in the soil which may be of concern from an environmental quality standpoint. More years of data are needed to verify these results. Further study is also needed to see if the NO_3-N moves downward in the soil profile with time and further applications of nitrogen.

7. On the virgin soil in Martin county, the applied nitrogen is reflected in the top 2 feet of soil after one year. The levels of accumulation would appear to be in relation to the rates of nitrogen applied. Unlike the continuous corn in Martin county, where the NO_3-N levels are confounded with many years of fertilizer nitrogen and manure applications, the virgin soil profile indicates no additional accumulation of NO_3-N from the fertilizer applications in the 3 to 6 foot depth after one year.

8. The NO_3-N levels at the Waseca location are relatively low at all nitrogen fertilizer rates except that receiving the 400 pounds of N. It is interesting to note that the soils at Waseca and Martin counties are classified as Websters, since they have quite different nitrogen regimes. This difference may be due in a large measure to differences in rainfall and perhaps other climatic conditions. Of equal importance, perhaps, is the fact that the Waseca location has not received any barnyard manure for at least 20 years, whereas, the Martin county continuous corn site has received several manure applications in recent years.

9. Based on these preliminary data, it would appear that serious consideration should be given to adjusting nitrogen fertilizer recommendations for corn, based on the NO_3-N level on soil samples taken from perhaps 0 to 3 feet in depth.

PESTICIDES - THEIR EFFECT ON BEEKEEPING

Robert Banker
Pres. Banker's Honey Inc.
Sec.-Treas. American Beekeeping Federation
Cannon Falls, Minnesota

Area confined to Minnesota

Applications and area where major damage to colonies occur

Climatic conditions, available pollen and nectar sources and their influence on losses

Can bees be moved away from area of application

Pollination value of honeybees must be protected

Losses in 1969 and 1970

Cooperating efforts to alleviate losses

BEE KILLS IN MINNESOTA & ATTEMPTED CONTROL

Richard A. Hyser, Supervisor
Minnesota Department of Agriculture
Section of Apiary Inspection
Division of Plant Industry

Minnesota is one of the largest honey producing states in the nation as well as one of the largest sweet corn and canning pea areas in the Midwest.

Most bee kills have been associated with the changeover of chemicals used for control. Example: DDT to Sevin

Biological control is not expected to be of major importance in controlling canning crop insects in immediate future. New selective chemicals that kill the bad insects and save the beneficial insects are slow to develop, costly to produce.

Our problem, therefore, is how can beekeepers and canners live with each other year after year.

HISTORY OF BEE KILLS LAST FOUR YEARS

1968 reports of bee kills from Cygon used in controlling pea aphid. 1969 very few reports. 1970 heavy kills on peas and corn, hot dry year, good honey crop most areas of state. 1971 heavy bee kills mostly sweet corn, cold wet year, poor honey crop, 65 bee yards reported damaged or destroyed. Colonies affected by spray damage estimated near 2,000 or over. 1970 - 1600 colonies killed or damaged.

Canning companies operates in 35 counties in southern Minnesota. Twelve firms operate in Minnesota and many counties have three to four firms in the same county. Insert map

Bee kills shown as yards reported by beekeeper and most yards have 25 to 40 colonies per yard.

PRINCIPAL INSECTS AND CHEMICALS USED FOR CONTROL

Pea aphids - Parathion, Cygon, Phosdrin
Cabbage loopers - Sevin & Molasses, Sevin & Phosdrin
Corn borer & Corn earworm - Sevin

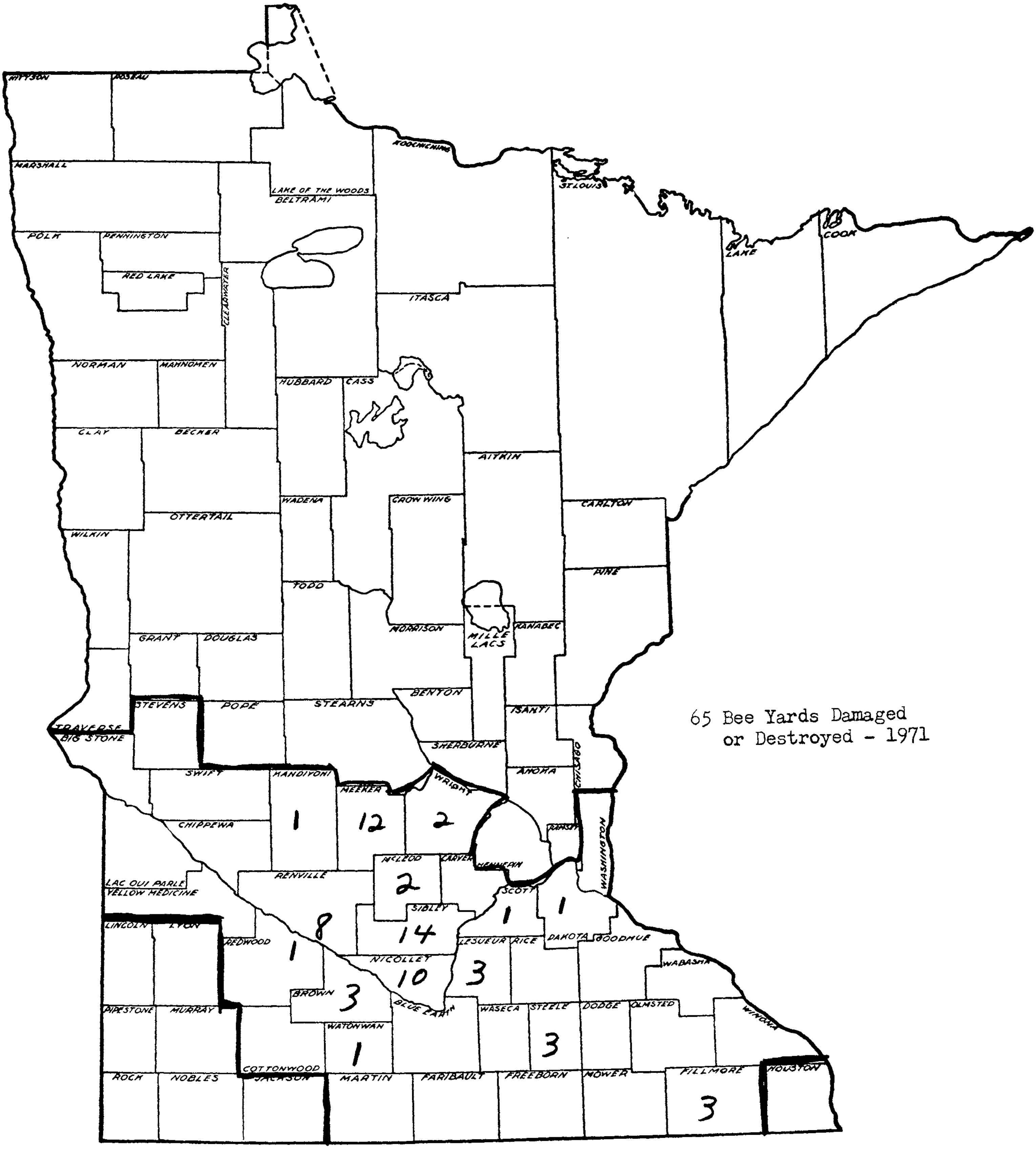
MINNESOTA DEPARTMENT OF AGRICULTURE PLAN TO REDUCE BEE KILLS

1. Accurate locations secured from beekeepers according to ¼ section, township, range, and county.
2. Contact canning company as to area they operate in.
3. Plot all locations, 10 colonies or more per yard, on county map. Identify each location with owners name, address, and telephone number.
4. Send completed maps to canning companies before contracting time.

Past history shows most bee kills associated with late peas and medium to late sweet corn. Very little kill on early peas and early harvested corn. Suggest early maturing crops of peas and corn near bee yards, therefore, canning companies must know location of yards.

Why communication and cooperation is necessary between beekeepers, canning companies, State Department of Agriculture, and Extension Entomologist if the plan is to work.

1. Local fieldmen and beekeeper to discuss current situation prior to growing season. Example: bee yard added or deleted
2. Canners Association send list of key personnel in each plant. This list was sent to all beekeepers in 35 county area.
3. Canning Association to use care in spraying areas near bee yards.
4. Beekeepers to report all losses to Minnesota Department of Agriculture and local fieldmen.
5. Extension Entomologist issued precautions on use of insecticides near bee yard (Extension Bulletin #263). Check on new materials. Example: Sevin granuals, 1st generation corn borer control, test repellent and attractants as they appear on market.
6. Hold meeting between interested parties on how to improve plan or why it is not working.
7. Coordinate information and send out reports to interested personnel.



65 Bee Yards Damaged or Destroyed - 1971

CROP SPRAYING AND BEE KILLS

Lee E. Woodruff, President
Minnesota Canners and Freezers Association

The 1970 season, by all reports, was a year of heavy bee losses, amounting into the thousands of dollars.

This came to the attention of the canning industry of this State approximately a year ago last September because it was felt that the 1970 spraying operations on canning crops were intensified considerably due to above normal infestation of insects in peas and corn.

Naturally, with this accusation, the canning industry became very concerned and decided to investigate further if losses were really much higher than normal and, if so, what were the reasons and what could be done.

With this in mind, I arranged, along with the Minnesota Department of Agriculture, to meet with the Minnesota Beekeepers Association to discuss this matter. This meeting was held October 15, 1970, and due to the participants and the tone of the meeting, the subject of bee losses was thoroughly discussed, and I believe a considerable amount of knowledge was absorbed by everyone in attendance.

The Department of Agriculture stated that bee losses were above average for the year because of dry weather and high temperatures during the middle of the day, a very high infestation of corn borer and earworm--the worst since 1948, therefore causing considerable spraying operations in sweet corn and a reduction in pollen production, causing bees to migrate to less desirable pollen producing plants such as sweet corn.

It was recognized that the bee industry is an important segment in the agriculture industry of the State and that it was necessary for the canning industry to continue their spraying operations to produce a wholesome food.

With this understanding, the group decided to further refine the present program of communication coordination between canners and beekeepers concerning spraying operations, and therefore develop new ideas to expand on this program.

As a result, the beekeepers agreed, (1) to submit 1971 maps showing locations of bee yards as soon as possible to be ahead of contracting for crops, and that every effort be made to get more accuracy in the maps; (2) canners were to contact beekeepers early to discuss the coming year's operations as to location of acreage; (3) beekeepers were to mark yards if possible so they can be identified from the road or air if possible; (4) beekeepers would be notified ahead of time of spraying operations in the vicinity of their colonies if at all possible; (5) spraying of fields close to colonies would be done early in the morning or late in the evening, if possible, to avoid bee flights to and from the hives; (6) spray operators would be made aware of the problems and asked for their cooperation in this matter; (7) new materials, if suitable for borer control and less toxic to bees, would be investigated and used if practical.

This program was adopted for 1971, and I am sure a real effort was put forth by both parties to make it successful. The borer infestation in 1971 was as bad or worse than in 1970, and there is still a strong desire for further improvement and coordination of this program for the coming year, which unfortunately looks like another year of serious borer infestation.

We think we have made improvements but also realize that this group here today, the aerial applicators, could very well provide additional suggestions and help in providing further improvement in further minimizing bee losses. Your additional suggestions and help would be very much appreciated for this coming year.

11-9-71

MINNESOTA PESTICIDE PROGRAM FOR 1972

Rollin M. Dennistoun, Ph.D.
Administrative Supervisor
Minnesota Department of Agriculture

RESTRICTED PESTICIDES:

1. As of this date the following pesticides have been designated as "Restricted Use" pesticides in Minnesota for 1972:

DDT	Dieldrin
DDD or TDE	Heptachlor
Aldrin	Lindane
Endrin	

PERMITTED USES FOR RESTRICTED PESTICIDES:

1. The Department will shortly hold hearings to consider updating the "permitted uses" of the restricted pesticides for 1972.

LICENSE FOR SELLERS OF RESTRICTED USE PESTICIDES

1. Any person offering for sale or having in his possession with intent to sell or otherwise distribute to the ultimate user, and any person purchasing from an unlicensed source any restricted use pesticide shall obtain a license from the Commissioner of Agriculture.

   a. Exemptions

      (1) Custom pesticide applicator when he sells and applies

      (2) Licensed pharmacist, physician, dentist, or veterinarian when prescribing, dispensing, or administering a restricted use pesticide for use in man or other animal in his practice.

   b. Application for license

      (1) Shall be made on forms and in such manner as the Commissioner prescribes to determine qualifications of applicant.

      (2) Includes taking a test.

   c. Fee - $20.00 per year which shall accompany application

   d. License Expiration

      (1) Each license expires on January 1 following date of issuance

e. Penalty for none or late licensing

   (1) Ten percent of the license fee shall be imposed as the penalty if a license is not applied for on or before January 1 of each year, or written the same month such restricted use pesticide is first offered for sale in the state by the seller.

f. Records to be kept

   (1) Each dealer, custom applicator and pest control operator shall keep a record of each sale of restricted pesticide materials.

   (2) Forms for this purpose are provided by the Department at the time license is issued.

   (3) Such information shall be forwarded to the Department when requested.

<u>CUSTOM SPRAYING AND DUSTING</u>

1. Aquatic custom applicators

   a. Now included in the spraying and dusting law and are subject to licensure the same as all other custom applicators.

   b. Must obtain an endorsement to license from Department of Natural Resources.

2. Record keeping required

   a. Date of treatment

   b. Material and dosage used

   c. Number of units, acres treated

   d. Name of customer

   e. Name of person or company licensed

   f. Signature of operator (These are required, additional information should be kept.)

3. Person required to be licensed

   a. The person who receives the compensation and who is responsible for the proper application of the pesticide materials

4. Identification cards required

   a. Each licensee and each operator that he hires to operate his equipment <u>shall</u> have an identification card issued by the Department and shall display same upon demand of an authorized representative of the Commissioner or a law enforcement officer.

5. Fees

   a. Each application for a license must be accompanied by a fee of $5.00.

   b. Each identification card requested requires an additional fee of $5.00. (The $2.00 equipment inspection fee is no longer required.)

6. Claim of damage, inspection report

   a. Persons claiming damage from pesticide application may file a written statement with the Commissioner

   b. Such a written statement must contain:

      (1) Claimant's name and address

      (2) If different, the name of the person who had the pesticide applied

      (3) Name of applicator

      (4) Date of application

      (5) A description of damage

      (6) A request that the Commissioner inspect the damage

      (7) Other information as required by the Department

   c. If such a statement is filed within 60 days after the damage occurred, or before 25% of the damaged crop has been harvested, Department personnel will inspect the damage and file a report of findings.

   d. Unsatisfied judgements

      (1) An unsatisfied judgment is one that has been arrived at by legal process.

      (2) Any licensee has 30 days to settle such a judgment. If not settled in 30 days, the Department may revoke or suspend the license.

1971 FERTILIZER AND SOIL CONDITIONER LAW

Leo M. Lehn, Supervisor
Fertilizer & Economic Poisons
Division of Agronomy Services
Minnesota Department of Agriculture

I. Law Changes.

A. License
B. Registrations - Agricultural Products
C. Minimum Plant Food Requirements
D. Specialty, Small Package and Soil Conditioner Registration
E. Penalty for late filing of Tonnage Report
F. Soil Testing Laboratories
G. Labeling of Products
H. Research Data Required
I. Custom Mixing of Fertilizer and Pesticides

II. Problems encountered with Fertilizer and Soil Conditioners.

A. Anhydrous Ammonia

1. Carless handling
2. Unapproved installations
3. Unlabeled and unlocked facilities
4. Use of nurse tanks and applicators for storage
5. Dual use of nurse tanks (Propane and Anhydrous Ammonia)

B. Dry and Liquid Materials and Grades

1. Improper labeling and invoicing
2. Verbal claims
3. Law level mixtures for agricultural use
4. Pesticide - fertilizer mixture
5. Liquid spills and overflows.

C. Soil Conditioners

1. Exotic claims
2. More new companies and products
3. Policing problems

D. Soil Testing and Recommendations

1. Contracts and promotions
2. Unusual recommendations

FUNGICIDE SPRAYING OF CORN
INDIANA - 1971

Herbert G. Johnson
Extension Plant Pathologist
University of Minnesota

Dr. Eric Sharvelle, Extension Plant Pathologist at Purdue University, did considerable field testing of fungicide applications on corn for control of southern corn leaf blight in 1971. More detailed information will be available later but the following are some of the early results:

Plots of three replications each were set up in an irrigated field of T-cytoplasm corn. Applications of Dithane M-45 were applied by aircraft at 7-10 day intervals. The same amount of fungicide was applied per acre in all cases, but the total gallons of spray mix and the number of applications were varied. On August 10 readings were made of the percentage of leaf area affected by disease, stalk rot infection, and husk infection on 150 plants per plot:

Gallons per acre	No. of Applications	% leaf area affected	% stalks infected	% husks infected
Check	-	34.6	74.3	47
4	4	7.2	14.7	16
3	4	4.6		
4	6	6.0		

Differences between 4 and 3 gallons per acre and 4 and 6 applications were not significant in percentage of leaf area affected.

A twenty acre field of T-cytoplasm corn with southern corn leaf blight infection was divided into two ten-acre units. One unit was sprayed with a fungicide using four gallons and four applications at 7-10 day intervals. Equal areas were harvested with a conventional corn harvester and the following results were obtained:

Bushels Per Acre

Treatment	Bushels per acre	Bushel Increase
Check	87.1	
Fungicide	115.5	28.4

After subtracting the cost of treatment, a $16 per acre profit was calculated.

Several tests were run in northern Indiana on irrigated corn. Plots in a field of T-cytoplasm corn were treated by helicopter with 3 applications of 3 gallons of spray mix per acre. A light infection of southern corn leaf blight occurred. The general range of yields was 160-170 bushels per acre. Twenty to twenty-six bushels per acre increase resulted from spraying. In the same field, N-cytoplasm corn with no disease was given the same fungicide applications and a 10 bushel increase resulted from the fungicide treatment. Leaf analysis showed that the check plot leaves contained 76 ppm of manganese while the leaves from the sprayed plots contained 176 ppm of manganese. The increase in manganese in the leaves is believed to have come from the fungicide and corrected a deficiency that resulted in a yield increase. Other micronutrient elements were essentially equal in the leaves of check and treated plots. In the same experiment, blend corn showed a 12-15 bushel increase from spraying and a 2-4% higher moisture content in the corn was found in sprayed plots.

The use of adjuvants is considered essential in spray mixes. They help keep wettable powders in suspension, improve distribution of the fungicide over leaf surfaces, and reduce fungicide removal by weathering.

Indiana farmers sprayed an estimated 250,000 to 300,000 acres of T-cytoplasm corn with fungicides in 1971. Results are believed to have been generally satisfactory since no complaints were received.

MEMORANDUM OF UNDERSTANDING TO AVOID INCIDENTS OF PESTICIDE POISONINGS

John T. Hayward, State Supervisor, Minnesota-Wisconsin
USDA, APHS, Plant Protection [1]

Before the Pesticide Regulation Division of the USDA became a part of the relatively-new Environmental Protection Agency, they had been working with their counterparts in all states on a cooperative "Memorandum of Understanding to Avoid Incidents of Pesticide Poisonings".

These memoranda were prepared for signature at the Director or Commissioner of Agriculture level in the states and at the Administrator level in the Agricultural Research Service, USDA.

When the Pesticide Regulation Division became a part of the Environmental Protection Agency, it was felt that this work should remain in the U. S. Department of Agriculture. Subsequently, the Plant Protection Division was asked to assume the responsibility.

MEMORANDUM OF UNDERSTANDING TO AVOID INCIDENTS OF PESTICIDE POISONINGS

On January 1, 1971, a "Memorandum of Understanding to Avoid Incidents of Pesticide Poisonings" was signed by the Minnesota Department of Agriculture and the Agricultural Research Service of the U. S. Department of Agriculture.

This memorandum declared that the "control of pests of animals, plants, and plant products is in the interest of the Agriculture of the United States and the United States Departments of Agriculture and the respective States have legal responsibilities concerning such activities". It was also agreed that "certain highly toxic pesticides are sometimes used in efforts to combat such agricultural pests, and the handling and use of such pesticides involve unnecessary dangers to the public if the persons applying the pesticides or others who may be affected are not informed as to the dangers involved and the appropriate safety precautions that should be taken".

It was therefore deemed in the public interest for the Agricultural Research Service and the Minnesota Department of Agriculture to cooperate in a program which essentially provides for: the dissemination of information; a joint selection of pesticides subject to the memorandum; adoption of mutually-agreed-upon procedures to be followed; and publication in the Federal Register of those states cooperating in the program.

A total of 44 States signed the basic "Memorandum of Understanding to Avoid Incidents of Pesticide Poisonings".

[1] Plant Protection was formerly a Division in the Agricultural Research Service. Effective 10/31/71, they became a part of the newly-created Animal and Plant Health Service.

ETHYL PARATHION SUPPLEMENT TO MEMORANDUM OF UNDERSTANDING TO AVOID INCIDENTS OF PESTICIDE POISONINGS

For various reasons, ethyl parathion was the first pesticide selected to receive special attention. A total of 41 States signed an ethyl parathion supplement to the "Memorandum of Understanding to Avoid Incidents of Pesticide Poisonings". The agreements varied somewhat in content, but I believe the agreement between the Minnesota Department of Agriculture and the Plant Protection Division of the Agricultural Research Service is typical. The responsibilities outlined in the Minnesota ethyl parathion agreement pertain to essentially four groups of cooperators: the basic manufacturers; the Minnesota Department of Agriculture; the Extension Service, University of Minnesota; and the Plant Protection Division, ARS, USDA.

The basic manufacturers agreed to furnish prepurchase acknowledgement cards as a means of documenting that a buyer has been notified of the hazards associated with the use of ethyl parathion. Special safety literature, product labels, placards for posting treated fields, etc., were provided by the basic producers. They agreed to notify ethyl parathion formulators of the purpose of the program and urge them to pass the information and materials on to distributors and/or dealers.

It was intended that each dealer pass the following information on to each purchaser:

(a) toxicity information as it relates to accidental ingestion, inhalation, and skin absorption (b) the antidote (c) precautions on entering treated fields (d) ethyl parathion should only be mixed with chemicals specified on the label (e) treated fields should be posted (f) poison control center phone numbers

The Plant Protection Division agreed to assume the leadership in initiating, coordinating, and checking on the progress made.

The State of Minnesota Department of Agriculture was the agency designated to receive the prepurchase acknowledgement cards. They supplied dealers with rubber stamp imprints to facilitate the mailing of these cards. They agreed to: respond to inquiries concerning the proper posting of fields with the placards furnished by industry; advise the medical profession of areas of ethyl parathion use and other pertinent information; acquaint dealers and formulators with the program and the proper use of prepurchase acknowledgement cards.

The Extension Service, University of Minnesota agreed to: respond to inquiries concerning pesticides that can be mixed with ethyl parathion and take the leadership in developing an informational program with assistance from the other participants.

It should be pointed out that some phases of the agreement plans never materialized while some were very successful in certain states. This is to be expected on a new program. We learned much from the problems which were encountered during the implementation of the agreement.

Comments to a Plant Protection Division questionnaire were solicited from cooperators in the ethyl parathion project in order to evaluate our first season's effort. The majority of replies to the questionnaire indicated that the use of placards to post treated fields was not desired in most States. However, some States now have laws requiring placarding of fields treated with highly toxic pesticides (Minnesota presently does not). There also is a possibility that forthcoming Federal legislation may require placarding when certain pesticides are used. The use of the prepurchase acknowledgement card was favored. The card supplies documentary evidence of the high-use areas and gives concrete evidence that users are being given information pertinent to the safe use of ethyl parathion.

Some of you may have been the recipients of an additional evaluation questionnaire which was sent out in November to Extension Pesticide Coordinators, Pesticide Regulation Division - EPA, National Agricultural Aviation Association and the National Agricultural Chemical Association. I hope you took the time to send us your comments - they are appreciated.

We are hopeful that, if the program continues, there will be increased cooperation and coordination in the States involved so that a comprehensive USDA-State-Industry safety program can be realized. Some of the most effective pesticides against certain pests are highly toxic and when it becomes necessary to use them they must be used in a manner to avoid incidents of poisoning. If you do become involved with the use of parathion and have questions pertaining to this program, please contact one of the cooperators listed below:

Dr. R. M. Dennistoun
Administrator of Plant & Environmental Concerns
Minnesota Department of Agriculture
526 State Office Building
St. Paul, Minnesota 55155 Phone: 221-2856

C. D. Floyd, Director
Division of Plant Industry, Minn. Dept. of Agric.
670 State Office Building
St. Paul, Minnesota 55155 Phone: 221-3347

Dr. P. K. Harein, Extension Entomologist, Phone: 373-1705
Dr. J. A. Lofgren, Extension Entomologist, Phone: 373-1704
University of Minnesota, St. Paul Campus
226 Entomology, Fisheries, and Wildlife Building
St. Paul, Minnesota 55101

J. T. Hayward, State Supervisor
Plant Protection, APHS, USDA
Room 473, Federal Courts Building
110 So. 4th Street
Minneapolis, Minnesota 55401 Phone: 725-2815

THE ALFALFA WEEVIL, A PEST NEW TO MINNESOTA

Edward B. Radcliffe and Huai C. Chiang
Department of Entomology, Fisheries and Wildlife,
University of Minnesota

Alfalfa weevil, Hypera postica (Gyllenhal) was first observed in Minnesota in 1970. Surveys that year revealed low numbers of weevils present in 5 southeastern counties, Houston, Fillmore, Winona, Wabasha and Olmstead. In 1971, the weevil was found to have expanded its range west to Mankato and north to the Twin Cities, an apparent advance of 100 miles west and 50 miles north. Similar extension of the weevil's range may be anticipated for 1972 (Fig. 1).

Alfalfa weevil now occurs in each of the contiguous 48 states but as 2 distinct and, until this year, geographically isolated populations, eastern and western.

The western strain, first detected near Salt Lake City in 1904, occurs in 16 states including the western halves of both Dakotas, Nebraska and Kansas. The eastern strain, first detected near Baltimore in 1951, has spread explosively and now occurs in 35 states including Minnesota, Iowa, and eastern portions of Nebraska and Kansas. The strains appear to have merged this year in Nebraska, Kansas, and Oklahoma. Throughout its range the eastern strain weevil is the major pest of alfalfa. Blickenstaff estimated U. S. yield losses for 1966 to be $56 million with an additional $14 million spent on chemical control measures. In some eastern and southern states substantial reductions in alfalfa acreages have been attributed to establishment of the alfalfa weevil.

A fairly typical pattern has emerged with respect to the experience of the eastern states with alfalfa weevil. For two or three years following detection the weevil does not reach population densities sufficient to cause economic losses. But, for the following several years the problem can be severe. In many instances growers have found it necessary to use multiple (2, 3, or even 4) applications of insecticide. With time, the problem appears to become less acute. In most states, where the weevil has been established for a number of years, much acreage is not treated at all and little receives more than one application.

It is not unusual to find a newly introduced pest particularly devastating in the new environment, one reason being the absence of the natural enemies associated with the pest at its origin. A number of alfalfa weevil parasites have been introduced to the U.S. and at least 6 are now established. The most important is the ichneumonid, Bathyplectes curculionis (Thomson). By appropriate timing of insecticide treatment, i.e., when adult B. curculionis are not present, it is possible to integrate biological and chemical control. Also many cultural practices serve to minimize weevil injury. Vigorous varieties, good stands, and adequate soil fertility substantially reduce losses. The potential of using plant resistance was demonstrated by the development of the weevil-resistant variety Team.

Pest management practices should be based on the concept of economic thresholds. The costs of control measures, both immediate and long-term, have to be weighed against the benefits of increased yield or improved quality likely to result. For example, a long-term effect of insecticide use may be delay, or even failure, of natural enemies to become established. Accordingly, primary reliance should be placed on biological control and cultural practices with insecticides used only when essential.

The problem is in determining when that economic threshold has indeed been reached. With proper cultural management alfalfa has a remarkable tolerance of weevil injury. In the eastern U.S. it is generally thought that treatment is undesirable unless more than 50% of the stem terminals show injury. USDA workers in Maryland have recently revised this criterion upward to 75% injury. In Indiana, larval population of 1-3 per stem appear to represent the economic threshold.

A primary factor determining the severity of injury is how much growth the alfalfa makes before eggs of the weevil hatch in the spring. Appreciable fall egg laying is unlikely to occur in Minnesota. Therefore, unless we experience unusually warm weather in the early spring, our alfalfa should be well established before the weevils hatch, and withstand relatively high populations without appreciable losses.

In recognition of the potential importance of this pest to Minnesota Agriculture, research on alfalfa weevil has been initiated (1971) by the Minnesota Agricultural Experiment Station. A primary objective of this research will be to obtain the basic biological information necessary for formulation of an integrated management program. One aspect will be to obtain sufficient experience to predict the need for, and appropriate timing of, control measures.

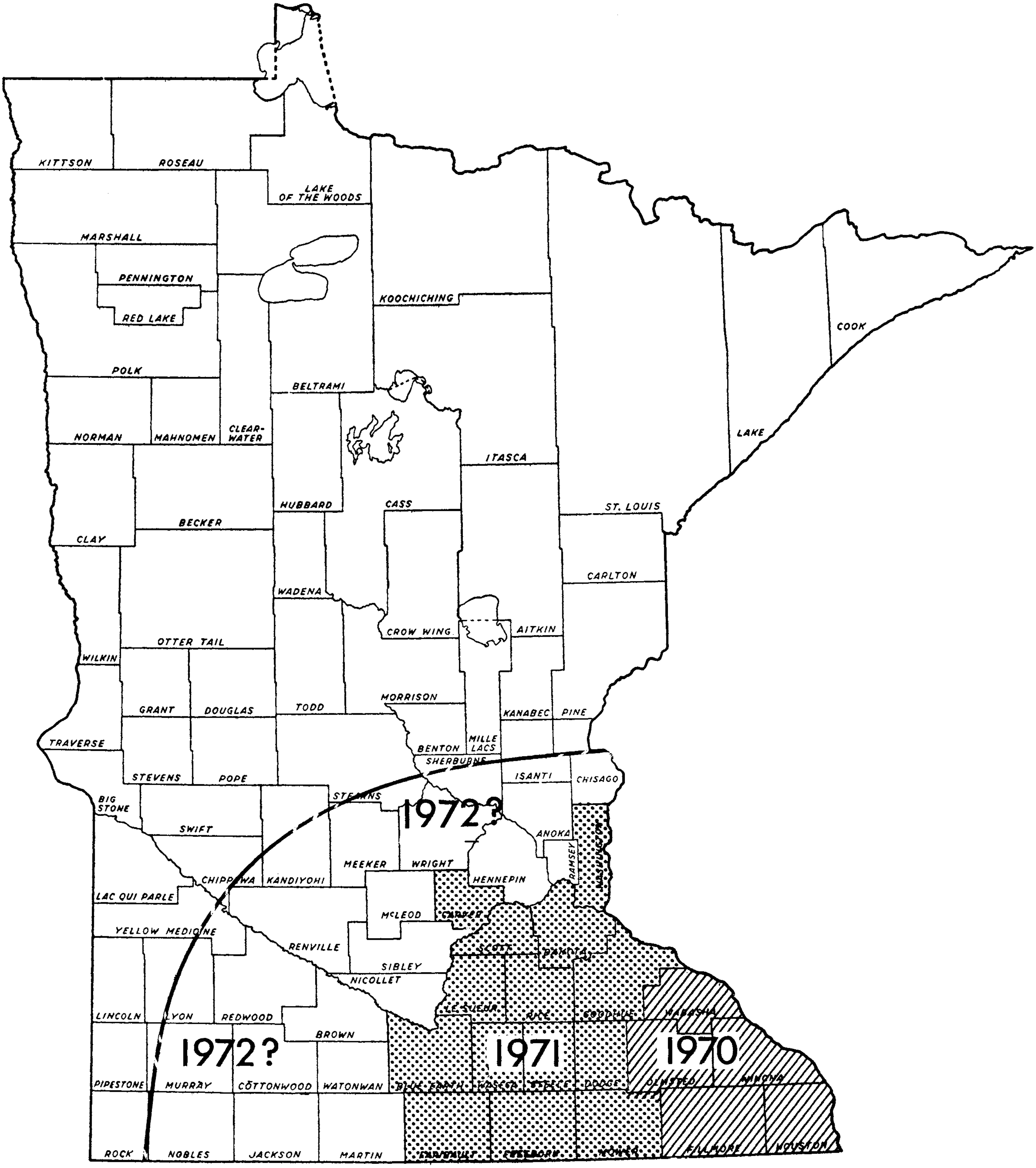


Fig. 1 Known distribution of the alfalfa weevil in Minnesota in 1970, 1971, and as projected for 1972.

FEDERAL ENVIRONMENTAL PESTICIDE CONTROL ACT OF 1971 (HR 10729)

Phillip K. Harein
Professor and Extension Entomologist

The primary purpose of this new pesticide bill is to amend the Federal Insecticide, Fungicide and Rodenticide Act under which the federal government has registered and labeled pesticides. The new bill, passed by a house vote on November 9, is based on the philosophy that safety in the use of pesticides requires an improved degree of standardization, especially regarding the use of the more hazardous materials.

The following are some of the major provisions of the bill that will affect the availability and future use of pesticides.

1. All pesticides will come under one of two groups – those for general use or those for restricted use. Those in the general use category include pesticides that are not considered dangerous to human beings or the environment. Those in the restricted category are highly toxic to man or the environment and are to be used only by or under the immediate supervision of certified applicators. A pesticide may be on the restricted list for some labeled uses but not for others.

   The applicators themselves will be divided into two groups: commercial and private. Farmers will comprise the majority of the private applicators. These private applicators are not subject to record keeping requirements.

2. All pesticide formulations will be registered with the federal government whether they are intended either for intrastate or interstate use. States may assist EPA in the registration of a pesticide use within their own geographical boundaries.

3. The registration of pesticides will depend on the benefit-risk ratio on the basis of their intended use.

4. Criminal penalties of up to $25,000 and up to a year imprisonment is provided for companies and their responsible officials.

   The civil penalties section provides a maximum fine of $5,000 against a company (including pest control operators) and up to $1,000 against a farmer who has ignored a warning that he was engaging in a prohibited use. No appeal is provided in the bill at present.

5. The bill still carries a provision that would prohibit the importation of any agricultural commodities from a country that does not have equal restrictions with respect to the use of pesticides as are enforced in this country. This restriction applies only to commodities produced in substantial quantities within the continental U.S. Thus it would not apply to such items as bananas and coffee.

6. An advisory committee, named on recommendation by the National Academy of Sciences, may be requested by an applicant to pass judgment on issues involved when the EPA has turned down the applicant. Thus a complete, independent scientific review of the proposed registration appears feasible.

7. Federal restricted pesticides are not to be placed on any "general use" basis by any state. The state has the authority to further restrict all classes of pesticides.

8. Indemnities are authorized for those who have pesticides left on hand if and when the EPA administrator should issue a cancellation of registration. The owner of such banned products would be reimbursed for the fair market value of the pesticides.

9. Instead of a "notice of cancellation," as in the past, there would be a scientific review followed by an "intent to cancel" if advisable. A "notice of suspension" is still possible where there is an imminent hazard to the public.

10. The President has the authority to exempt federal agencies from being covered by this bill if he deems emergency conditions exist where it is in the public interest to use pesticides irrespective of restrictions set forth in the law.

11. There is authorization for states to certify pesticide applicators if their plan meets federal approval as to the responsible agency, legal authority, adequate funds for administration, assurance of a report to Federal authority, and assurance that the certifications conform to federal standards. Four years is allowed for certification after passage of the bill. Thus the major impact of this bill will not be felt until about 4 years after the bill becomes law.

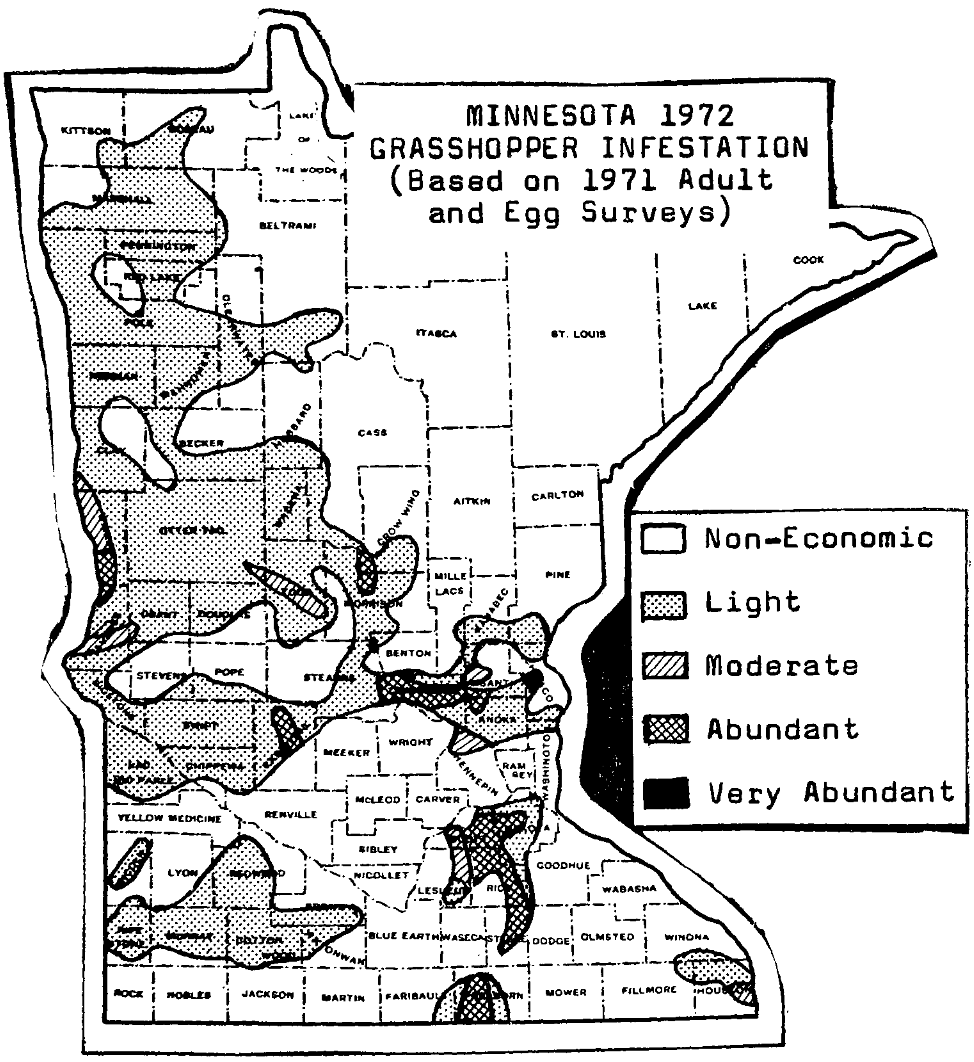
12. The bill makes it unlawful to use pesticides in any other fashion than so labeled.

13. The registration and reclassification of previously registered pesticides is to be completed in 2 to 4 years.

If and when this bill is passed, it will be a compromise bill for all agencies involved. One of the current problems appears to be a lack of communication with pertinent environmental groups or regulatory agencies. The details of the wording also appears to be a major concern.

GRASSHOPPER OUTLOOK AND CEREAL LEAF BEETLE SITUATION

Hart P. Graeber, Assistant State Supervisor, Minnesota-Wisconsin
USDA, APHS, Plant Protection [1]



GRASSHOPPER OUTLOOK - MINNESOTA

The areas of economic populations of eight or more grasshoppers per square yard in 1971 were substantially the same as in the past four years. Populations in 1971 were down, however, to levels comparable to the 1969 season. An estimated 252,000 acres of forage crops had economic populations in 1971. This was a decrease from 1970 of about 153,000 acres. Crop damage was generally light.

[1] Plant Protection was formerly a Division in the Agricultural Research Service. Effective 10/31/71, it became a part of the newly-created Animal and Plant Health Service.

In October, an egg survey, confined to fields that had economic populations during the adult survey, showed that 56% had grasshopper eggs present. An average of 0.64 egg pods per square foot was found in these fields.

The predominant species throughout Minnesota continues to be the red-legged grasshopper. The two-striped and differential grasshoppers were predominant in only a few scattered fields. The migratory, packard, and other grasshopper species were present in many fields but were of minor importance.

The outlook for the 1972 season as indicated by the grasshopper infestation map shows that moderate to very abundant infestations lie in small areas of east central, central, west central, and south central Minnesota. Small areas can also be found in south east counties. Infestations in 1972 are expected to be dispersed throughout these areas. Alfalfa and other forage crops will be the primary host crops. Field margins and roadsides will have added importance as sources of infestations of cropland. Light infestation areas indicated on the map will have widely-scattered problems in some fields. Weather conditions at the critical time of egg hatch and early nymphal growths could modify this outlook.

CEREAL LEAF BEETLE SITUATION

The cereal leaf beetle, Oulema melanopus, a relatively new and destructive insect to the North American continent, continues to increase in number and infest larger areas of the United States and Canada. It was first found and identified in two south western Michigan counties in 1962. That same year it was also found in two adjacent Indiana counties.

Since the cereal leaf beetle was found in Michigan and Indiana, annual surveys have shown a steady increase in the area infested. This spread has been most rapid to the north, east, and south from the center of the infestation. However, movement to the west has occurred and has crossed the state of Illinois to the Missouri border. Cereal leaf beetle larvae were also found from one field of oats in south eastern Wisconsin this past June.

This insect is one of the most serious pests of small grains in Europe and parts of Asia. It has a history of causing severe damage to small grains in the Old World dating back to 1831. Infestations in much of the area in the United States are very light, with economic infestations found only in scattered fields in Michigan, Ohio, and northern Indiana. Surveys have been conducted in states surrounding the infested area each year since 1963. All surveys in Minnesota have been negative for cereal leaf beetle.

The adult beetle is 3/16 of an inch long. The wing covers, underside of the abdomen, and head are metallic blue in color. The legs and front segment of the thorax are reddish-orange. The beetle overwinters as an adult. It will be found in straw and corn stubble, in grasses, fence rows and woodlots, under rubbish, and other protected.sites. The adults leave winter hibernation in Michigan generally early in April and begin feeding on native grasses and winter grains. They are strong fliers and are very active on warm sunny days. During cool, cloudy weather, they are very inactive and will be found hiding in clumps of grass.

Mating begins soon after emergence. Egg-laying begins about one week after adult emergence, and may continue for a period of two months. The eggs are laid singly on the leaves of grain and grasses. Each female can lay 100 to 150 eggs. The eggs will hatch in seven to ten days. Both the larvae and adults feed on the leaves of grains and grasses by eating longitudinal strips from the leaf blades.

The larvae are similar in shape to the Colorado potato beetle larvae, but are smaller and lighter in color. They are usually covered by a globule of black fecal matter that obscures its coloration except for the head and legs. The larvae feed for twelve to twenty days, and then pupate in the soil. Adults emerge in late June and early July. These summer adults go into a resting stage soon after emergence and remain quite inactive for the remainder of the summer.

Our objectives in the cereal leaf beetle program are to: (1) delay spread to major grain-producing areas of the United States (2) intensify the release of parasites.

Aerial applications of malathion spray in the past near the Illinois-Indiana border, cultural practices and overwintering conditions in Illinois, wind direction patterns and enforcement of quarantines appear to be factors which have slowed the westward movement of this beetle. Small grains, hay, straw, sod, harvesting equipment, and christmas trees are some of the commodities affected by the quarantine program.

The delay of westward movement of this pest has allowed research to progress further toward developing resistant varieties and parasite rearing and release techniques before the major small grain-producing areas of the country have become infested.

The pubescent character of certain wheat varieties has enabled scientists to make some progress towards developing commercially-acceptable resistant wheat.

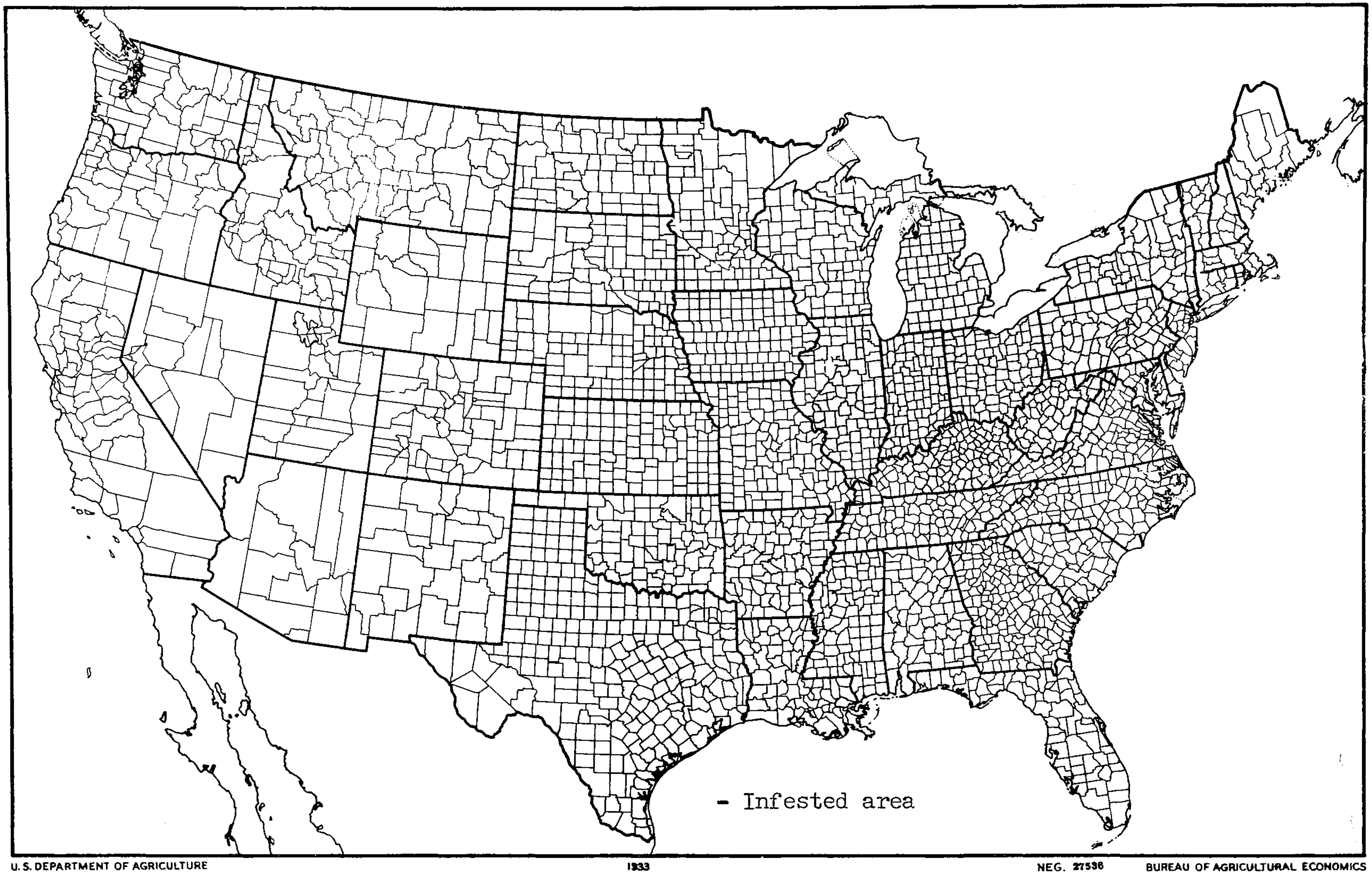
The information shown in the table at the end of the test indicates that we have progressed in the ability to produce cereal leaf beetle parasites. The releases in 1971 involved three species of larval parasites and one egg parasite.

In order to assure cereal leaf beetle populations that are adequate to support parasites in certain infested locations, insectories are being established where no pesticides will be used. Choice hosts are maintained throughout the feeding season and overwintering sites are available. This insectory program has been started in Ohio, Illinois and Indiana. In addition, two areas exist in Michigan where numerous parasites are being maintained for testing and release programs.

Table 1. Estimated numbers of egg and larval parasites of the cereal leaf beetle released in 1971

State	Parasites	
	Egg	Larval
Illinois	4,640	-
Indiana	13,920	45,822
Kentucky	52,840	-
Michigan	22,380	117,049
New York	18,650	7,220
Ohio	324,800	33,621
Pennsylvania	153,120	-
West Virginia	100,020	4,157

CEREAL LEAF BEETLE - 1962-1971



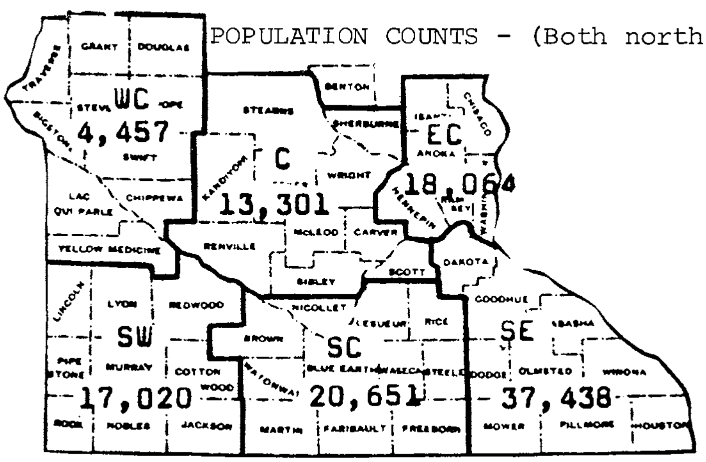
CORN ROOTWORM AND EUROPEAN CORN BORER SITUATION

John A. Lofgren, Extension Entomologist,
Dept. of Entomology, Fisheries, and Wildlife
University of Minnesota

ADULT CORN ROOTWORM SURVEY - 1971
(Division of Plant Industry, Minn. Dept. of Agr.)

During August a total of 54 counties in the principal corn growing areas of Minnesota were surveyed to determine the corn rootworm situation. The survey showed that populations of corn rootworms declined in all survey districts except the east central. Although lower numbers were found this year, damage to corn was still serious in some areas.

POPULATION COUNTS - (Both northern & western species)



AVERAGE NUMBER OF BEETLES PER ACRE

Southwest District - Population counts declined in 7 counties and increased in two counties. Counts averaged 17,020 beetles per acre in this district, a decrease of 45% over 1970. Lyon County had the highest populations in the southwest.

South Central District - Seven counties had population declines and 4 had increases. Counts averaged 20,651 beetles per acre, a decrease of 53% over 1970. Watonwan County had the highest populations in this district.

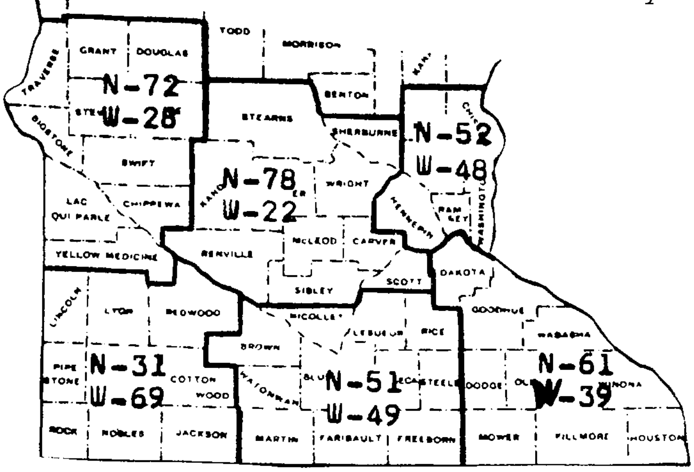
Southeast District - Populations declined in 7 counties and increased in two. Counts averaged 37,438 beetles per acre, a decrease of 65% over 1970. This district had the highest populations again this year. Winona County had the highest populations in the southeast.

West Central District - Eight counties had population declines and two increases. Counts averaged 4,457 beetles per acre. a decrease of 28% over last year. Stevens County had the highest populations.

Central District - All 10 counties had population declines. Counts averaged 13,301 beetles per acre. a decrease of 35% over 1970. Scott County had the highest counts in this district.

East Central District - Three counties had population increases and 2 had decreases. Counts averaged 18,064 beetles per acre, an increase of 55% over last year. Hennepin County had the highest populations in this district.

The following map shows the percentage of Northern and Western corn rootworm beetles in each surveyed district.



N - Northern Corn Rootworm
W - Western Corn Rootworm

CROPPING HISTORY AND ROOTWORM POPULATIONS

Corn rootworm problems are closely related to the cropping history of a field. During the survey we again recorded the cropping history (last 2 years) of all the fields surveyed. The fields were divided into two classifications: (1) First year corn; (2) Corn grown 2 or more years. By relating the number of beetles counted to the cropping history of the fields, we found that 96.71% of the beetles were in fields that had been in corn 2 or more years. Only 3.29% of the beetles counted were in first year corn fields. This indicates rather strongly again that corn rootworm problems in Minnesota are in fields where corn follows corn.

The following table shows the relationship of cropping history to corn rootworm populations for the last 3 years:

Dist.	Percentage 1st year corn			Percentage - 2 or more years corn			Population (Average no. beetles per acre)		
	1969	1970	1971	1969	1970	1971	1969	1970	1971
SW	36	33	44	64	67	56	21,421	37,969	17,020
SC	42	33	38	58	67	62	14,921	39,319	20,651
SE	30	16	16	70	84	84	39,145	57,873	37,438
WC	32	40	46	68	60	54	3,746	15,751	4,457
C	20	18	18	80	82	82	7,258	38,162	13,301
EC	15	24	8	85	76	92	755	9,868	18,064

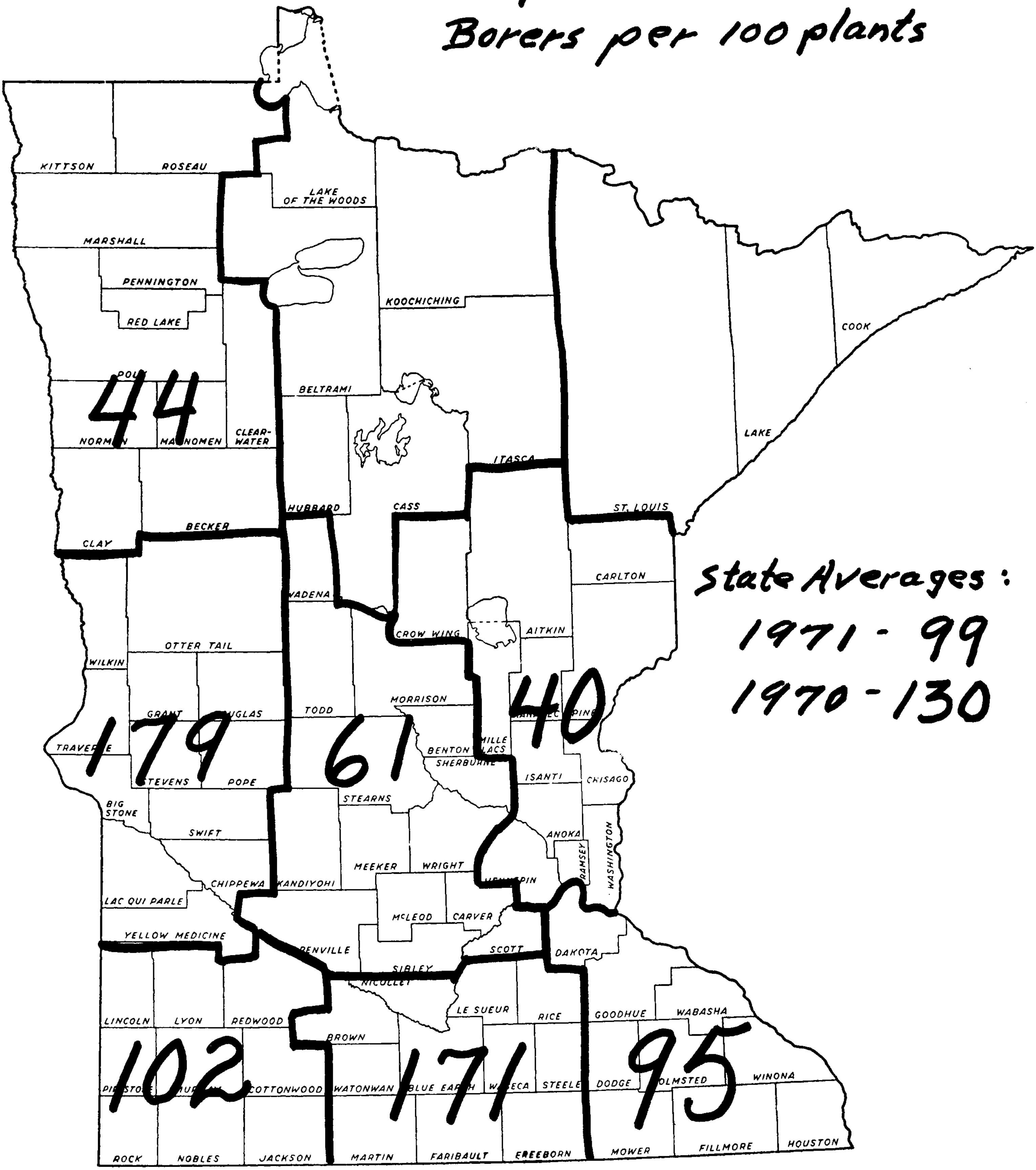
Lodging due to corn rootworm damage varied greatly again this year, ranging from 0-100%. The percent lodged plants increased in two districts as the table below indicates.

District	Average Percent Lodged	
	1970	1971
SW	2.11	1.13
SC	9.81	1.40
SE	7.43	16.50
WC	2.78	0.30
C	4.96	1.3
EC	2.44	9.88

1971 OUTLOOK

Although populations declined generally in the State in 1971, we still will have enough in some districts to cause problems in 1972. This would be especially true in the SE and SC Districts and to a lesser extent in the SW & EC Districts. Past experience has shown that fields planted to corn for two or more years are most likely to have corn rootworm problems. On that basis, almost any field with such a cropping history could have rootworm problems next year regardless of what district it may be in. Farmers should evaluate their own fields based on 1971 populations locally and by district.

European Corn Borer - 1971
Borers per 100 plants



State Averages:
1971 - 99
1970 - 130

Corn Rootworm Control Trials
Southern Expt. Sta.
University of Minnesota
Waseca, Minnesota
1971
Wm Lueschen, cooperator

Planted May 7, 1971, treatments applied in 7 inch band with planter attachment
Funks G 4444
Cultivation Treatments applied June 25, 1971 at base of plants.
Roots Rated August 4, 1971

Treatment - Rate actual toxicant per acre		Average root rating (0-5)	Yield Bu/A.
Carbofuran Furadan 10G	2 lb.	1.06	94.1
carbofuran Furadan 10G	3/4 lb.	1.25	104.4
carbofuran Furadan 10G	1 Cult. (6/25)	1.50	84.8
phorate Thimet 15G	1	1.75	94.1
Dyfonate 10G	1	1.81	92.3
Dyfonate 20G	1	1.81	86.0
Dasanit 15G	1	1.81	83.7
Mocap 10G	1	1.88	94.0
Mocap 15G	1	1.94	85.5
Bux 10G	1	2.00	88.2
Mocap 15G	1/2	2.25	89.6
Mocap 10G	1/2	2.25	94.8
Diazinon 14G	1	2.25	87.9
Dyfonate 10G	1 Cult. (6/25)	2.38	86.8
Chlordane Belt Plus 33 1/3 G	1	2.88	83.6
Check		2.75	86.1

European Corn Borer Control '71

1. Whorl treatments, Waseca
   (Wm Lueschen & Mark Windels)

Treatment	"shotholed"	Av. Borers/Plant	Tunnels/Plant	Yield
Carbaryl (Sevin 10G)	87%	0.65	1.20	92.0
(1 lb. act. ingred.)				
Diazinon 14G	89%	0.37	0.62	83.3
(1 lb. act. ingred.)				
Check	96%	1.30	2.90	72.4

2. Whorl treatments, Lamberton
   (D. Rasmussen)

Treatment	Av. Borers/Plant	Yield
Carbofuran (Furadan 10G)	0.30	98.6
(2 lb. act. ingred.)		
Diazinon 14G	0.60	100.8
(1½ lb. act. ingred.)		
Trichlorfon (Dylox 5G)	1.20	95.6
(1½ lb. act. ingred.)		
Trichlorfon (Dylox 5G Bait)	1.25	99.0
(1½ lb. act. ingred.)		
Check	4.65	82.7

3. Carbofuran (Furadan) applied as soil treatment at planting time (May 5-7)

A. Preplant broadcast application, Lamberton

Treatment	% "shotholed"	Borers per plant	Empty cavities per plant
Furadan 10G 20 lb./A	100	3.0	2.5
(2 lb. act. ingred.)			
Check	100	2.8	0.0

B. Row treatment, Lamberton (7" band) at planting time.

Treatment	% "shotholed"	Borers per plant	Empty cavities per plant
Furadan 10G 20 lb./A	98	2.5	1.5
(2 lb. act. ingred.)			
Check	99	4.7	1.2

C. Row treatment, Waseca (7" band) at planting time.

Treatment	% "shotholed"	Borers per plant	Empty cavities per plant
Furadan 10G 20 lb/A	76	1.5	1.5
(2 lb. act. ingred.)			
Check	64	1.3	1.9

Rootworm Control for 1972

1. Rotate

2. Where corn must follow corn, sorghum or sorghum - sudan apply one of the following in a 7-inch band at planting time with a planter attachment.

		Amount per Acre (40' rows)	
		Formulation	Active Ingred.
Bux	10G	10 lb.	1 lb.
carbofuran (Furadan)	10G	7½	3/4
Dasanit	15G	6½	1
diazinon*	14G	7-14	1-2
Dyfonate	10G	10	1
//	20G	5	1
Prophos (Mocap)	10G	10	1
" (Jolt)	15G	6½	1
phorate (Thimet)	15G	6½	1

* For planting dates after May 15 or for basal treatment in June

Liquid formulations of some compounds for use with liquid starter fertilizer solutions are available. If such products are used, they should be applied in a split band nad placed on both sides of the seed.

Some compounds are registered for post emergence, basal applications after the larvae hatch in June. In general, these applications have not been as effective as the planting time treatments.

WEED CONTROL FOR CORN

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With proper selection and use of chemicals supplemented with optimum row width, planting date, population and cultivations, it is possible to control most weeds in corn. About four-fifths of Minnesota's corn acreage is treated annually with herbicides. More than one-third of the treated acreage receives both preemergence and postemergence applications.

To select the proper chemical for a particular field, you must understand the capabilities and limitations of each herbicide. Some chemicals control most grasses and broadleafs. Others control primarily grasses, while some usually control just broadleafs. Then consider for each field the kinds of weeds present, the soil organic matter content and texture, safety to the crop and whether soil residues may be a problem for subsequent crops. The best answer may be one herbicide or it may be a mixture of herbicides or a sequence of herbicide treatments combined with cultural practices. Tolerant species may build up into major problems if you rely completely on one herbicide.

Of the chemicals now in use, butylate (Sutan), alachlor (Lasso) and propachlor (Ramrod) are primarily annual grass control chemicals, although they will frequently give pigweed and some lambsquarters control. Prynachlor (Basamaize) is a new chemical similar to alachlor and propachlor that may be cleared in the future for annual grass control in corn.

Butylate must be disked into the soil immediately after application as a preplanting treatment. Either butylate or alachlor disked in preplanting has effectively controlled nutsedge, a weed which other herbicides have not controlled. For annual weed control, alachlor has given better control if applied preemergence and left on the soil surface rather than incorporated into the soil. Propachlor is more soluble than alachlor and we have observed that propachlor often performs better than alachlor under marginal rainfall conditions, but alachlor works better than propachlor on sandy soils.

Atrazine (AAtrex), linuron (Lorox), chlorbromuron (Maloran), SD-15418 (Bladex) and cyprazine (Outfox) control both grasses and broadleafs, but are somewhat more consistent on the broad-leafed weeds than on grasses.

Atrazine may be applied preplanting, preemergence or postemergence. Crabgrass, witchgrass and panicum are tolerant to atrazine and have developed into problems in some fields where atrazine has been used repeatedly. Atrazine is the best chemical for controlling quackgrass. Soil residues of atrazine may carry over and be a problem on crops grown the following year. Atrazine residue has been more of a problem on soils with high pH and following dry or cool seasons. Small grains are more susceptible than soybeans, but soybean injury has occurred, especially in southwestern Minnesota. Addition of special petroleum or vegetable oils to atrazine has improved postemergence weed control. Various formulations of detergents and surfactants used with atrazine have not improved weed control as much as the use of oils.

Linuron and chlorbromuron work better on low than on high organic matter soils and are better on broadleafs than on grasses. Generally, their use should be limited to soils with less than 4 percent organic matter.

SD-15418 and cyprazine are triazine chemicals that control both annual grasses and broadleafs, but do not control perennial weeds. Pigweed has shown some tolerance to SD-15418. Neither chemical carries over in the soil to affect subsequent crops when used as directed. Both chemicals have crop tolerances approved and will probably be labeled for use in 1972. SD-15418 should be applied preemergence and left on the soil surface. Cyprazine is applied early postemergence when weeds are less than 1 1/2 inches tall.

Dicamba and 2,4-D applied postemergence control only broad-leafed weeds. Precautions should be taken in timing and rate of applications and placement of sprays to reduce corn injury. Drift can be minimized by reducing sprayer pressure, increasing water volumes with larger nozzles, using drop nozzles and avoiding spraying under windy or high temperature conditions.

Several mixtures of chemicals are approved for use in corn. Generally, the mixtures include a chemical that is better on grasses with one that is better on broadleafs. These mixtures offer the potential for controlling more kinds of weeds, getting more consistent performance with different soil and weather conditions, reducing soil residues and reducing crop injury.

For detailed information on herbicides for corn, get Extension Folder 212, Cultural and Chemical Weed Control in Field Crops, 1972, which will be available after January 1 from County Extension Agents or from the Bulletin Room, Coffey Hall, Institute of Agriculture, University of Minnesota, St. Paul, Minnesota 55101.

BROADLEAF WEED CONTROL IN SOYBEANS[1/][2/]

R.N. Andersen[3/], D.D. Warnes[4/], W.E. Lueschen[5/], and W.W. Nelson[6/]

We evaluated a new herbicide, 3-isopropyl-2,1,3-benzo-thiadiazinone-(4),-2, 2-dioxide (BAS 3512-H) as an early postemergence treatment in soybeans. Studies were conducted at the University of Minnesota Experiment Stations at Waseca, Morris, Lamberton, and Rosemount, and in a farm field near Waseca.

Applications of BAS 3512-H of 3/4 lb/A resulted in 95 to 100% control of young plants of wild common sunflower, common cocklebur, velvetleaf, wild mustard, common ragweed, Pennsylvania smartweed, and common lambsquarters. Pigweed (Amaranthus spp.) exhibited considerable tolerance to BAS 3512-H. Weed grasses were not controlled by BAS 3512-H.

Soybeans, treated in various stages from the unifoliolate stage up to the second trifoliolate leaf stage, appeared to be very tolerant and in most instances showed little or no effect even from 3 lb/A of BAS 3512-H, the highest rate used. However, as this is written, we have not yet obtained yield data from all of our studies.

BAS 3512-H has shown excellent potential in our studies for the control of broadleaf weeds, some of which are not consistently controlled by currently available practices. Whether or not it will become available for use cannot be predicted at this time. Commercial use can be possible only after additional studies, such as we are conducting, and if safety to people and the environment is established.

1/ This is a report on the current status of research involving use of certain chemicals that require registration under the Federal Insecticide, Fungicide, and Rodenticide Act. It does not contain recommendations for the use of such chemicals, nor does it imply that the uses discussed have been registered. All uses of these chemicals must be registered by the appropriate State and Federal agencies before they can be recommended.

2/ Cooperative investigations of the Plant Science Research Division, Agricultural Research Service, U.S. Department of Agriculture, and the Minnesota Agricultural Experiment Station.

3/ Plant Physiologist, Plant Science Research Divison, Agricultural Research Service, U.S. Department of Agriculture, Department of Agronomy and Plant Genetics, University of Minnesota, St. Paul.

4/ Agronomist, University of Minnesota, West Central Experiment Station, Morris.

5/ Agronomist, University of Minnesota, Southern Experiment Station, Waseca.

6/ Superintendent, University of Minnesota, Southwestern Experiment Station, Lamberton.

Biographical sketch for "Broadleaf Weed Control in Soybeans"

Dr. Andersen, who will make the presentation, is employed by the U.S. Department of Agriculture and works on soybean weed control in cooperation with the Minnesota Agricultural Experiment Station at St. Paul. Dr. Warnes is Agronomist at the University's West Central Experiment Station at Morris. Dr. Lueschen is Agronomist at the University's Southern Experiment Station at Waseca. Dr. Nelson is Superintendent of the University's Southwestern Experiment Station at Lamberton.

MIXING AGRICULTURAL CHEMICALS

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There is considerable interest in tank-mixing agricultural chemicals and applying these at one time. This practice would save time, money, and labor and would reduce the number of trips across the field. Two questions often asked about tank-mixing are: "Are spray tank mixes legal?" and "Are spray tank mixes practical?"

Agricultural pesticides (herbicides, insecticides, fungicides) must be registered, and the safety and residue aspects must be checked by the federal Environmental Protection Agency (EPA). Registering mixtures of previously "cleared" pesticides was fairly easy in the past. Now a set of data on all facets of the mixture is required as though the mixture was a completely new pesticide.

The following is quoted from IR-4 Newsletter No. 3, September 11, 1970, Rutgers University:

> To quote the governing regulations here would require too much space, but we summarize the salient points. Also see PR Notice 69-8, April 21, 1969, USDA-PRD.
>
> Related pesticide chemicals are not necessarily related chemically but are considered related when they cause additive pharmacological effects in test animals. Each pesticide combination will be considered on its own. Absence of additive pharmacological effects must be proven. One reason for using combinations is to obtain additive or synergistic biological activity toward pest organisms, and it is a reason to suspect additive pharmacological effects in man or animals. In any event it must be proven that any combination used will not result in illegal residues in or on food or feed. In many instances the "proof" costs will be prohibitive.
>
> The toxicology and tolerance for a given pesticide may limit the percentage of its content in the combination. For the most part a low tolerance for any component in the combination will drastically limit or eliminate the use of the combination.
>
> Yes, the applications of pesticide combinations apply to tank mixes. The grower is much less likely to run into excessive pesticide residue difficulties if he avoids combinations wherever possible. Pesticide combinations can be used safely if the restrictions and limitations are understood, but excessive residues may be the rule rather than the exception.

Supposedly, if the label does not state how the pesticide can be applied in combination with fertilizer, then such a combination should not be used. However, farmers can still apply on-the-farm mixtures if the company does not register or label the combination.

The user assumes the responsibility that food and feed products are free of illegal residues.

Are tank mixes practical? Timing, placement, and distribution of each component of a tank mix must be checked to see if restrictive requirements are met. Some pesticides are to be placed on the surface while others require incorporation. Distribution requirements for fertilizers are not as exacting as for herbicides. Compromising one requirement may limit the usefulness and safety of the mixture.

What are some of the problems with tank-mixing? One of the biggest problems is failure of components to remain uniformly dispersed. Some of the causes are inadequate agitation, insufficient spray volume, or lack of a stable emulsifier. Wettable powders (WP's) and water-dispersible liquids (WDL's) require good agitation to keep them dispersed. Mechanical and hydraulic jet or sprayer agitation is better than by-pass agitation. Suspensions also require about 1 to 2 gallons of spray carrier per pound of product to maintain a good dispersion.

Some emulsifiable concentrates (EC's) may contain emulsifiers which are not saltstable in salty solutions such as fluid fertilizers. Some manufacturers have special pesticidal formulations (fertilizer grade) for liquid fertilizer application, while others specify that you check emulsion stability and if needed that you add a compatibility agent such as Compex or Sponto 168. These compatibility agents are usually added at the rate of 1 to 3 pints per 100 gallons of spray volume.

Mixing procedures can also make a difference between a satisfactory blend and a "gunky" mess. Never put a pesticide in an empty tank. Always partially fill the tank before adding the pesticide. Wettable powders should be mixed with water to form a slurry before they are added to a spray tank unless you have an inductor system. Emulsifiable concentrates should be preemulsified in water before they are added to a fluid fertilizer. Wettable powders should be added before emulsifiable concentrates. Use special fertilizer formulations of EC's when available. If there is a compatibility agent such as Compex to be added, it should be added before the pesticides.

CHECKING COMPATIBILITY

It is best to think small and check compatibility in quart jars before mixing tankfuls. You must first determine the spray volume to be used per acre, and this will depend upon the analysis and amount of nutrients desired with liquid fertilizers. Also determine the rate of the chemicals to be applied in volume or weight of product. Then convert quarts and pounds per acre to amounts per pint of spray. Milliliters (ml) and grams (g) may be unfamiliar measurements, but are very useful small units when calculating and working with small amounts. One pint is 473 milliliters and one pound is 454 grams. Then 1 pound per 25 gallons = 2.2 grams per pint, and 1 quart per 25 gallons = 4.7 milliliters per pint. If gram scales and pipettes are not available for using gram and milliliter units, then approximations can be made with measuring spoons. One teaspoon is approximately 5 milliliters of liquid. Wettable powders differ in density, but weights can be approximated by volume. One level teaspoon of wettable powder is approximately 2 to 3 grams. Thus 1 quart of EC and 1 pound of WP to be added to 25 gallons of spray would be approximately 1 teaspoon per pint of each component.

Testing Procedure

1. Calculate spray volume per acre and volume or weight of pesticide.

2. Place 1 pint of carrier in each of two quart jars.

3. Add 1/3 teaspoon of compatibility agent (3 pints per 100 gallons) to one jar and mark "A," adjuvant added. Mark the other jar "B."

4. Add the proper amount of each pesticide to each jar in the proper sequence (note above on mixing procedure).

5. Close the jars and shake or invert to mix.

6. Observe the mixtures at once and again after 30 minutes.

Comparing jar"B" with jar "A" will determine the value of adding a compatibility agent. If materials remain suspended or if they are easily resuspended, mixing is possible with good agitation. If they separate, precipitate, or form "gunk," check jar "A" to see if adding a compatibility agent will solve the problem. If so, you may want to repeat the test using varying amounts of compatibility agent to determine the optimum amount needed.

Wild Oat Control in Wheat and Barley

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Wild oat is the most serious weed problem in many small grain fields in northwestern Minnesota. This was particularly evident during 1971. An annual weed with growth habits similar to small grain, wild oat will normally mature before the small grain crop and a large percentage of the wild oat seed will shatter and fall to the ground before harvest.

Wild oat seed in the soil may germinate and grow right along with the small grain crop after planting or may germinate and emerge unevenly over a six week period depending on soil moisture and temperature conditions. When wild oats emerge over an extended period of time as they did in 1971, control is more difficult.

Both cultural and chemical control methods are needed when small grain fields become infested with wild oats. Cultural control methods of crop rotation and early spring tillage can be used to encourage the wild oat seed to germinate and grow when it can be effectively destroyed by subsequent tillage. However, delayed seeding of small grain made necessary by such tillage is often not desirable. Two herbicides are suggested in Minnesota for wild oat control in wheat or barley.

Triallate (Far-go) is available for preplant or preemergence use with immediate soil incorporation. Barban (Carbyne) can be used as an early postemergence application after the crop and weeds have emerged and does not require soil incorporation. To be effective, however, barban must be applied in the 2-leaf stage of the wild oats from 4 to 10 days after emergence. Wheat is more sensitive to injury from barban than is barley. To reduce crop injury, barban should not be applied after wheat or barley is in the 4-leaf stage or more than 14 days after crop emergence.

In 1971, wild oat control with herbicides was erratic in some fields because dry weather delayed germination of both crop and weeds. Herbicide applications could not be applied safely in many cases because the wild oat seed germinated too late in the season. Thin stands of small grain due to poor germination in some fields did not provide enough crop competition for effective wild oat control.

On fields badly infested with wild oats in 1971, consider the following cultural practices for 1972. 1) Delay seeding and plant an adapted late season crop after repeated tillage to kill wild oats. 2) Summer fallow with repeated tillage to kill wild oats. 3) Seed small grain early, immediately after spring plowing or after late fall plowing; use a heavier seeding rate and commercial fertilizer to provide more crop competition. 4) Barley is more competitive with wild oats than is wheat 5) Harrow or use rod weeder on infested small grain stands as soon as the crop is sprouted to reduce wild oat population.6) Harvest crop as hay or silage before wild oats mature. New chemicals and new concepts of wild oat control are currently being developed. Two experimental herbicides show promise for late postemergence (emergency) use in barley or wheat. Granular formulations of triallate (Avadex BW) were effective in wheat or barley (Table 1). These new chemicals and formulations when available for use, will provide more flexibility for wild oat control.

Table 2. Wild oat control and yields of wheat and barley with use of selected herbicides at two locations in Minnesota, 1971.

Type of Application	Herbicide	Rate lb/A	Crookston[1/] Wild oat plants/ft^2	Crookston[1/] Wheat bu/A	Crookston[1/] Barley bu/A	Stephen[2/] Wheat bu/A	Stephen[2/] Barley bu/A
Preemergence, incorporated	Triallate (Fargo EC)	1.0	3.1	37.6	61.3	43.1	75.6
	Triallate (Avadex BW, 10G)	1.25	3.4	35.4	62.0	41.0	75.9
	Triallate (Avadex BW, 10G)	2.50	3.3	38.9	61.0	40.8	77.0
	Untreated check	-	28.0	20.5	41.4	31.0	80.1
Early postemergence (2 leaf stage of wild oats)	Triallate (Avadex BW, 10G)	1.25	2.9	36.7	69.0	45.6	73.6
	Triallate (Avadex BW, 10G)	1.75	1.4	39.6	70.3	48.5	75.9
	Triallate (Avadex BW, 10G)	3.50	0.6	40.9	70.6	48.7	78.1
	Barban (Carbyne)	3/8	17.9	28.0	53.9	39.4	80.7
	Untreated check	-	26.3	22.3	49.7	35.6	77.1
Late postemergence (4-5 leaf stage of wild oats)	Triallate (Avadex BW 10G)	1.25	1.0	36.0	63.8	34.4	74.0
	Triallate (Avadex BW 10G)	1.75	0.8	34.0	64.7	33.6	70.6
	Triallate (Avadex BW 10G)	3.50	0.3	28.3	65.0	25.6	64.9
	Barban (Carbyne)	3/8	13.9	28.1	54.6	34.5	82.0
	Untreated check	-	27.3	23.5	51.0	33.5	81.3
	LSD (.05)			8.3	9.9	7.4	NS

1/ Agricultural Experiment Station, Crookston, The wild oat counts are an average of the stands in wheat and barley. The stand of wild oats were very uniform over the entire experimental area.

2/ Bruce Hamness farm, Stephen. The wild oat counts averaged 14 plants/square foot in wheat check plots. There was essentially no wild oats in the barley. Wild oat control was excellent from all treatments in wheat except barban did not give effective control.

HERBICIDE COMBINATIONS FOR WEED CONTROL IN SUGARBEETS - 1971

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EPTC (Eptam), cycloate (Ro-Neet), diallate (Avadex), EPTC + diallate, cycloate + diallate, and TCA + diallate were applied as preplant incorporated treatments and TCA was applied as a preemergence treatment at Casselton, North Dakota and Crookston, Minnesota in 1971. Phenmedipham (Betanal) and pyrazon + dalapon (Pyramin Plus) were applied postemergence as individual treatments and also following all preemergence and preplant incorporated treatments. Visual ratings of percent weed control and percent sugarbeet retardation were taken.

No individual herbicide gave sufficiently good broad spectrum weed control. TCA did not perform well in 1971 because of lack of rain following application. Diallate controlled wild oats effectively but did not control other weeds. EPTC and cycloate controlled most grassy and broadleaf weeds but were weak on wild mustard and were poorer than diallate for wild oat control. Phenmedipham and pyrazon + dalapon controlled both grasses and broadleaves to some extent but both were more effective when following a preemergence or preplant incorporated treatment. Preemergence or preplant incorporated herbicides used alone averaged 53 percent redroot pigweed control and 72 percent wild oat control. Postemergence herbicides used alone averaged 58 percent redroot pigweed control and 40 percent wild oat control but when the preemergence or preplant incorporated herbicides were followed by a postemergence herbicide, control of redroot pigweed increased to 83 percent and wild oat control increased to 91 percent.

Sugarbeet injury as well as weed control increased with the use of herbicide combinations. Preemergence or preplant incorporated herbicides used alone averaged 1 percent injury, postemergence herbicides averaged 4 percent injury, and preemergence or preplant incorporated herbicides followed by postemergence herbicides averaged 21 percent injury. The visual rating of injury given the sugarbeets does not always indicate yield loss because sugarbeets have a large capacity to recover from early season injury. In 1971, yield reductions occurred only when the stand of sugarbeets was reduced so that an adequate population could not be maintained after thinning. Yield reductions in test plots occurred only at one location where the preemergence and preplant incorporated herbicides had slightly stunted the sugarbeets and the temperature on the day of postemergence application went over 80° F.

When postemergence herbicides are applied following preemergence or preplant incorporated herbicides, certain precautions can be taken to minimize chances of injury. The herbicide rates can be kept toward the low end of the recommended range of rates, temperature on the day of postemergence application should not exceed 80° F, postemergence application can be made in late afternoon or early evening rather than in the morning, and sugarbeets should be allowed to grow out of any injury from the preemergence or preplant incorporated herbicides before the postemergence herbicides are applied.

POISONOUS PLANTS

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Plants are pesky when they poison or injure man or animals. Often such plants are weeds, and they become prominent by man's disturbance of nature. By intelligent husbandry of crops and livestock, numbers of pesky plants that pollute the biological environment can be reduced to manageable levels if not eliminated. There are some 700 species listed by Kingsbury that are poisonous. Some are weeds, some ornamental and woody plants and some are house plants. Certain plant families contain an unusual number of poisonous plants, but this does not warrant stating that some plant families are poisonous and others not. Poisonous plants might be classified by the poisonous substance involved; this often brings unrelated plants together. Or plants might be classified by the type of symptoms produced in man or animals. Then again plants might not even be poisonous but may be armed with barbs, prickles, spines, or stinging hairs that enable them to wound animals and effect secondary infection.

PLANT FAMILIES

Ferns and Horsetails

Bracken fern (*Pteridium aquilinum*) and horsetails (*Equisetum* spp.) are poisonous in all their plant parts. They contain thiaminase and other unknown toxins, which are not affected by drying or storage although the toxicity may be lost with age.

Bracken fern is the most frequently encountered poisonous fern. It is a cumulative poison, taking from one to three months to develop in animals depending on the amount eaten, the time of year, and the condition of the animal. It is sometimes hard to convince a farmer that the plant is poisonous, because symptoms can appear two or more weeks after the animal is removed from the fern-infested area. Poisoning occurs mainly in late summer and early fall, especially after drouth in spring or summer.

If present in hay, bracken can be toxic. Cases of poisoning have occurred in winter from feeding fern-contaminated hay or from using fern-infested hay as bedding material. Both leaves and underground stems contain toxin, and the toxin concentration can vary with the season. Two toxic principles are involved. One is thiaminase, an enzyme that breaks down thiamine (vitamin B complex). This factor is toxic to horses, partially to sheep, and apparently not to cattle. The second toxic principle causes aplastic anemia, which depresses the function of bone marrow in cattle.

Buttercup Family

The sap of many buttercups is poisonous and contains protoanemonin which is unstable to drying. Plants may cause dermatitis in man and intestinal inflammation in animals. Hay containing buttercups is not dangerous. Larkspurs, pasque flower, and the tall field buttercup have been reported poisonous.

Mustard Family

Plants usually are not considered poisonous, but seeds containing mustard oil glycosides are poisonous. Feeds may contain seeds of mustards.

Spurge Family

All species contain resinous, blister-producing milky juice. They are irritant drastic purges, so all species are potentially hazardous.

Nearly 40 species of spurges (Euphorbia spp.) occur in northeastern United States and Canada. The most common ones are weedy annual or perennial herbs. Some are grown as ornamentals.

Castor beans (Ricinus communis), also in this family, are poisonous. The constituents in the seeds are proteins that induce allergic reaction in man. From two to four seeds can seriously poison a man, and eight are usually fatal if the seeds are eaten. Castor bean meal fed to animals can still be poisonous even when heated. Meal with toxin removed has caused growth retardation in chicks, so several principles may be involved.

Milkweed Family

Like the spurges, milkweeds contain milky juice that is an irritant to animals. Two groups have been identified: narrow-leaved and broad-leaved milkweeds. Probably most of all species are toxic although this has not been established with certainty. In the Pacific northwest, some poisoning has occurred from feeding livestock hay containing milkweed. Sheep, cattle, horses, and fowl have been poisoned.

Nightshade Family

In this family are plants counted among the most useful to man as well as those that are deadly, mainly because of the alkaloids in them. Belladonna, henbane, and Jimson weed contain powerful alkaloids. All species of Solanum should be regarded as potentially dangerous. A wide range of species have been incriminated as poisonous to man and animals.

Black nightshade (Solanum nigrum) contains a glycoalkaloid in all its parts, and is poisonous to man and animals but is rarely fatal. Bitter nightshade (S. dulcamara) contains an irritant that causes inflammation of the stomach lining and breaks down red blood cells.

SYMPTOMS IN ANIMALS

Plant poisons may affect the nervous system, digestive system, or circulatory system. They may cause lesions on the skin or in the linings of the throat, stomach, and intestines. Symptoms may be complex enough that a veterinarian is needed to diagnose poisoning in animals and a physician to diagnose it in man.

Cyanide Poisoning

Plants can contain cyanide-generating glycosides which yield prussic acid (HCN) on digestion. Young, rapidly growing plants have more cyanide than older plants. The content of these glycosides in plants can be increased by heavy nitrate fertilization, by wilting of plants, by trampling of plants, and by plant diseases. Freezing does not ordinarily increase the glycoside content of these plants, but it does tend to increase the amount of free HCN, resulting in a temporary increase in toxicity of the plants.

Spraying cyanide-producing plants with 2,4-D, 2,4,5-T, and MCP apparently increases cyanide toxicity of the plants. Some cyanide-producing plants are: chokecherry (Prunus virginiana), pin cherry (P. pensylvanica), wild black cherry (P. serotina), arrow grass (Triglochin sp.) Johnson grass (Sorghum halepense), sudan grass, and sorghum.

Photosensitivity

An animal may become hypersensitive to light because of a photodynamic agent in plants eaten by animals. This is not sunburn, in which lightly pigmented skin of animals becomes inflamed by exposure to ultraviolet light. In photosensitization, active rays are absorbed by the agent in plants eaten by animals. Such plants are: St. Johns wort (Hypericum sp.), buckwheat (Fagopyrum esculentum), species of clovers and alfalfa, and water bloom (Blue-green algae). Rape (Brassica napus) causes photosensitization when plants are young. Sheep and cattle are animals mainly affected but other animals may become sensitized.

Gastroenteritis

Symptoms of gastroenteritis in which diarrhea and vomiting occur can be caused by pollen in the respiratory tract as well as by ingestion of certain food plants. Mustard oils present in charlock, (Brassica kaber), wormseed mustard (Erysimum cheiranthoides), wild radish (Raphanus raphanistrum), and stinkweed (Thlaspi arvense) can cause symptoms of gastroenteritis in livestock.

Allergy of Respiratory Tract

Man and animals, especially dogs, can be affected by hayfever. Pollen of both common and giant ragweed, pigweed (Amaranthus), Russian thistle (Salsola pestifer), and prairie sage (Artemisia gnaphalodes) causes hayfever.

Mechanical Injury

Some plants are fiercely armed with stout or slender spines or hooked prickles which puncture or cut skin of man or animals, creating open wounds that lead to microbial infection. Some, such as the stinging nettle, not only puncture skin but inject poison into the flesh to further irritate the victims. Plants coated with hairs can when eaten by animals form "hair balls" in the digestive tracts, for example, the pasque flower. Wild barley (Hordeum jubatum), downy brome (Bromus tectorum), and yellow foxtail (Setaria lutescens) have barbed flower parts which frequently cause sores in mouths and lips of grazing animals. Brambles (Rubus spp.) become lodged in nasal passages of large animals and inflict nuisance injuries to man in his occasional excursions in nature. Cockleburs, sandburs, burdock, and prickly ash are notorious for their lacerative effect on man hunting, camping, or vacationing in picnic areas.

POISONOUS SUBSTANCES

Poisonous plants and fungi contain chemicals toxic to living cells. Most of these poisons are alkaloids or glycosides. Resinous substances and volatile oils can also be toxic. Alkaloids are complex chemical substances and are found widely in the plant kingdom. Some are poisonous only if taken in large quantities, but they may be medicinal in small quantities.

Poisons may be concentrated in only certain organs of plants; others may be present in roots, stems, leaves, fruit, or seeds. The amount of poison may vary from plant to plant and with the season, habitat, weather, and soil. With mushrooms the amount of poison may vary with the plant's age. The health and age of the person or animal and the amount eaten may determine whether toxicity occurs. Heating, boiling, or drying may alter or destroy poison in plants. Animals may avoid eating poisonous plants because of their odor or taste, but this is not always so.

Alkaloids

These are present in about 5 to 10 percent of plant species and are especially common in the legume and amaryllis families. Some common alkaloids and plants in which they are found are: tropane (Jimson weed, henbane), pyrrolizidine (crotalaria, viper's bugloss, groundsel), pyridine (poison hemlock, Indian tobacco), isoquinoline (Dutchman's breeches, bloodroot), indole (ergot in grains and grasses), quinolizidine (lupines), and steroid alkaloids (nightshades, death camas).

Polypeptides and Amines

These poisons are present in blue-green algae of water bloom, in such poisonous mushrooms as *Amanita*, and in ergot of grains and grasses.

Glycosides

These toxins are more widely distributed in the plant kingdom than alkaloids are. Some are cyanogenetic glycosides, described earlier under cyanide poisoning, and occur in plants of the rose family. Others are cardiac glycosides and occur in plants of the dogbane, figwort, and lily families.

Irritant Oils

Many of these occur in seeds of the mustard family. Species of *Brassica* and *Erysimum* contain well-known irritants to the digestive tract. There is some evidence too that mustard plants are poisonous to grazing animals.

Oxalates

These substances in plants are toxic to most animals except to ruminants, which are at least less affected by them. Sorrel (*Oxalis* spp.), docks (*Rumex* spp.), and lambsquarters (*Chenopodium*) are examples of oxalate-bearing weeds. Oxalate-producing fungi may grow in moldy forage and raise oxalate content of that forage to toxic concentrations.

Resins

These comprise a group of complex compounds, some of which are not known chemically. Resins irritate nerve or muscle tissue of man and animals. Examples of plants producing resins include: milkweed (Asclepias), marihuana (Cannabis sativa), water hemlock (Cicuta spp.), and rhododendron.

Phytotoxins (Toxalbumins)

These substances are proteins of high toxicity similar to bacterial toxins in structure and in their physiological effect. Castor bean (Ricinus communis) and black locust (Robinia pseudoacacia) are two common examples of plants containing phytotoxins.

Nitrate-Nitrite

Nitrates may be produced in plants in amounts high enough to be toxic. Some of such plants are crops (corn, sorghum, oat hay) and some are weeds of the pigweed, goosefoot, mustard, nightshade, and sunflower families. Whenever such plants are eaten in quantity, abortion can occur. Sometimes the application of herbicides increases nitrate content of these weeds.

SEASONAL TOXICITY

Spring

Water hemlock (Cicuta sp.) is toxic to all animals and man and is especially a problem in spring when habitats are wet and when plants pull easily from mud. Also less pasture is available to grazing animals at that time so water hemlock is often eaten. Pokeweed found in clearings, pastures, and waste places is more dangerous in spring to cattle and swine. Cocklebur, found in waste places mainly, contains a hydroquinone in seed leaves of the plant; thus only seedlings are toxic to animals, especially swine.

Spring-Summer

Because of lack of good pasture in spring and early summer, grazing animals often forage in clearings or wooded areas where perennial plants have already made substantial growth. Bracken fern, chokecherries, and buckeye, present in woods and thickets, have young succulent shoots and new leaves that attract animals when grass is scarce. As pastures become available, there is less frequent occurrence of poisoning from these plants.

Summer

Cattle and sheep can be poisoned by white snakeroot (Eupatorium rugosum), which contains tremetol and causes milk sickness in cattle and sickness in man on consumption of the milk. Nightshades and nettles contain glycoalkaloids in leaves, shoots, and berries and grow in waste places as well as in grain and hay fields; they affect all animals. Johnson grass is a weed of open fields and waste places and is toxic to all grazing animals.

Spring-Summer-Fall

Crotalaria and Jimson weed are examples of plants that are toxic throughout the growing season and occur in fields and roadsides. The alkaloids in crotalaria are cumulative and occur in all parts of the plant, especially the seeds. Poison ivy is poisonous to man throughout the season; leaves, stems, and berries contain the toxins that produce blisters. They may even be toxic in winter. Sometimes poison ivy stems and roots have been grubbed out of the ground in the fall and burned in the winter when danger of fire to other vegetation is low. Persons standing in the smoke may become covered with the irritant oils that cling to particles of smoke. Here it is possible to become severely blistered in winter from poison ivy.

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Effect of Atrazine Additives on Weed Control in Corn.

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The use of petroleum oil additives has consistently improved the performance of early postemergence applications of atrazine on corn. There has been considerable interest in the use of vegetable oils, surfactants and combinations of oils and surfactants as atrazine adjuvants. In 1970, four petroleum oils, three vegetable oils, two combination oils and four surfactants were evaluated near Rosemount, Minnesota, using two rates of additives with two rates of atrazine applied as an early postemergence spray on corn. In 1971, most of the same additives, with two additional products, were evaluated near Waseca and Lamberton at the same two rates of atrazine but with an additional rate of additive in order to determine more precisely the optimum rate of additive needed. Rates of additive used in 1971 were 1 quart, 2 quarts, and 4 quarts of the oil and 1/4 quart, 1/2 quart, and 1 quart of the surfactants. Lower than normal field rates of atrazine were used (3/4 lb and 1 1/2 lb/A) in order to detect differences in weed control due to the additive.

Experimental design at all locations was a randomized complete block with three replications. Plots were two 30 in. rows wide and 30 feet long. Two untreated check rows were left adjacent to each plot for observation purposes. Herbicide sprays were applied when grass weeds were in the 2-3 leaf stage in 1970. Grass weeds had progressed to the 4-5 leaf stage at both locations in 1971 due to rain and wet soil conditions. Sprays were applied at 23 gpa in 1970 and at 17 gpa in 1971. Plots were not cultivated. Rainfall was more favorable for chemical activation in 1970 than in 1971.

Percent weed control and injury index ratings were made 7 to 10 days after application at all locations. There was no visible corn injury from any of the treatments at any location. Weed yields were harvested in 1970, about six weeks after herbicide application. Weed yields were harvested at both locations in 1971 about one month after herbicides were applied. Predominant weed species at all three locations were green foxtail (Setaria viridis) and yellow foxtail (Setaria glauca). Scattered redroot pigweed (Amaranthus retroflexus) were also present. (Grass weeds made up 84 percent of the total weed weight at Waseca).

Weed yields were greater in 1971 than in 1970. The low rate of atrazine was not effective in controlling weeds in 1971. The additional rate of additive used in 1971 did not result in different weed control than the other additive rates used. Therefore, only the low and high rate of the additive is reported (Table 1).

All additives improved weed control as compared to atrazine alone. There was little difference in performance among the various oil additives when averaged over both years at the three locations. Although differences were not significant in 1971, due to considerable variation in weed yields, the high rate of the additive caused somewhat better weed control than did the low rate. Oils as a group tended to be more effective than surfactants as a group, with the exception of one surfactant which performed as well as many of the oils.

Table 1. Effect of additives on early postemergence weed control in corn with atrazine (1½ lb atrazine/A).

Additive	Rate of additive qts/A	Dry weed yields-lb/A 1970 Rosemount	1971 Waseca	1971 Lamberton	3-location average
Petroleum oil					
Sun 11E 1/	1	544	470	991	668
	4	395	252	650	432
Amoco 2/	1	720	413	723	619
	4	352	233	407	331
Vegetable oil					
Linseed 3/	1	524	1151	765	813
	4	240	918	790	649
Soybean 3/	1	656	553	1114	774
	4	224	851	506	527
Sunflower 3/	1	640	704	599	648
	4	352	365	454	390
Bio Veg 4/	1	-	895	1307	-
	4	-	1551	1184	-
Concentrates					
Agri-oil plus 5/	1	499	748	1309	852
	4	368	429	1049	615
Amoco conc. 2/	1	-	748	1314	-
	4	-	560	729	-
Surfactants					
Surfol 6/	¼	609	822	906	779
	1	512	960	765	746
Bestline LC 7/	¼	803	1276	1049	1043
	1	753	1148	1281	1061
L.O.C. 8/	¼	912	1027	1853	1264
	1	801	992	1420	1071
No Adjuvant	-	1120	1327	2285	1577
	-	961	1471	1990	1474
LSD (.05)		198	733	896	609
Untreated check		2438	2756	2945	2713

1/ Sunoco Oil Company, Marcus Hook, Pennsylvania.
2/ American Oil Company, Chicago, Illinois.
3/ Crude soybean, linseed and sunflower oil with 5 % TH-AO_2 emulsifier added. Minnesota Linseed Oil Company and Thompson-Hayward Chemical Company, Minneapolis.
4/ Barzen of Minneapolis.
5/ Gordon Corporation, Kansas City, Kansas.
6/ Castle Chemical Company, Savage, Minnesota.
7/ Bestline Products, San Jose, California.
8/ Amway Corporation, Ada, Michigan.

WEED CONTROL FOR SOYBEANS

Gerald R. Miller[1/]

Herbicides are playing an increasing role in soybean weed control in Minnesota. Two-thirds of Minnesota's 3 1/2 million acres of soybeans are treated with herbicides. But optimum row spacing, plant population, planting date and timely cultivations are still important inputs for obtaining maximum weed control and top yields. And last summer you could even see the "man and his hoe" still toiling up and down the soybean rows. Usually he was after problem broad-leaved weeds or volunteer corn.

To guide the farmer in getting effective weed control from chemicals, you, the dealer or custom applicator, must know the characteristics of each herbicide well enough to pick the chemical or combination of chemicals that will control the specific kinds of weeds that are in a particular field of a certain soil type. Some herbicides are highly effective against certain weeds but useless against others. Some weeds are tolerant to all soybean herbicides.

You should consider soil texture and organic matter content in selecting a soybean herbicide. Some herbicides may cause severe soybean injury on sandy soils or soils with low organic matter. The rates of most herbicides must be adjusted for soil type.

The chemicals trifluralin (Treflan) or vernolate (Vernam) applied preplanting and disked in have effectively controlled annual grasses but have usually controlled only pigweeds and lambsquarters of the broadleafs. Alachlor (Lasso) applied preemergence has also been effective primarily against annual grasses and pigweeds.

Chloramben (Amiben), fluorodiphen (Preforan) and linuron (Lorox) are broader spectrum herbicides that control annual grasses and several broad-leaved species. Linuron works best on soils with less than four percent organic matter. Fluorodiphen liquid formulation has performed well as a preemergence treatment, but the granular formulation did not give satisfactory results in 1971. Chloramben is a good grass killer, controls many broadleafs and is adapted to a wide range of soils. Usually the 3 lb/A acid equivalent rate should be used.

Several chemicals control only one or a few weed species. Preemergence chlorpropham (Chloro IPC) is effective against annual smartweeds and gives some wild mustard control. Dinoseb (DNBP) applied preemergence or as a very early postemergence "cracking stage" treatment usually controls only wild mustard. Postemergence 2,4-DB controls only cocklebur. Chloroxuron (Tenoran) applied early postemergence usually gives good control of wild mustard and fair control of common lambsquarters, wild sunflower and cocklebur.

Some weeds are almost impossible to satisfactorily control in soybeans. These problem weeds include the perennials such as quackgrass and Canada thistle and annual broadleafs such as cocklebur, wild sunflower, venice mallow, giant ragweed and velvetleaf. Generally the best approach to handling these problem

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weeds is to grow corn, small grains or forages until the weeds are brought under control. Some growers are having success controlling Canada thistle by treating with 1 lb/A of 2,4-D in May when thistle growth is 6 to 10 inches tall, then waiting two to three weeks to plant soybeans.

Using mixtures of preemergence chemicals or sequential treatments of preplanting, preemergence and postemergence chemicals is proving to be a sound approach to getting improved weed control with chemicals. Following preplanting applications of trifluralin with preemergence chloramben or linuron has resulted in good control of both grasses and broadleafs. Several preemergence mixtures are now labelled for use and offer the possibility of broader spectrum weed control, improved crop safety and more consistent performance with varying soil and weather conditions. These mixtures include alachlor with linuron, chlorpropham, or dinoseb. The mixture of naptalam and chlorpropham (Solo) has given fair broadleaf control but poor grass control and serious soybean injury has sometimes occurred. Study the characteristics of the individual components of mixtures before selecting one for a specific field situation. Then check labels for clearance and observe field performance before committing yourself to a mixture.

For detailed information on soybean herbicides, get Extension Folder 212, Cultural and Chemical Weed Control in Field Crops, 1972, which will be available January 1 from County Extension Agents or the Bulletin Room, Coffey Hall, Institute of Agriculture, University of Minnesota, St. Paul, Minnesota 55101.

PESTICIDE APPLICATION AND BEE KILLS - THE ROLE OF EXTENSION

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The function of the extension service is educational. The materials prepared by extension and the information given are as objective as they can be made.

As extension entomologists we provide information that can be used by beekeepers, canners, aerial applicators and growers alike. Among these kinds of educational materials are:

I. Insecticide recommendations.

II. Information about proper and safe chemical use.

III. Information on real or potential environmental damage.

IV. Information on residues - both in products and in bees.

V. Cost evaluations.

Insecticide recommendations are made with all relevant factors in mind.

I. Insecticides must do greatest good with least harm.

A. In our present discussion DDT was the best compound form from the standpoint of all parties for insect control.

B. Replacement compounds, of which Sevin is the primary one, are less suitable for the following reasons.

1. Early in the game it was difficult to handle (mix, etc.)

2. More applications required.

3. Highly toxic to bees.

Among the points to be considered in our present discussion are the following:

I. Public is demanding even cleaner food than we are now producing and the National Canners' Association has been very wise (in a political sense) in going along with this. Thus, insecticides will be even more essential, and yet we will have to retain margins of safety.

A. It goes without saying that food production is still absolutely essential.

B. Where corn and peas are grown in Minnesota their value greatly exceeds that of honey, beeswax and pollination.

Parenthetically, we feel it unwise to place additional beekeepers in areas where high potential for bee injury exists.

II. Some considerations involved in the present problem.

A. Bee kills have occurred on peas, corn, cucumbers, and now on sunflowers.

1. In case of cucumbers and sunflowers, kills will reduce pollination as well as injure bees directly.

2. Kills are not entirely predictable.

B. Molasses has been blamed for kill. Experimental information from New York, Wisconsin and Minnesota tends to cast doubt on this.

C. In the case of corn, and probably peas, we face a dilemma.

1. Canning companies cannot have insects in the pack, so they must spray.

2. Acceptable sprays are all moderately to highly toxic to bees.

3. Need for rapid and inexpensive application dictates need for aircraft.

4. Methodology of application places insecticide where bees are quite vulnerable.

III. An indemnity mechanism is presently available to compensate for bee kills.

A. Aerial applicator might take this to mean he is no longer responsible.

B. Likewise beekeepers may be less careful in placing their bees.

Neither A nor B is particularly palatable to me.

IV. Thus it appears we can do the following things:

A. Do everything we can to let neighbors know what we are doing. Communication.

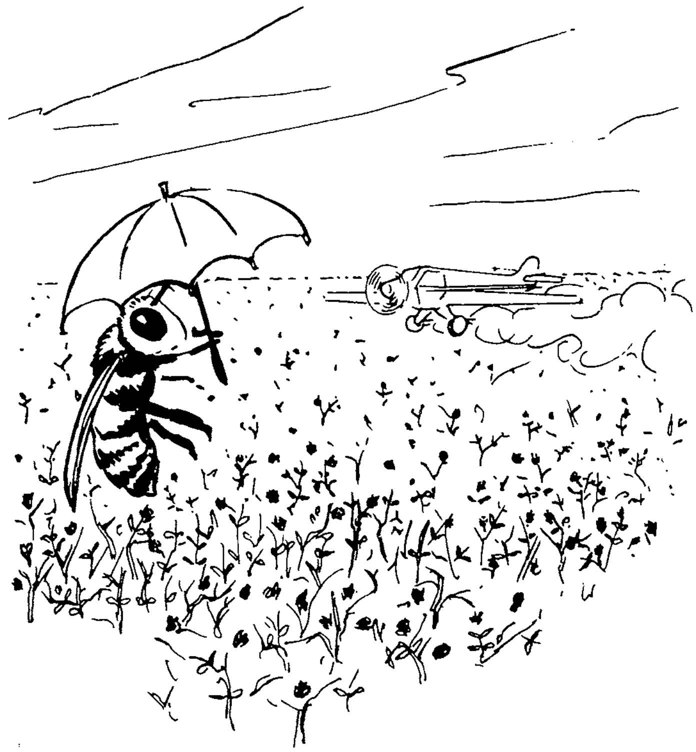
B. Be as careful and responsible in our work as we can.

Agricultural Extension Service • University of Minnesota

FACT SHEET

ENTOMOLOGY NO. 44–1971
DAVID M. NOETZEL

Protecting honey bees from insecticides



Honey bee managers, prior to World War II, were subjected to the initial bee losses in the chemical attack on agricultural pest insects. For example, early grasshopper control programs using a combination of bran, molasses, and sodium arsenate produced severe bee kills in some areas. Other arsenicals used on such diverse crops as apples and cotton also contributed to honey bee kills.

Following World War II, chlorinated hydrocarbon insecticides came into widespread use. Although records of honey bee losses were not kept either prior to or during this period, there did appear to have been less honey bee poisoning. Yet, it was observed quite early that this chemical family left toxic and somewhat persistent residues on the treated products. Subsequently, new groups of insecticidal chemicals, such as phosphates and carbamates, began to replace DDT and its relatives. However, some of these new insecticides were more hazardous to the honey bee than the hydrocarbons. With this increased honey bee hazard, it is even more necessary that we have both increased knowledge about the chemicals and increased care in their use.

Various federal and state research workers have provided excellent information on toxicity to honey bees of all commonly used insecticides. The summary list that follows is taken from a review article by Anderson and Atkins in the 1968 Annual Review of Entomology.

When using this list, keep in mind that toxicity is a relative quality. For example, relatively nontoxic materials may produce bee kills if sprayed directly on the bees. On the other hand, a compound in the highly toxic group, if used as recommended, rarely harms bees.

A single star by an insecticide name indicates it is on the Minnesota restricted use list. You are unlikely to encounter these anymore. Two stars indicate the compound has a very short residual life and only will be hazardous when applied to bees in flight.

Malathion, with three stars, is very toxic to bees when applied in its concentrated (ULV) form. It is considerably less hazardous when used as a diluted spray. This general difference in toxicity is true for all concentrated sprays.

Insecticides highly toxic to honey bees

Aldrin*
Arsenicals
Azinphosmethyl (Guthion)
Benzene hexachloride*
Carbaryl (Sevin)
Dasanit
Diazinon (Spectracide)
Dichlorvos (DDVP, Vapona)
Dieldrin*
Dursban
EPN
Fenthion (Baygon, Baytex)
Gardona (Rabon)
Heptachlor*
Imidan
Lindane *
Malathion***
Methyl parathion
Methomyl (Lannate)
Mevinphos (Phosdrin)**
Naled (Dibrom)**
Parathion
Phosphamidon (Dimecron)
TEPP**
Zectran

Insecticides moderately toxic to honey bees:

Abate
Carbophenothion (Trithion)
Chlordane
Crotoxyphos (Ciodrin)
Coumaphos (Co-Ral)
DDT*
Demeton (Systox)
Disulfoton (Di-Syston)
Endosulfan (Thiodan)
Endrin*
Oxydemetonmethyl (Meta-Systox-R)
Perthane
Phorate (Thimet)
Ronnel (Korlan)

Insecticides relatively nontoxic to honey bees:

Allethrin
Aramite
Bacillus thuringiensis (Thuricide, Biotrol)
Binapacryl (Morocide)
Chlorbeside (Mitox)
Chlorobenzilate (Acaraben)
Chloropropylate (Acaralate)
Dicofol (Kelthane)
Dimite (DMC)
Dioxathion (Delnav)
Ethion (Nialate)
Methoxychlor
Morestan
Nicotine
Omite
Ovex (Ovatran)
Pyrethrin

Insecticides relatively nontoxic to honey bees: (cont.)

Rotenone	Tetradifon (Tedion)
Sabadilla	Toxaphene
TDE (Rhothane, DDD)*	Trichlorfon (Dylox)

PRECAUTIONS FOR INSECTICIDE USERS

(1) Be sure use is justified

Use an insecticide only when it is economically justifiable. Most growers have generally followed this guideline, but when bees are foraging in or near the area to be treated, the value of the bees also must be considered. Vegetable, fruit, or seed crop yields can be reduced through pollinator reduction as a result of bee kill in neighboring fields. It is always wise to check the field to be treated for both harmful and beneficial insects before applying an insecticide.

(2) Select proper insecticide

Always use the insecticide safest for bees that will give the most economical insect control. Avoid using an insecticide hazardous to bees on any plant in bloom, including field or orchard flowering weeds.

(3) Apply in the safest manner possible

Use ground equipment for application whenever feasible. Avoid the use of dusts. Make applications when honey bees are in the hives, such as early morning or late evening. Do not make applications when excessive drift will occur.

(4) Communicate with beekeepers

The grower can anticipate most insect problems. Before insecticides need to be applied, contact the local beekeepers. If a grower shows an interest in the beekeepers' problems, a mutual working arrangement can be developed.

PRECAUTIONS FOR THE BEEKEEPER

(1) Record locations

Register your beeyards, with the State Department of Agriculture. In many cases of insecticide damage, unregistered yards have been involved. Also, there seems to be a tendency on the part of the beekeepers to hide beeyards. In either case, an applicator cannot be expected to avoid a yard he does not know about.

(2) Select safe locations

It is not sound judgment to place beeyards adjacent to areas heavily and routinely treated with insecticides. With modern mobility we do enjoy a somewhat wider latitude in selecting beeyard locations.

(3) Identify your colonies

It is relatively simple to post your name, address, and phone number in the beeyard. One should always be sure the farmer on whose land the hives are placed knows to whom the bees belong. Let the surrounding growers know that you have bees located nearby, especially when you know of a potential target crop. Always do this in a spirit of cooperation. Beekeepers know best that "honey catches more flies than vinegar."

(4) Cooperate with the insecticide user

The beekeeper should indicate a willingness to make any reasonable adjustment that will protect the bees. In some cases this may be done by covering the hives with wet burlap or moving the bees. Where there is a potential problem, particularly with a high value crop over a wide area, some county-wide planning may be necessary.

(5) Understand the insecticide indemnification law

The new Agricultural Act includes an amendment permitting federal idemnification for honey bee losses due to insecticides. This should in no way reduce the care both grower and beekeeper should follow in preventing honey bee poisoning.

On the other hand, to recover losses, the beekeeper will need adequate information to support damage claims. The best support is residue information from poisoned bees, although this is not required under the law as presently written. Firm documentation as to chemicals incriminated, crops treated, and harmful insects controlled will be necessary. In addition, long-term (5 years) yield data will be required to determine relative losses .

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Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Roland H. Abraham, Director of Agricultural Extension Service, University of Minnesota, St. Paul, Minnesota 55101.