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Prairie Vole Damage Control In No-Till Corn And Soybean

Ron A. Hines
University of Illinois

Introduction

The prairie vole *(Microtus ochragaster) is* the primary rodent that reduces no-till crop plant stands in Southern Illinois. Because the vole requires a full canopy cover for protection from predators, established grass or legume sod fields and field borders (including wheat or rye stubble, set-aside and cover crop seedings) provide an ideal habitat for the development of a very high population of this rodent. In fields that have had the vegetative cover maintained for more than one year prior to planting no-till corn, plant stand reductions can reach 80 to 100 percent in intense (more than 30 per acre) vole populated areas.

Some understanding of the prairie vole's habits, life cycle, habitat preferences, and identifiable characteristics are essential before we can design damage prevention measures for no-till corn.

The mature prairie vole is reddish brown to gray in color. It is larger than a house or field mouse but smaller than a rat. The ears of a vole are very small. Its torpedo shaped body is about four to five inches long. The tail of a prairie vole is one and one-half times as long as its hind foot.

High field populations can develop very rapidly. In ideal conditions, the vole's annual reproductive period is from March through October. Litters of three to eight -voles can be produced about every 21 days. The females mature in 35 to 40 days and start raising litters of their own. Population change from March to planting time in early May can be dramatic.

The actual number of litters and the litter size that is produced is closely associated with the amount of food that is available, and the population pressure (competition) for that food. The lush vegetation produced in the early spring and fall usually encourages rapid reproduction.

The average life span of a prairie vole is about 2 to 16 months. However, the mortality of some litters may be as high as 80 percent during the first month if food supply is short and predators are abundant. Vole populations usually peak every two years or so.

Prairie voles are active feeders day and night, the year around. They do not hibernate. Their favorite habitat is the dry ridge area of a rolling hill field that has a closed canopy of lush vegetation. At such locations, the voles will build a network of one- to two-inch wide above ground runways under the vegetative canopy. These runways connect to shallow mounded underground colonies (burrows). When they are actively in use, these mounded colonies usually represent

vole pair and its young. One colony can represent the home of many adults.

The active feeding range of an active vole colony can be as small as 10 to 15 feet from the active burrow if the food supply is abundant. However, the average feeding range of a colony is usually about one-fourth acre.

The favorite food of a prairie vole is probably high protein succulent legumes or grasses. Established stands of alfalfa, clovers and other legumes usually develop the highest vole populations. Undisturbed, established grass sod in the spring and fall also provide ideal food and habitat. Feed grains such as corn, wheat, etc., will be eaten if present, particularly if competition for other existing food is high. Seeds, underground tubers, insects and some animal remains are also used for food if needed.

Damage in no-till field corn usually occurs during the first 21 to 28 days after planting. The prairie vole will burrow or dig into the planter slot to eat the germinating seed and small seedling. Once the corn kernel is decayed, or the plant reaches 8 to 10 inches in height, the feeding damage usually stops.

. Scouting

Scouting fields and field borders to identify the prairie vole population at least 30 days prior to planting no-till corn is the first step to prevent losses by the rodent. This is usually mid to late March.

Look for active vole colonies and runways while scouting. Start scouting in field areas with good drainage and soil aeration. The dark green, high spots in a grass area usually signifies a colony. Urine and feces deposited close to the burrow opening usually gives the vegetation a dark green color. If a colony is found, inspect the opening to determine if it is actively in use. The presence of fresh clippings and/or fresh feces next to a slick, open hole is a sure sign of activity.

If at least five active vole colonies per acre are identified, damage prevention control measures should be planned. This guide is based on the reproductive potential of the prairie vole and the population per acre required at planting to signal the presence of an intense vole population.

Volt Danube Prevention

Predators. Natural predators of voles include: snakes, owls, coyotes, foxes, etc. Relying on natural predators for control of high populations of voles has not been found to be successful. Although natural predators help reduce the population, other control measures will be required if intense vole populations exist on the proposed planting site.

In the fall of 1989 the U.S. EPA withdrew the label clearance for the use of zinc phosphide treated bait on field corn for rodent control. Since this was the only labeled toxicant for that use, there are currently no labeled products available.

Research completed at the Dixon Springs Agricultural Center in the early 1970s had proven zinc phosphide treated bait to be very effective at preventing vole damage when applied in the furrow, even in the presence of an intense vole population (Table 1). However, there is no current label clearance for that use. Other uses of zinc phosphide treated baits in orchards and non-cropland areas are still labeled.

ell nt . Methiocarb (Mesurol) was investigated as a possible repellent for voles in field corn at the Dixon Springs Agricultural Center in the early 1970s (Table 1). Although it was shown to be as effective as the zinc phosphide bait, the product was never labeled for that use. As of December 1989, the label for the use of the product on field corn as a bird repellent was withdrawn by the company. Conversations with two of the product manufacturers indicate there are no current plans to develop a label for its use.

Other repellents have been advocated from time to time. However, there are no other repellents currently labeled to control voles in field corn.

,Alternative Feeding. The first 21 to 28 days after planting is the most critical time to prevent vole damage in a no-till field. Thus, if alternative feeding is to be effective, it must be:

- as attractive to the vole as the planted seed.
- applied prior to planting in order to let the voles become attracted to it, before they find the seed in the furrow.
- applied in a sufficient amount to feed the vole population for at least 21 days.
- applied effectively, so there is an even distribution across the vole populated areas of the field.

Feed grains such as shelled or cracked corn, wheat and oats are all possible alternative baits. The common recommendation in previous years had been to broadcast up to six bushels per acre of shelled corn. However, there has been little statistical data available to support this recommendation's effectiveness. Some farmers have also complained of obtaining volunteer corn that reduced their hybrid's performance when whole kernel shelled corn was used.

In 1990, research was conducted at the Dixon Springs Agricultural Center (DSAC) to investigate the use of cracked corn as an alternative bait to prevent prairie vole damage to no-till corn planted into established stands of legumes and grasses (Tables 2 and 3).

Shelled corn had gone through a roller mill (a grinder-mixer with the screen removed may also work) and was placed in a four ton double-fan dry fertilizer spreader for application. The buggy was calibrated to apply two and four bushels per acre on a 40-foot wide swath. (The test weight of the cracked corn was multiplied by 0.8 in order to determine the pounds per cubic foot setting for use with the bait.) The bait treatments were applied one day before planting. The trials were both planted at 26,000 seeds per acre in 30-inch rows. Lorsban 15G soil insecticide at 8.7 pounds per acre was applied in the furrow at planting. All seed was treated in the hopper with Agrox D-L Plus. The preemerge (PRE) pesticide treatment was applied immediately after planting to both trials. It consisted of Atrazine 4L @ 2 qt; Dual 8E @ 1 qt; Roundup 3AS @ 1 qt; 2,4-D

LV ester @ 1 pt; 28% UAN @ 1 qt; and Ambush 2E @ 6.4 oz. per acre.

Vole populations in both of the 1990 trials were estimated at over 100 voles per acre as a result of trapping done in the trial areas.

Although the four bushels per acre rate of cracked corn gave respectable yields, we were not able to keep seed damage under 40 percent. Of the 26,000 seeds per acre planting rate the intense prairie vole population resulted in almost a 90 percent stand reduction in the "no bait" treatments in each trial. Almost 70 percent damage was seen when only two bushels per acre of cracked corn was applied.

In 1991, this study was expanded to include six bushels of cracked corn, two bushels of winter wheat, a conventional tillage treatment and an early preplant (EPP) herbicide treatment. The pesticide treatments, seeding rates, and other procedures remained the same as were used in the 1990 trials (Tables 2 and 3). The field site was a tall fescue/smooth bromegrass mixture that had been established for several years.

Based on active vole colony counts taken in March in the 1991 trial area, the estimated average prairie vole population at planting was about 50 voles per acre. This was considerably less than what was encountered with the trials in 1990.

Even with the lower vole counts a 40 percent damage was sustained in the notill PRE treatment that received "no bait" (Table 4). All of the other no-till PRE treatments that did receive grain baits had less than 20 percent damage. The four bushels per acre of cracked corn treatment had less than five percent damage. There was no statistical difference between the "two bushels per acre" treatments of cracked corn or winter wheat.

In 1992, two bushels of whole kernel corn broadcast per acre was used as a treatment in the trials done on Taake Farms near Ullin Illinois (Tables 5 and 6). Stand counts indicated that this treatment may be as effective as four bushels of cracked corn in deterring vole damage. There was no statistical difference in the final plant stand or crop yield of these two treatments in comparison to each other, or in comparison to any other successful treatment in the two trials. The pesticide application that was used on all of the treatments at Taake Farms was as follows: 1 pt. Aatrex, 1 gal. Bullet, 1 qt. Gramoxone Extra, 4 oz. Pounce, Activator 90 @ 1 qt./100 gals., and 38F @ 8 oz./100 gals. All seed was treated with Agrox D-L Plus in the hopper box before planting.

This information indicates that alternative baits can be very effective when used to prevent prairie vole damage. However, good scouting of the prairie vole population is needed to determine the amount of alternative bait that needs to be applied. The four bushels per acre treatment was sufficient in the 1991 and 1992 trials. However, that treatment sustained 40 percent damage in the very intense vole pressure that was seen in the 1990 trials.

Use "weed free" bait! It is not recommended to use shelled corn from the bin if noxious weed seeds such as shattercane and Johnsongrass are present. All you do is reseed them on your fields. Small grain seed from the bin is probably safer than corn because you are

much less likely to find it contaminated with noxious weeds.

Cultural Control

Destroying the prairie vole's colony, cover and food supply by clean tilling or plowing before planting is a very effective way to control vole damage. Voles will not stay where they do not have food or cover.

This practice, however, has several disadvantages on highly erodible land and drouthy soils. Some disadvantages include:

- the benefits of erosion control are lost.
- the benefits of moisture conservation through mulch cover are lost.
- in sod, the natural allelopathic release from decaying sod may give reduced stands in *conventional tillage*.
- the cost of tillage increases the cost of production.

In the 1991 trial at DSAC (Table 4), the *conventional tillage* treatment with no bait had 25 percent damage. This damage was not due to voles. Spot *inspection of* the unemerged sprouts two weeks after planting indicated that they had decayed before they could emerge. Although not confirmed by laboratory analysis this was typical of an allelopathic reaction from sod decay. The sod had been moldboard plowed less than one day prior to planting.

The lack of vole damage in the conventional tillage treatment of the 1991 trial helps confirm that clean tillage is an effective vole control option. However, this option in most cases should not be used on highly erodible land if other effective control options can b= utilized.

Habitat Modification Without Tillage

Prairie voles basically live where they have adequate cover from predators and a sufficient supply of food. Changing the amount of cover or food that is available can be an effective way to control the vole population at a particular location.

However, you must recognize that habitat modification does not reduce the vole population. It simply forces it to move. This type of vole control used in the spring next to a developing small grain field or legume seeding could encourage serious damage to those crops. Good management and good planning is the key to safe and effective use of this control option.

In the 1975 trial at DSAC (Table 1), removing hay as a means of habitat *modification was* successfully used for vole damage control. The hay was removed just prior to planting the corn on the same day. Yet, no vole damage occurred to the planted corn where the hay had been removed. A 16.4 percent damage was found where the vegetation was not harvested before planting.

With bay removal, the potential for increase in soil erosion and the loss of moisture conserving mulch does occur. However, if the hay is needed, hay removal before planting no-till can be used as an effective and productive control for voles.

Another habitat modification technique that seems to be very effective is using early preplant (EPP) sprays to kill the vegetative cover about one month prior to *planting no-till*. This process removes the food supply of the vole for an adequate period of time to allow vole

migration to another food supply area. The 1991 trial at DSAC included the use of an EPP treatment (Table 4). This treatment produced the highest plant population of any of the treatments in the study. Only the 4 bu/A of cracked corn treatment produced comparable plant stands. The yield of the EPP treatment was also worth noting. It was statistically comparable to the highest yielding treatment in the trial. Because the vegetative cover on the EPP treatment was killed one month earlier than the PRE treatments, there was more subsoil moisture left in the soil for use during the growing season. Even with the statistically significant higher plant stand than the lower population PRE treatments, the EPP treatment was able to yield comparably in a drought year.

Final results of the 1992 trials on Taake Farms (Tables 5 and 6) also indicate that EPP treatments can be very effective in prairie vole damage control.

One other advantage of using EPP sprays vs PRE sprays is the potential to reduce the total quantity (if applied early enough, no "burn-down" herbicide is needed) of products used to control the vegetation. This can also result in a reduction of the total herbicide cost. Note: In the 1991 and 1992 trials, the EPP and PRE pesticide treatments were composed of the same products at the same rates in order to prevent herbicide treatments from causing potential additional error in the treatment comparisons. The EPP spray was applied in early April. The PRE sprays were applied after planting in early May. Both sprays provided excellent full season weed control. Consult your County Extension Specialist for a list of EPP treatments that work well in your area.

If you do not kill the voles when you use habitat modification with EPP herbicides, will they return to damage the next year's crop at the same site? Probably not, if EPP sprays are also used for the next crop. Work completed in 1991 (Tables 7 and 8) indicated no significant difference in the plant stand or yield of soybeans planted after vole damaged corn when EPP herbicides were applied for the soybeans. Additional work completed in 1992 (Table 9) further supports the 1991 trial results.

Low mowing is another "habitat modification" technique that can be effective. Keeping the field borders clipped low enough to discourage vole movement into your growing crop may pay big dividends. Low mowing in the late fall of the vegetation on the fields that you plan to plant the next spring Is also effective. This reduces the vole's cover and encourages predators to thin the vole population during the winter. When this practice is combined with EPP sprays, no other vole control should be required.

Conclusions

Of all the techniques currently available for prairie vole control in no-till corn, utilizing a combination of the "habitat modification" techniques may be the most effective, lowest cost, easiest to complete, and safest on the environment. Second in all of these categories would be the use of alternative baits such as corn or wheat.

The best control prescription may be:

- mow fields low in late fall if they are to be planted next spring.

check fields in late March for active vole colonies in order to determine the population potential.

if more than five active colonies per acre are found in late March, plan a control prevention program.

if no-till early preplant (EPP) herbicides are to be used, apply them about 30 days before planting.

scout again for active vole colonies about one week before planting. If few are found, plant when you are ready. If over five colonies per acre are still active, plan to apply an alternative bait.

apply the bait mixed with dry fertilizer (this saves a trip across the field) within two days prior to planting. Make sure the vegetation is dry when the bait is spread, so it can fall to the ground. Notice: Be sure to use "weed free" bait! plant the field no-till.

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Table 1. Vole damage as affected by treatments in no-till corn at DSAC' L. E. Beasley and G. E. McKibben, U. of 1.

Treatment	1973 Damage	1973 Yield	1974 Damage	1974 Yield	1975 Damage	1975 Yield
	(%)	(bu/A)	(%)	(bu/A)	(%)	(bu/A)
1) Control (no treatment)	56.7	-b	31.6	82.7	25.3	104.59
Zinc phosphide						
2) Broadcast	33.2	-b	16.9	91.9	-	-
3) In row	15.7	-o	4.4	114.9	0.4	122.20
Mesurol seed treaters (Chemagro)						
4) Slurry, 0.67)b/100 Ib seed	18.7	-b	2.8	110.3	0.0	117.40
5) HB`, 0.50 lb/100 lb seed					5.3	119.43
6) HB, 0.25 lb/100 lb seed					8.5	119.53
Mesurol seed treater (Hopkins)						
7) HB treaters @ 8 oz/bu (37.2 lb)					0.5	119.04
Hay removal trial						
8) Fescue and orchardgrass remaining					16.4	104.91
9) Removed					0.0	119.53

'Mouse damage calculated as percent of population of seed planted.
'Data not recorded.

Table 2. Prairie vole response to broadcast cracked corn in a dime year old mixed alfalfa/red clover sod planted to no-till corn at DSAC in 1990 using pree merge herbicides. R Nines

Treatment rate	Yield (bu/A)	Plant stand (/A)	Damage' (%)	Bait cost' ($/A)	Gross return` (S/A)	Bait use net return' ($/A)
No cracked corn	29.3 c	2323 c	91.1 c	-	67.39	-
2 bu/A	85.2 b	8422 b	67.7 b	5.00	195.96	123.57
4 bu/A	152.2 a	16359 a	7 3 a	10.00	350.06	272.67
L.S.D	28.6	3301	12.7			

0 0s

'Damage is calculated as a percent of the 26,000 seeds per acre that were planted. (Ex. 26,000 - 2323 = 23,677 = 26,000 = 91.1 %)
'The cost of the cracked corn used for bait was $2.50 per bushel.
`The "Gross returns" were figured by multiplying the treatment yield by $2.30 per bushel (the local market price on the day of harvest).
'The "Bait use net return" was figured by subtracting the cost of the bait and the "Gross return ($67.39) for the "no bait" treatment from the gross returns for the baited treatment.

Table 3. Prairie vole response to broadcast cracked corn in a 7-year old mixed tall ***fescue/smooth*** bromegrass sod planted to no-till corn using preemerge herbicides at DSAC in 1990. R Nines

Treatment rate	Yield (bu/A)	Plant stand (/A)	damage ege'___ (%)	Bait cost' ($/A)	Gross return` _ ($/A)	Bait use net return° (S/A)
No cracked corn	25.5 c	3098 c	88.1 c	-	58.65	-
2 bu/A	63.8 b	7018 b	73.1 b	5.00	146.74	83.09
4 bu/A	136.3 a	15101 a	41.9 a	10.00	313.49	244.84
L.S.D.005	26.5	3281	12.6			

'Damage is calculated as a percent of the 26,000 seeds per acre that were planted. (Ex. 26,000 - 3098 = 22,902 = 26,000 = 88.1%)
'The cost of the cracked corn used for bait was $2.50 per bushel.
`The "Gross returns" were figured by multiplying the treatment yield by $2.30 per bushel (the local market price on the day of harvest).
'The "Bait use net return" was figured by subtracting the cost of the bait and the "Gross return ($67.39) for the "no bait" treatment from the gross returns for the baited treatment.
Note: Data in the same column followed by the same letter are not significantly different at the LSD 0.05 level.

Table 4. Prairie vole response to non-pesticide baits and different cultural practices in a 10-year old caned tall fescue/smooth bromegrass sod planted to no-till corn in 1991. R 111Gnes

Treatment rate	Plant stand (/A)	Damage' (%)	Yield! (buVA)
No-till early preplant herbicides + No bait	25,652 a	1.3 a	115.00 ab
No-till preemerge herbicides + 4 bu/A of cracked corn	25,604 a	1.5 a	90.11 d
No-till preemerge herbicides + 6 bu/A of cracked corn	23,184 b	10.8 b	93.47 cd
No-till preemerge herbicides + 2 bu/A of cracked corn	22,942 b	11.8 b	124.76 a
No-till preemerge herbicides + 2 bu/A of soft red winter wheat	21,780 b	16.2 b	118.41 ab
Conventional tillage preemerge herbicides + No bait	19,505 c	25.0 c	110.66 abc
No-till preemerge herbicides + No bait (Check)	15.730 d	9.5 d	104.20 bcd
L.S.D. $_{0.05}$,	2,259	8.7	
18.83			

'Damage is calculated as a percent of the 26,000 seeds per acre that were planted. (Ex. 26,000 - 15,730 = 10270 + 26,000 = 39.5%)

"Yield was not affected by vole damage as much as it was by dry weather in 1991. The trial area only received 32 percent of the average precipitation in June, July and August (3.73 inches vs. 11.55 inches). The best indication of treatment effectiveness and yield potential is the "Plant stand" column in an average year.

Note: Data in the same column followed by the same letter are not significantly different at the LSD 0.05 level.

Pesticide vs. non-pesticide control of prairie vole damage in no-till corn planted in 1992 into established tall fescue sod that has not bee mowed during the last 12 months. R. Hines, U. of 1.

ıt rate	Active colonies'	Plant standb	Damage`	Volunteer plants °	Total plant stand'	C yi
__-	(/A)	(/A)	(%)	(/A)	(/A)	(b
P + No bait	39 a	23,426 a	6.0 a	0 c	23,426 a	18
E + 2 bu W.K. corn	42 a	22,458 ab	10.0 ab	629 b	23,087 ab	17
E + 5 lb ZP in furrow	42 a	21,974 ab	12.0 ab	0 c	21,974 ab	16
E + 4 bu C. corn	36 a	21,635 ab	13.0 ab	4162 a	25,797 a	17
RE + 2 bu C. corn	47 a	18,102 be	28.0 be	774 b	18,876 be	1
RE + No bait (check)	47a	16.795 c	33.0 c	0 C	16.795 c	
LSD 005	NS	4,409	18.0	525	4,195	

's of active prairie vole colonies as identified per acre in each treatment on March 27, 1992.
r of plants per acre developing from seeds planted on May 6, 1992, and counted at harvest (September 30, 1992). `Damage is calculated a of the 25,000 seeds per acre that was planted on May 6, 1992. (Ex. 25,000 - 23,426 = 1,574 + 25,000 = 6.0%) ° Number of plants count and determined not to be developing from seed planted on May 6, 1992. (Plants outside of the seed furrow.) `Total number of plants per at harvest (Planted + Volunteer = Total).

Data in the same column followed by the same letters are not significantly different at the LSD 0.05 level.

Pesticide vs. non-pesticide control of prairie vole damage in no-till corn planted in 1992 into established tall fescue sod that had been m
last year dung August. R. Hines, U. of 1.

t rate	olonies (/A)	Plant" st d (/A)	c Dama e °--- ( )	Volunteer plan stand' (/A)	Total plant (/A)	Co yie (b
E + 5 lb ZP n furrow	36 a	23,523 a	6.0 a	0 b	23,523 a	
E + 2 bu W.K. corn	23 a	23,159 a	7.0 a	3267 a	26,426 a	
P + No bait 42 a		22,796 a	9.0 a	0 b	22,796 a	
E + 4 bu C. corn	31 a	20,570 a	18.0 a	1839 ab	22,409 a	
E + 2 bu C. corn	39 a	18,537 a	26.0 a	871 6	19,409 b	
E + No bait (check)	27 a	12.487 6	0 0	0 b.	12-487 c	
.SD 005	NS	5,550	22.0	2249	5,614	

s of active prairie vole colonies as identified per acre in each treatment on March 27, 1992. "Number of plants per acre developing from see
on May 6, 1992, and counted at harvest (September 30, 1992 . `Damage is calculated as a percent of the 25,000 seeds per acre that was
on May 6, 1992. (Ex. 25,000 - 23,523 = 1,477 + 25 000 = 6.0%) d'"umber of plants counted at harvest and determined not to be developing
nted on May 6, 1992. (Plants outside of the seed furrow.) `Total number of plants per acre counted at harvest (Planted + Volunteer = Total)

a in .the same column followed by the same letters are not significantly different at the LSD 0.05 level.

Table 7. Second year soybeans after no-till corn damaged by voles in legume sod, 1991.

Treatment	Yield (Bu/A)	Plant 2Qpulabon (Plants/A)	% of planted (Stand/A)
EPP + No bait	35.5 a	156,332 a	89.7 a
EPP + 2 bu CC	36.1 a	- 145,200 a	83.3 a
EPP + 4 bu CC	5~.0 a	135.326 a	77.7 a
L.S.D. $_{0.05}$	NS	NS	NS
	3.7	32,555	18.7

EPP treatment = 7 oz Canopy, 1 qt Dual, 1 qt Roundup + Activator 90 @ 12.8 ozs./A.
EPP applied: 4/03/91
CC = Cracked corn applied broadcast 5/07/91
Planted: 5/08'91 @ 10 seeds/ft in 30" rows
DSAC: Hines, Bonwell, Steffey, Ebelhar

Table 8. Second year soybeans after no-till corn damaged by voles in tall fescue/smooth bromegrass sod, 1991.

Treatment	Yield (Bu/A)	Plant population (Plants/A)	% of planted (Stand/A)
EPP + No bait	38.7 a	131,261 a	75.3 a
EPP + 2 bu CC	38.8 a	145,587 a	83.6 a
EPP + 4 bu CC	34.6 a 31 5.665 a		77.9 a
L.S.D. $_{0.05}$	NS	NS	NS
	7.4	30,930	17.8

EPP treatment = 7 oz Canopy, 1 qt Dual, 1 qt Roundup + Activator 90 @ 12.8 ozs./A.
EPP applied: 4/03/91 CC = Cracked corn applied broadcast 5/07/91 Planted: 5/08/91 @ 10 seeds/ft in 30" rows DSAC: Hines, Bonwell, Steffey, Ebelhar

Table 9. Controlling prairie vole damage in 1992 soybeans one year after established grass s and herbicide systems. R. Hines, U. of I.

grass sod was planted to co

Treatment rate'	Plant stand"	Damage`
No-till early preplant herbicides + No bait		
No-till preemerge herbicides	137,650 a	21 a
+ 6 bu/A of cracked corn	109,723 b	37 b
Conventional tillage preemerge herbicides + No bait		
?V^-till preemerge herbicides	107,158 b	38 b
+ 2 bu/A of cracked corn	104,738 b	40 b
No-till preemerge herbicides + No bait (Check)	102,801 b	41 b
No-till preemerge herbicides + 4 bu/A of cracked corn	98,736 b	43 b