BIOLOGY AND CONTROL OF THE SUGARBEET ROOT MAGGOT IN THE RED RIVER VALLEY - 2001

Mark A. Boetel, Assistant Professor
Robert J. Dregseth, Research Specialist
Allen J. Schroeder, Research Specialist
Department of Entomology
North Dakota State University
Fargo, ND

Larry J. Smith, Superintendent
Northwest Research & Outreach Center
University of Minnesota
Crookston, MN

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Sugarbeet Insect Pest Problems during the 2001 Growing Season

Cool, wet conditions prevailed throughout much of the Red River Valley during early spring of 2001. Seed bed preparation and planting operations were delayed for many growers. Thus, a concern was that plants would be slightly smaller than optimal and more vulnerable to attack by sugarbeet root maggot (SBRM) larvae. Adult fly activity was monitored during the 2001 season by university personnel and American Crystal agricultural staff using sticky-stake traps. Activity levels were generally lower than the previous few years and varied from very low in the southern and central areas of the Valley to moderate levels with patches of high infestations in the northern portion. Peak fly activity in current-year beet fields occurred within 1-2 days of June 13 at most monitoring sites throughout the Valley with the highest counts (133 flies per trap per day) being recorded near St. Thomas, ND (Fig.1). Capture rates at our other research plot sites (Crookston and Glyndon, MN and Minto, ND) were quite low throughout the season. Typically, maggot fly pressure was most severe in fields established adjacent to those that had been in beets during the preceding season. Fly activity gradually decreased until a second peak in fly captures (99 per trap per day) occurred on June 22 in the Grafton/St. Thomas area. Levels fluctuated for several days after the second peak throughout the remainder of June and into the first week of July, at which only very low levels were detected. Fluctuations in fly counts, including the apparent second peak, were probably an artifact of thunderstorms and associated cool and windy conditions during fly emergence, mating, and egg-laying periods which likely delayed movement of flies into current-year sugarbeet fields.

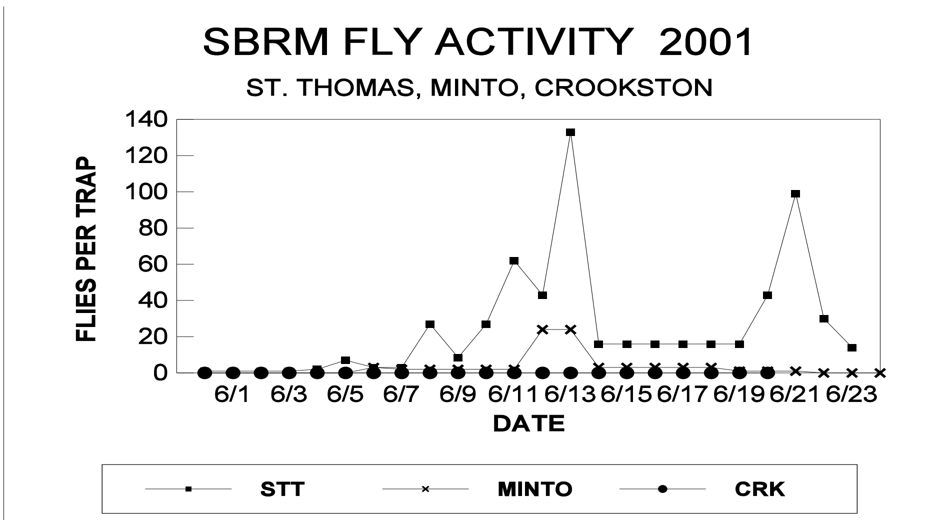


Fig. 1. Sugarbeet root maggot fly activity during the 2001 growing season near St. Thomas and Minto, ND, and Crookston, MN (counts represent flies captured on sticky stakes on a per-trap per-day basis).

Soil conditions, although sub-optimal in several fields, seemed to be adequate to prompt most larvae to feed at moderately shallow soil depths (i.e., away from beet tap roots and near/within insecticide-treated zones). Therefore, young beet plants were able to outgrow most SBRM feeding injury, very few tap roots were severed, and insecticides performed adequately in most cases. However, less-than-optimal levels of protection from maggot feeding injury were observed in a few isolated fields between St. Thomas and Bathgate, ND.

Other insect pest problems for Red River Valley sugarbeet producers during the 2001 growing season involved wireworms, white grubs, springtails, leafminers, armyworms, cutworms, flea beetles, grasshoppers, sugarbeet root aphid, and tarnished plant (*Lygus*) bug. Early in the season, wireworms caused significant sugarbeet stand losses in Cass, Richland, and Traill counties of North Dakota, as well as Clay, Norman, and Wilkin counties in Minnesota. White grubs were reported infesting beet fields in Richland county, North Dakota and Roberts county in extreme northeastern South Dakota. Springtails caused isolated stand losses in the eastern Grand Forks and Richland counties in North Dakota and western Polk and Wilkin counties on the Minnesota side of the river.

Historically, significant stand reductions from wireworms, white grubs, and springtails have been most prevalent in fields that were either treated with a planting-time soil insecticide at a very low application rate or more commonly in those that were not treated at all. Depending on the species present, wireworms can have a 3- to 5-year life cycle and, thus, feeding injury can occur in consecutive seasons. Also, wireworm infestations are more likely to occur in fields that had grassy weed problems or a cereal crop during the preceding season, or in acreages that had been in sod or the Conservation Reserve Program (CRP) for several years. Therefore, growers planning on establishing sugarbeets in fields that had grassy weed outbreaks, were planted to a cereal crop, were in CRP, or were adjacent to a field that had wireworm problems during the preceding season should consider treatment with a preventative planting-time insecticide application to avoid losses.

Installation of bait stations can also aid in deciding whether to put a an insecticide treatment on at planting to protect the crop from wireworms. This process can be very labor-intensive, since 10 to 12 stations (1 ft square by 6 to 9 inches deep) have been suggested to be installed per 40 acres in the past. Moreover, installation is a significantly less demanding procedure when compared to sifting through large volumes of soil to process the samples. However, an alternative protocol has been developed by Dr. Armon Keaster, a retired entomologist with the University of Missouri, and a nationally recognized authority on wireworm biology and management. Dr. Keaster suggests installation of 5 to 10 stations per field (2- to 3-inches deep) at about two to three weeks before planting. As earlier protocols suggested about 0.5 cup of untreated corn and wheat kernels (1:1 ratio) is to be sprinkled into the bottom of the hole. Then, bury the seed mixture under a mound of soil, cover it with an 18-inch square sheet of black plastic, and place a 1 square yard sheet of clear plastic sheeting directly over the top of the black plastic material. It is advisable to mark each station with a flag to assist with retrieval after the baiting period. Finally, dig up the bait stations few days before planting, and sift through the seed and its associated soil for wireworm larvae. If an average of one wireworm larva or more per station is recovered, a planting-time soil insecticide may be warranted.

Similar to wireworms, white grubs have a long life cycle, but theirs takes three years to complete. They do their most significant feeding during their second year. Therefore, grub problems are not very likely to be evident in consecutive seasons. The most significant injury from white grubs will occur one year after peak adult activity which will be characterized by high numbers of adults (June beetles) in and adjacent to deciduous (broadleaf) shelterbelts and around light poles during evening hours. The bait station technique mentioned above for sampling wireworms can also be used as a tool to decide on whether to treat for protection from white grubs. The existing threshold also suggests that a density of one white grub larva per sample may justify an insecticide treatment at planting.

Springtails are usually present in low numbers in many areas of the Red River Valley. They proliferate in heavy soils with high organic matter content, and are most often problematic if cool temperatures and wet conditions prevail during early spring. Their attack can occur when sugarbeets are in the seedling stage and are, thus, very vulnerable to feeding injury. Extensive feeding injury from springtails can result in severing of the tap root, which can cause the tuber to be sprangled or stunted, or ultimately can cause death to the plant.

Leafminers were observed at fairly high population levels in the Lake Park, MN area during mid- to late-June. A few fields received a foliar insecticide application and control appeared to be very effective; however, whether the treatments were economically justified remains unclear because the two very divergent economic thresholds have been published for this insect. These were the first documented cases of leafminer outbreaks on record for sugarbeet production in the Red River Valley.

Armyworms were observed feeding on foliage of mature sugarbeets in isolated fields in Stearns and Kandiyohi counties of Minnesota and Richland county in North Dakota. One armyworm-infested field in southern Minnesota was reported as being treated but it also had the *Lygus* bug as an additional target insect for the application. Flea beetles were also observed in Wilkin and Ottertail counties in Minnesota; however, no major outbreaks were reported.

Damaging cutworm infestations developed during the middle of August in several sugarbeet fields throughout the central and southern areas of the Red River Valley. Outbreaks of both variegated and black cutworms were detected at varying levels in several fields in the counties of Grand Forks, Traill, Cass, and Richland of North Dakota, as well as Clay, Grant, Norman, Ottertail, Polk, Stevens, Traverse, and Wilkin counties in Minnesota. Variegated cutworms are typically a climbing species, and can usually be adequately controlled with a foliar application of a liquid insecticide. Under normal conditions, black cutworms tend to feed at or just below the soil surface. These and other cutworm species are relatively easy to manage if soil moisture is adequate. Moist soil results in a preference by larvae to feed at or above the soil surface and, therefore, foliar liquid insecticides can be very effective. However, large numbers of cutworm larvae (up to 7 per beet root) were observed in the southern portion of the Red River Valley (Richland county, ND) feeding as deep as 4 and 5 inches below the soil surface. Attempts at control of those infestations would have been useless because of the depth at which they were feeding. Feeding injury resulted in large open cavities on the outer surface of the root.

Dry conditions that persisted in the southern Minnesota production area set the stage for development of both grasshopper and sugarbeet root aphid infestations. Grasshopper outbreaks were very isolated and infrequent; however, root aphid infestations, although not severe or widespread were found in Kandiyohi, Chippewa, Swift, and Renville counties of Minnesota and were likely present at lower levels in additional areas.

The tarnished plant (*Lygus*) bug was a major problem in mid- to late-August of 2001 for several producers in Chippewa, Kandiyohi, Polk, Red Lake, Stearns, Stevens, and Swift counties in Minnesota, and Grand Forks and Traill counties of North Dakota. An estimated 1,600 acres were treated with foliar insecticides in vicinity of Crookston, MN vicinity, and an additional 3,000 acres were treated in the southern Minnesota growing area. Many more acres likely went untreated either because of infestations believed to be at sub-economic levels or because fields were not diagnosed early enough to allow for treatment. Since this insect invades sugarbeet fields late in the season, the pre-harvest interval (PHI) for respective labeled insecticide products needs to be considered when selecting an insecticide to control it.

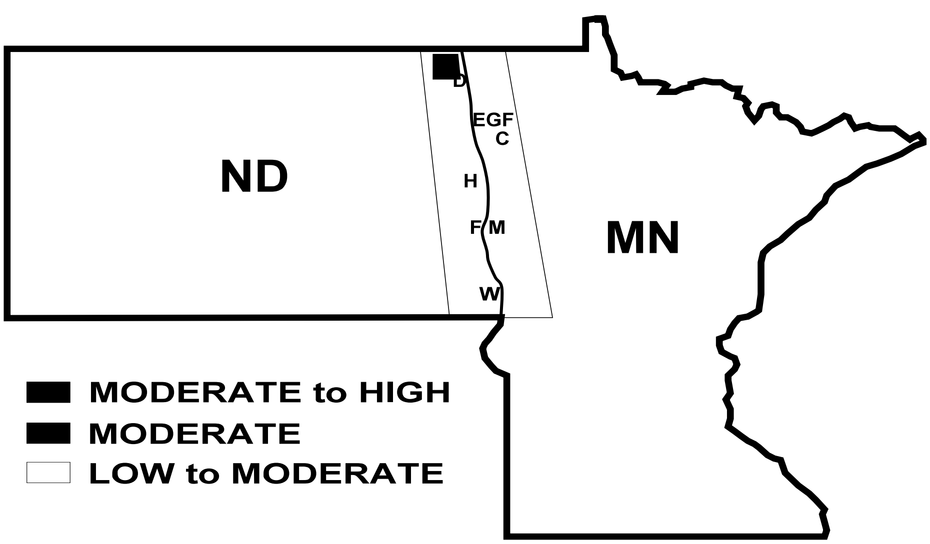
SBRM Population Forecast for 2002

The population forecast for the 2002 production season (Fig.2) suggests growers on the Minnesota side of the Red River from the Sabin/Baker area and north all the way to the U.S./Canadian border will likely experience generally low SBRM infestations with intermittent pockets of moderate pressure. Growers farming in the Grafton/Hoople vicinity in northeastern Walsh county and the Cavalier/Bathgate area in northern Pembina county of northeastern North Dakota can expect moderate to high infestations. Naturally, moderate infestations can be expected to occur in the marginal areas between those where low and high populations are projected. Proximity of current-year sugarbeets to fields previous-year beet fields can often increase the risk of damaging population levels. **It should be clearly understood that significant fly activity is likely for beets planted adjacently to previous-year beet fields that had moderate to high fly densities and/or substantial maggot feeding pressure.** Environmental conditions within the growing season can affect the precision of this forecast. Therefore, fly populations must be monitored for producers and pest managers to make that determination.

Fig. 2. Anticipated SBRM population levels for the 2002 growing season in the Red River Valley.

This forecast is general in nature, and will not always be precise on an individual field basis. Growers are encouraged to continue using planting-time insecticides. Fields should then be carefully monitored from late May through June for significant increases in fly activity. High activity or an extended emergence period may warrant the need for additional control tactics. Growers are encouraged to review research findings published in recent volumes of "Research and Extension Reports" to design effective management programs. NDSU extension will continue to inform growers on SBRM activity each spring via radio reports, DTN, and issues of the NDSU "Crop & Pest Report."

Sugarbeet Root **Maggot**
Control Trials:



Research trials were conducted at two sites (St. Thomas and Minto) in North Dakota and two locations (Crookston and Glyndon) in Minnesota to evaluate the performance of various chemical, cultural, and bioinsecticidal strategies for control of the sugarbeet root maggot. The Glyndon plots were planted early since it was drier in the southern end of the Red River Valley. Shortly following planting this plot this location received a timely rain enough to germinate and activate the seeds and insecticides. However, root maggot fly activity was very low at Glyndon and feeding injury in the untreated control plots was not sufficient to result in any meaningful treatment comparisons. Therefore, those data are not included in this report.

High fly numbers were observed at the St. Thomas throughout the month of June in 2001. As a result, some of the trials had fairly high larval infestations; however, only moderate maggot feeding pressure was observed in some of the trials at St. Thomas. Soil conditions remained very wet during early spring at our St. Thomas plot, which resulted in a delay in our planting efforts. The wet soil was worked and planted as early as possible so sugarbeet plants would be up when maggot flies were actively seeking egg laying sites. This was especially critical to a few of our experiments which included a date-of-planting study and other trials where multiple applications of soil and foliar insecticides would be applied. The first replicate (area adjacent to road ditch) of our registered, planting-time versus postemergence, incorporation, and cover crop experiments was more wet than the other replicates during tillage and planting and, as a result, the soil became somewhat hard-packed. This soil may have discouraged some female maggot flies from laying eggs in this area. During damage rating we observed very low levels of scarring on beets collected from the first replicate of the registered, planting-time versus postemergence, incorporation, and cover crop experiments. Levels were so low in that replicate for those four tests that elimination of those data points improved the soundness of all statistical comparisons therein. Intermittent rain showers persisted through May and June and made it very challenging to apply postemergence insecticide treatments at the appropriate timing. Also, along with the rain and thundershower activity came cooler temperatures and wind which likely forced many flies to remain in the old-beet fields they emerged from longer than if it been sunny and warm.

Our Minto site was planted after the St. Thomas site was completed. Thus, the planting delays that occurred at St. Thomas resulted in very late planting at the Minto location. As we observed at Glyndon, fly counts were almost nonexistent at Minto. Our insecticide trials at that site also had to be abandoned because of poor larval infestations.

Damage Rating Scale:

The 0–9 damage rating scale has been implemented as our standard system for quantifying SBRM feeding injury. The major feature of this scale is that it broadens the 3 rating on the 0–5 scale that has been used in previous years. This refinement may allow us to achieve a closer association of feeding injury with yield. Criteria for the respective points on the 0–9 damage rating scale are as follows:

0 = no scars
1 = 1 to 4 small (pin head size) scars
2 = 5 to 10 small scars
3 = 3 large scars or scattered small scars
4 = few large scars and /of numerous small scars
5 = several large scars and/or heavy feeding on laterals
6 = up to 1/4 root scared
7 = 1/4 to 1/2 of root blackened by scars
8 = 1/2 to 3/4 root blackened by scars
9 = more than 3/4 of root area blackened

Insecticide Application Methods used in Experiments:

All planting-time treatments were applied by using either standard or after-market equipment mounted on a 6-row John Deere 71 Flex planter. Banded applications of granules were applied in a 5-inch swath over the row using Gandy™ banders. The spoon application involved an in-furrow tube, however, a small galvanized steel device is attached to the terminal end of the tube. A no. 10 bolt with two nuts facing upward (inner face of spoon; near the tip) helps to laterally deflect the heavy central concentration of granules coming down the tube and., thus, reduces the likelihood of phytotoxicity to beet seedlings. The resulting application is a 3 to 4-inch swath with the heaviest concentration of granules being placed immediately adjacent to, but outside of, the seed furrow. Modified in-furrow placement consisted of dropping granules down a standard planter-equipped in-furrow tube over the row; however, granules were directed near the rear press wheel so some soil would cover the seed before the insecticide reached the row. This placement method results in a 2 to 3-inch band with the heaviest insecticide concentration being placed immediately over the row (it is critical that the insecticide does not come in contact with the seed when using this application technique). Planting-time applications of Mustang 0.8EW and Capture 2EC liquids were metered by using a Mustang/Raven™ Liquid Application System and were delivered at 5GPA spray volume using Teejet™ 4001E nozzles. Both Mustang and Capture were applied directy in-furrow via microtube and as a 3-inch band over the open furrow in front of the rear press wheel of the planter. Force 30CS was metered using a CO_2-powered system calibrated to deliver an output of 20 GPA through Teejet[TM] 8002E nozzles. Postemergence granules were applied directly over the row in 4-inch bands through Kinze[TM] banders and output was regulated by using Noble metering units. Postemergence liquid treatments were applied in 7-inch bands by using a CO_2-powered cannister system that delivered a spray volume of 10GPA through Teejet[TM] 8001E nozzles.

Placement Method Experiment:

This experiment was established on May 17 at St.Thomas, ND to evaluate the impact of placement method on the efficacy of three registered soil insecticides applied at planting time. Treatments for this experiment included banded (B), modified in-furrow (M), and spoon (S) applications of Counter 15G, Lorsban 15G, and Temik 15G, and all were applied at high labeled rates. The seed bed for this experiment was dry with good sub-surface soil moisture at the time of planting and a 0.32-inch rain was received three days afterward. Therefore, excellent conditions existed for seed germination and insecticide activation.

This study was established in an area of the field that had relatively light-textured soil, which is attractive for egg laying and favorable for maggot survival. Accordingly, maggot pressure was quite heavy as was evidenced by the 7.0 average damage rating (0-9 scale) recorded for the untreated control plots (Table 1). In comparing the insecticide treatments with regard to root protection, Counter 15G performed significantly better by using the spoon placement method (with the no. 10 bolt insert described earlier in this report). That finding was similarly reflected in total recoverable sucrose yield, although the comparison was not statistically significant. Also, the banded application of Counter provided statistically better root protection than modified in-furrow. Similar trends were observed with spoon-applied Lorsban 15G and Temik 15G allowing numerically less SBRM feeding injury than banded and modified-in-furrow treatments; however those disparities were not significant. Temik performance in preventing root injury was not significantly affected by placement, although the modified in-furrow treatment produced the highest numerical level of recoverable sucrose, and both the modified in-furrow and banded applications yielded significantly more sucrose than the spoon treatments. Similar to our findings in 2000, Temik out-performed the other two materials used in this trial. Temik-treated plots had significantly lower damage ratings than Counter or Lorsban, irrespective of placement method. Finally, all insecticide treatments resulted in significantly less injury than the untreated check; however, only Temik (modified in-furrow and banded) and Counter (spoon and banded) applications were significantly better in comparing recoverable sucrose yield. No treatment differences were detectable in relation to tonnage or percent sucrose.

It should be noted that Lorsban 15G, Chlorfos 15G, and Nufos 15G can cause major plant injury to sugarbeet plants if the spoon technique is used without the no. 10 nut/bolt modification because too heavy of an insecticide concentration will be placed adjacent to (or in contact with) beet seedlings. Producers that choose to use the spoon method to apply one of these products at planting time are strongly advised to modify it properly with the nut/bolt set to avoid these problems.

Table 1. Effect of insecticide placement method on control of sugarbeet root maggot larvae, St. Thomas, ND, 2001.

Treatment/ formulation	Rate lb (AI/ac)	Placement[a]	Recoverable sucrose (lb/ac)	Yield (T/ac)	Sucrose (%)	Damage rating (0-9)	Gross return ($/ac)
Temik 15G	2.1	M	6996 a	24.5 a	16.0 a	1.63 e	641
Temik 15G	2.1	B	6557 ab	23.0 a	15.9 a	1.90 e	597
Counter 15G	1.8	S	6394 abc	21.9 a	16.2 a	3.70 d	601
Counter 15G	1.8	B	6250 a-d	22.9 a	15.5 a	4.65 c	536
Counter 15G	1.8	M	6121 b-e	23.1 a	15.2 a	5.45 b	504
Lorsban 15G	2.0	S	5871 b-e	21.1 a	15.7 a	4.63 c	518
Temik 15G	2.1	S	5650 cde	20.4 a	15.7 a	1.40 e	494
Lorsban 15G	2.0	M	5484 de	19.6 a	15.7 a	5.13 bc	488
Lorsban 15G	2.0	B	5429 de	19.7 a	15.5 a	5.05 bc	473
Check	-	-	5333 e	20.4 a	15.1 a	7.00 a	429

Means within a column sharing the same letter are not significantly ($P > 0.05$) different (LSD).

[a]M = Modified-in-furrow; B = Band; S = Spoon

Registered Soil Insecticides and Application Rates Test:

This experiment was established at two sites (Minto and St. Thomas) in eastern North Dakota and two locations (Crookston and Glyndon) in western Minnesota to evaluate the performance of registered insecticides at high, standard, and low labeled rates in the Red River Valley for control of the sugarbeet root maggot. These trials were planted May 4, 10, 16, and 31, 2001 at Glyndon, Crookston, St. Thomas, and Minto, respectively. Root maggot fly populations were very low at both Glyndon and Minto and damage levels were virtually undetectable in the untreated check plots for all four replicates at these two locations. Therefore, no valid or meaningful data regarding compound performance could be derived from these sites, and they were both abandoned for research purposes prior to harvest.

Also, the soil moisture in the area in which this test was established at St. Thomas was quite high during spring tillage operations. As a result, the soil in the first replicate became somewhat hard-packed and clumpy. It also remained more moist than most other areas of the field throughout the season. Root maggot feeding injury was at very low levels, irrespective of treatment, on beet roots evaluated in that replicate. Hard-packed soil is unattractive to females for egg laying and an overabundance of soil moisture can diminish maggot survival rates. It is likely that these conditions resulted in the low incidence of maggot feeding injury in that portion of the experiment. Statistical comparisons were carried out on this test in two ways: with, and without the data from the first replicate. The analysis we performed with replicate one data removed resulted in a much-improved analysis of variance model. Therefore, that data was eliminated and our findings are based on the remaining three replicates, among which the treatments performed consistently. Also, the untreated control plots in replicates 2 to 4 incurred higher levels of injury , which suggested more likelihood of the validity of our testing in this experiment.

The sugarbeet root maggot infestation in this test was moderate as was evidenced by the mean damage rating of 5.5 (0 to 9 scale) in the untreated check plots (Table 2). Albeit, all insecticide treatments resulted in significantly higher recoverable sucrose yield and lower levels of root maggot feeding injury than that recorded for the untreated check. Numerically, Counter 15G at 1.8 lb (AI)/ac (high labeled rate) applied modified in-furrow was the top-yielding (7,674 lb recoverable sucrose and 23.7 tons per acre) treatment and produced the highest sucrose percentage (17.6) in the experiment. Also, it produced significantly higher (1,111 lb more total recoverable sucrose and 2.6 tons higher raw beet per acre) yield than the same application rate applied in a band.

Application rate comparisons revealed that the 1.5 and 1.8 lb (AI)/ac application rates of Counter 15G were not significantly different from each other in levels of root protection provided, but both resulted in statistically lower damage ratings than the 0.9 and 1.05 lb treatments. However, those disparities were not reflected in yield. Additionally, the 2 lb (AI)/ac application rate of Lorsban 15G was superior in root protection to both 1.0 and 1.5 lb rates, although yield data did not correspond well with that finding. In fact, the high (2 lb) rate produced the lowest numerical yield of all Lorsban 15G-treated plots in this test; however, yield differences among those treatments were not statistically significant. Performance of Counter CR was not affected by application rate or placement method, irrespective of response variable (damage rating, recoverable sucrose, or gross sugarbeet yield) being compared. In comparing insecticides as banded at the standard (1.5 lb [AI]/ac) application rate, Counter 15G performed statistically better than both Lorsban 15G and Counter CR in providing protection from sugarbeet root maggot feeding injury. Additionally, the banded treatment of Counter 15G at the standard rate yielded significantly more total recoverable sucrose and tonnage per acre than the CR formulation of Counter.

Higher application rates of both Counter 15G and Lorsban 15G resulted in better root protection. Differences among application rates in this study may have even been more pronounced had the SBRM infestation level in this test been more severe. Although yield was not significantly impacted by application rate, producers should be cautious in deciding whether to use a low application rate of one of these compounds at planting. Severe root maggot infestations, especially when accompanied by other stressors such as drought, will likely cause major losses if a low application rate is used. Growers choosing to use a low rate at planting should be prepared to consider use of a postemergence rescue insecticide if high fly populations develop.

Table 2. Rate and placement method comparison of registered insecticides for managing sugarbeet root maggot larvae, St. Thomas, ND, 2001.

Treatment/ formulation	Rate lb (AI/ac)	Placement[a]	Recoverable sucrose (lb/ac)	Yield (T/ac)	Sucrose (%)	Damage rating (0-9)	Gross return ($/ac)
Counter 15G	1.8	M	7674 a	23.7 a	17.6 a	1.73 ef	810
Counter 15G	1.5	B	7240 a	22.9 ab	17.2 ab	1.57 f	746
Counter 20CR	1.8	B	7193 ab	22.7 abc	17.2 ab	1.97 c-f	741
Counter 15G	0.9	B	7095 ab	22.9 ab	17.0 ab	2.53 cd	713
Lorsban 15G	1.5	B	7059 abc	21.9 a-d	17.5 a	2.70 bc	740
Counter 15G	1.05	B	7015 abc	22.1 a-d	17.3 ab	2.43 cde	725
Counter 15G	1.5	M	6957 abc	22.1 a-d	17.2 ab	2.07 c-f	713
Counter 20CR	1.8	M	6883 abc	21.2 bcd	17.6 a	2.03 c-f	727
Counter 20CR	1.5	M	6880 abc	21.5 a-d	17.4 ab	2.63 cd	717
Counter 20CR	1.5	B	6604 bc	20.5 cd	17.6 a	2.43 cde	692
Counter 15G	1.8	B	6563 bc	21.1 bcd	17.0 ab	1.33 f	662
Lorsban 15G	1.0	B	6505 bc	20.4 cd	17.3 ab	3.40 b	674
Lorsban 15G	2.0	B	6249 c	19.9 d	17.2 ab	1.90 def	639
Check	-	-	5244 d	17.2 e	16.6 b	5.50 a	517

Means within a column sharing the same letter are not significantly (*P* > 0.05) different (LSD).
[a]M = Modified-in-furrow; B = Band

The Crookston location of this test had relatively light SBRM pressure with a mean damage rating of 2.8 on the 0–9 scale being recorded for beets collected from the untreated check plots (Table 3). In comparing the treatments according to SBRM root injury ratings, Counter 15G applied in a band at 1.8 lb (AI)/ac provided the best level of protection. In fact, it was statistically more efficacious than the following: (1) Counter 15G at 1.5 lb applied modified in-furrow; (2) Lorsban 15G banded at 1 lb; and (3) Counter 20CR applied at 1.8 lb modified in-furrow, all of which failed to protect roots at levels statistically different from the untreated check. Application rate did not play a significant role in the efficacy of any of the compounds evaluated at this study site. General trends in root damage ratings suggest a slight advantage in using the band; however, insecticide performance relating to placement techniques can vary greatly among years due to post-application precipitation levels and the intensity of individual rainfall events.

Although yield parameters often correspond moderately with SBRM feeding injury level, yield comparisons are often very difficult to interpret. This is especially true in cases of light infestation levels such as that which developed at Crookston during 2001. For example, the top-yielding (8982 lb recoverable sucrose/ac) treatment was Counter 15G applied in a band at 1.5 lb (AI)/ac. Plots treated with this entry produced an average of 379 lb more sucrose per acre than the high banded rate (1.8 lb) of Counter 15G. Similar trends of an inverse relationship between application rate and recoverable sucrose yield were observed with Counter 15G applied modified in-furrow, and both band and modified in-furrow applications of Counter 20CR; however, no such pattern was evident with Lorsban 15G. These findings suggest, at a minimum, that efficacy-related conclusions from this trial should rely more heavily on root damage ratings.

Table 3. Comparison of application rates and placement methods of registered insecticides for managing sugarbeet root maggot larvae, Crookston, MN, 2001.

Treatment/ formulation	Rate lb (AI/ac)	Placement[a]	Recoverable sucrose (lb/ac)	Yield (T/ac)	Sucrose (%)	Damage rating (0-9)	Gross return ($/ac)
Counter 15G	1.5	B	8982 a	27.0 a	17.7 a	1.93 bcd	974

Table 3. Comparison of application rates and placement methods of registered insecticides for managing sugarbeet root maggot larvae, Crookston, MN, 2001.

Treatment/ formulation	Rate lb (AI/ac)	Placement[a]	Recoverable sucrose (lb/ac)	Yield (T/ac)	Sucrose (%)	Damage rating (0-9)	Gross return ($/ac)
Counter 15G	1.05	B	8828 ab	26.9 a	17.4 abc	1.68 cd	942
Counter 15G	1.5	M	8705 abc	26.3 a	17.6 ab	2.28 ab	938
Counter 15G	1.8	B	8603 abc	26.7 a	17.2 a-e	1.55 d	901
Lorsban 15G	2.0	B	8532 a-d	25.8 a	17.5 abc	1.85 bcd	917
Lorsban 15G	1.5	B	8519 a-d	26.0 a	17.3 a-d	1.83 bcd	906
Counter 20CR	1.5	B	8451 a-d	26.3 a	17.2 a-d	1.85 bcd	883
Counter 20CR	1.5	M	8225 b-e	26.0 a	16.9 a-e	2.00 bcd	848
Lorsban 15G	1.0	B	8180 b-e	26.0 a	16.8 b-e	2.35 ab	835
Counter 15G	0.9	B	8132 b-e	26.0 a	16.8 cde	2.03 bcd	828
Counter 15G	1.8	M	8037 cde	26.1 a	16.5 de	2.10 bcd	803
Counter 20CR	1.8	B	7984 cde	26.3 a	16.4 e	1.85 bcd	787
Check	-	-	7825 de	24.3 a	17.2 a-e	2.80 a	821
Counter 20CR	1.8	M	7542 e	24.4 a	16.6 de	2.25 abc	785

Means within a column sharing the same letter are not significantly ($P > 0.05$) different (LSD).
[a]M = Modified-in-furrow; B = Band

Planting-time and Postemergence Granular and Liquid Insecticide Combinations:

This experiment was established on May 17, 2001 at St. Thomas, ND to determine the relative efficacy of standard and low labeled application rates of registered insecticides at planting-time alone and followed by postemergence rescue treatments. An underlying goal was to assess whether it will be feasible for producers to apply a low rate of a soil insecticide at planting, and then decide on whether a postemergence is needed based on fly activity in their fields.

In this experiment, planting-time granules were applied using methods described previously and Kinze™ banders were used to apply postemergence granular treatments in 4-inch bands on June 7 (6 days before peak fly activity). Postemergence granules were regulated using Noble metering units on a tractor-mounted tool bar. Incorporation of the insecticide into the soil is a very important aspect of the application because it helps protect the product from the degradation due to the deleterious effects of sunlight, heat, and runoff. An incorporation device was mounted on each row-unit on the tool bar, and each was equipped with two sets of rotary tines: (1) a set placed ahead of the insecticide bander for breaking up the soil surface adjacent to beet seedlings immediately before granule drop; and (2) one set behind the bander for granule incorporation. However, due to moist soil conditions at the time of postemergence applications, the front set of rotary tines was collecting mud clods in test runs we performed before treatment applications were made. Therefore, the front rotary tine wheels were removed and only rear incorporators were used for these treatments. Postemergence liquid insecticide treatments were applied with the same tool bar. Application of the single Lorsban 4E treatment, as well as the first installment of a dual postemergence treatment of 4E took place on June 12 (one day before peak fly). The second application of Lorsban 4E in the dual treatment was carried out on June 21.

A rain shower of 0.33 inches fell within a few hours following our postemergence granular applications, which was probably adequate for activation of the insecticides. The first application of postemergence liquids was also followed by a rainfall event which dropped 0.31 inches of precipitation the next day (June 13), which may have caused some of the material to be washed off the plants and into the surrounding soil. Also, the rain would likely have assisted with further incorporation of the insecticide into the target zone and may have enhanced larval control by this treatment. No further measurable rainfall was received in the plot area until July 16. Therefore, the second application of the postemergence Lorsban 4E treatment would not have had the favorable conditions for incorporation and larval activity as the earlier single treatment, and any impact on efficacy would have been in the form of adult control. Our fly activity data for the site (Fig. 1) does indicate that there were still relatively large numbers of flies present when this application was made.

The results of this test are based on three replications of the treatments due to a poor larval infestation in the first replicate. However, an excellent infestation was present in the remaining replicates, as was demonstrated by a mean damage rating of 7.27 (0 to 9 scale) in the untreated check plots (Table 4). All insecticide treatments resulted in significantly lower levels of SBRM feeding injury than were recorded for the untreated check plots. In general, the dual (planting-time plus postemergence) treatments performed better than standard and high labeled rates of the stand-alone (planting-time treatments. For example, the two top-yielding (numerically) treatments in this test were (1) Counter CR applied at planting at 1.5 lb plus a postemergence application of Thimet 20G at 1.4 lb (AI)/ac, and (2) Lorsban 15G at 1.0 lb at planting-time followed by Counter 15G postemergence at a rate of 1.5 lb. The latter (Lorsban 15G plus Counter 15G postemergence) provided the best overall treatment when considering both yield and root protection parameters. The only stand-alone planting-time treatment that was not out-performed by the two top dual application entries was the 1.5 lb (AI)/ac planting-time application of the Counter 15G/Temik 15G blend. Also, it should be noted that neither of the two top-performing treatments were statistically superior (in yield or root protection) to any of the following treatments: (1) Counter 15G at 1.05 lb planting-time plus Lorsban 15G 1.5 lb postemergence; (2) Counter 15G/Temik 15G blend at 1.5 lb total active ingredient; (3) Counter 15G at 0.9 lb planting-time plus Lorsban 15G 1.5 lb postemergence; (4) Counter 15G at 0.9 lb planting-time followed by Thimet 20G 1.0 lb postemergence; (5) Counter 15G at 1.5 lb planting-time plus Lorsban 15G 1.05 lb postemergence; (6) Counter 15G at 1.05 lb planting-time plus 2 postemergence applications of Lorsban 4E at 1 lb; (7) Counter 15G at 0.9 lb planting-time plus Lorsban 15G at 1 lb postemergence; (8) Counter 15G at 1.5 lb planting-time followed by Thimet 20G 1.4 lb postemergence; (9) Counter 15G at 1.05 lb at-plant plus Thimet 20G 1.4 lb postemergence; (10) Temik 15G postemergence-only; or (11) Counter 15G at 1.05 lb planting-time plus single postemergence application of Lorsban 4E at 1 lb. The stand-alone (planting-time only) treatment of Counter 15G at the standard rate of 1.5 lb (AI)/ac was the only treatment that showed no significant increase in recoverable sucrose yield over that of the untreated check, whereas, the addition of a postemergence application of Thimet 20G at 1.4 lb (AI)/ac or Lorsban 15G at 1.05 lb resulted in a statistical improvement over the 1.5 lb stand-alone treatment of Counter in sucrose yield, tonnage, and root protection. Counter 15G at planting (0.9 lb [AI]/ac) followed by Thimet 20G post emergence at 1.0 lb (AI)/ac) and Counter 15G at planting (1.05 lb [AI]/ac) followed by Lorsban 4E post emergence (at 1.0 lb [AI]/ac) had the same results with the lowest rating (0.97) on the 0-9 rating scale but was not significant from other combinations. The combination that gave the highest yield was with Counter 15G (at 1.5 lb [AI]/ac) followed by Thimet 20G (1.4 lb [AI]/ac) post emergence. This yield was not significantly different compared to the treatments with the lowest damage ratings. These findings strongly suggest that a postemergence rescue insecticide application can augment control considerably. Favorable results are likely to be achieved by applying a moderate rate of Counter or Lorsban and, if fly activity levels warrant it, following with one of the postemergence treatments used in this experiment. Albeit, it is very important to note that prolonged periods of unfavorable weather can complicate and even preempt efforts to apply postemergence treatments at the most effective time of the maggot activity cycle. Therefore, until further research is conducted, growers should be very cautious when choosing whether (or how much) to reduce their planting-time insecticide application rate.

Table 4. Comparison of granular and liquid insecticides applied at planting-time and postemergence for controlling sugarbeet root maggot larvae, St. Thomas, ND, 2001.

Treatment/ formulation	Rate lb (AI/ac)		Placement [b]	Recoverable sucrose (lb/ac)	Yield (T/ac)	Sucrose (%)	Damage rating (0-9)	Gross return ($/ac)
	Planting-time	Postemergence[a]						
Counter 20CR +	1.5	---	B					
Thimet 20G	---	1.4	B	7425 a	23.2 a	17.6 a	1.20 ef	774
Lorsban 15G +	1.0	---	B					
Counter 15G	---	1.5	B	7422 a	22.4 ab	18.0 a	1.00 f	799
Counter 15G +	1.05	---	B					
Lorsban 15G	---	1.5	B	7386 a	21.8 ab	18.3 a	1.57 c-f	814
Counter 15G +	Blend	---	B					
Temik 15G	1.5	---	B	7190 ab	21.8 ab	18.0 a	1.57 c-f	772
Counter 15G +	0.9	---	B					
Lorsban 15G	---	1.5	B	7146 abc	21.2 ab	18.2 a	1.17 ef	782
Counter 15G +	0.9	---	B					
Thimet 20G	---	1.0	B	7125 abc	21.7 ab	17.8 a	0.97 f	760
Counter 15G +	1.5	---	B					
Lorsban 15G	---	1.05	B	7121 abc	22.1 ab	17.6 a	1.20 ef	746
Counter 15G +	1.05	---	B					
Lorsban 4E +	---	1.0	B					
Lorsban 4E	---	1.0	B	7080 abc	21.3 ab	17.9 a	1.07 f	764
Counter 15G +	0.9	---	B					
Lorsban 15G	---	1.0	B	7067 abc	21.3 ab	18.0 a	1.47 def	763
Counter 15G +	1.5	---	B					
Thimet 20G	---	1.4	B	7035 a-d	21.7 ab	17.6 a	1.40 def	742
Counter 15G +	1.05	---	B					
Thimet 20G	---	1.4	B	6913 a-d	20.8 abc	18.0 a	1.20 ef	748
Temik 15 G	---	1.0	B	6871 a-e	21.0 abc	17.9 a	1.47 def	732
Counter 15G +	1.05	---	B					
Lorsban 4E	---	1.0	B	6827 a-f	20.5 bcd	18.0 a	0.97 f	738
Lorsban 15G +	1.0	---	B					
Counter 15G	---	0.9	B	6632 b-f	20.8 abc	17.4 a	1.70 cde	688
Counter 15G	1.8	---	B	6488 c-g	20.0 bcd	17.7 a	1.87 cd	685
Counter 15G +	0.9	---	B					
Thimet 20G	---	1.4	B	6352 d-g	20.0 bcd	17.3 a	1.03 f	657
Counter 15G +	Blend	---	B					
Temik 15G	1.0	---	B	6211 efg	18.5 cde	17.8 a	2.10 c	676
Lorsban 15G	1.5	---	B	6145 fg	18.6 cd	17.9 a	3.20 b	660
Counter 15G	1.5	---	B	5826 gh	18.1 de	17.6 a	1.70 cde	610
Check	---	---	---	5181 h	16.0 e	17.7 a	7.27 a	545

Means within a column sharing the same letter are not significantly ($P > 0.05$) different (LSD).

[a]Postemergence granules applied June 7; Postemergence liquids applied June 12 & 21. Peak fly = June 13, 2001

[b]B = Band

Experimental Planting-time Soil Insecticides:

The number of insecticide options currently available to Red River Valley sugarbeet producers for managing soil insect pests is extremely limited. Therefore, it is critical that new products be aggressively screened whenever the agricultural chemical industry develops a material that may have potential for controlling our most important insect pest, the sugarbeet root maggot. Experimental insecticide materials used in this trial included granular (1.5G) and liquid (2EC) formulations of Capture (bifenthrin) and Mustang 0.8 EW. Both products were considered as experimental materials because neither compound was registered for use in sugarbeet at the time of this trial.

This trial was conducted at St. Thomas, ND and planting took place on May 21. Spray volume of liquid insecticide formulations in this experiment was metered by using a Mustang/Raven™ Liquid Application System and all liquids were delivered at 5GPA spray volume using Teejet™ 4001E nozzles. Both Mustang and Capture were applied directy in-furrow via microtube and as a 3-inch band over the open furrow in front of the rear press wheel of the planter. Counter 15G was applied at 1.5 lb (AI)/ac, and served as a registered standard for comparative purposes. Granular materials were applied by using spoon or modified in-furrow applicators.

Counter 15G applied at 1.5 lb (AI)/ac. produced the highest recoverable sucrose yield (5,901 lb/ac) and the lowest average damage rating (4.50) in this experiment (Table 5); however, treatments that were not statistically different from Counter 15G in both yield and root protection included Capture 2EC applied in a 3-inch T-band (over the open seed furrow)at 0.08 and 0.16 lb (AI)/ac rates. Also, Mustang 0.8EW applied at 0.022 lb (AI)/ac in the 3-inch T-band provided a root protection level that was not statistically outperformed by the registered standard, Counter 15G. Recoverable sucrose yield was, however, significantly higher (5,901 versus 5,074 lb/ac) in the Counter-treated plots. Interestingly, all experimental treatments that provided significant levels of root protection in comparison with the untreated control plots were applied via the 3-inch T-band placement method. In November of 2001, the manufacturer of FMC received full registration for a 1.5EW formulation of Mustang. Although we obtained encouraging findings regarding Mustang performance in this experiment, it should be noted that these are the results of only one growing season and further testing will be necessary to maximize the efficacy and to determine the consistency of this product under variable growing conditions common to the Red River Valley growing region. Currently, we suggest that producers avoid reliance on Mustang as a planting-time treatment for sugarbeet root maggot control in areas of the Valley where high population levels are expected. This is also in accordance with the label for this product which suggests only suppression under light to moderate SBRM population levels.

Table 5. Performance evaluation of FMC insecticide treatments for managing sugarbeet root maggot larvae, St. Thomas, ND, 2001.

Treatment/ formulation	Rate lb (AI/ac)	Placement[a]	Recoverable sucrose (lb/ac)	Yield (T/ac)	Sucrose (%)	Damage rating (0-9)	Gross return ($/ac)
Counter 15G	1.5	M	5901 a	20.4 a	16.2 a	4.50 e	550
Capture 2EC	0.16	3" TB	5867 ab	19.6 a	16.5 a	4.70 de	570
Capture 2EC	0.08	3" TB	5526 abc	18.4 a	16.6 a	4.88 de	536
Capture 2EC	0.08	M-tube	5513 abc	18.5 a	16.6 a	5.28 bcd	533
Mustang 0.8EW	0.064	M-tube	5456 abc	18.3 a	16.5 a	5.65 abc	527
Capture 1.5G	0.1	S	5317 a-d	17.6 a	16.6 a	5.95 a	519
Mustang 0.8EW	0.032	M-tube	5285 a-e	18.5 a	15.9 a	5.88 ab	482
Mustang 0.8EW	0.064	3" TB	5264 a-e	18.6 a	15.9 a	4.60 e	474
Capture 2EC	0.16	M-tube	5148 a-e	17.5 a	16.2 a	5.60 abc	488
Mustang 0.8EW	0.022	3" TB	5074 b-e	18.0 a	15.8 a	5.15 cde	455
Mustang 0.8EW	0.032	3" TB	5058 b-e	17.7 a	16.0 a	5.73 abc	463
Capture 1.5G	0.2	S	4940 cde	17.2 a	16.0 a	5.88 ab	454
Mustang 0.8EW	0.022	M-tube	4861 cde	17.1 a	15.9 a	6.10 a	441
Capture 1.5G	0.2	M	4767 cde	17.4 a	15.5 a	5.95 a	411
Check	-	-	4514 de	16.2 a	15 8 a	5.83 ab	400

Table 5. Performance evaluation of FMC insecticide treatments for managing sugarbeet root maggot larvae, St. Thomas, ND, 2001.

Treatment/ formulation	Rate lb (AI/ac)	Placement[a]	Recoverable sucrose (lb/ac)	Yield (T/ac)	Sucrose (%)	Damage rating (0-9)	Gross return ($/ac)
Capture 1.5G	0.1	M	4488 e	16.1 a	15.5 a	5.83 ab	396

Means within a column sharing the same letter are not significantly ($P > 0.05$) different (LSD).
[a]M = Modified-in-furrow; TB = 3" Band over open seed furrow; M-Tube = Microtube, directly in-furrow; S = Spoon

Cover Crop Experiment:

Although we have been investigating the cover crop cultural strategy for several years, we modified the approach in 2001 to address grower interest in the feasibility of reducing the cereal grain seeding rates. As in past years, the study was conducted at St. Thomas, ND. The experiment was arranged in a randomized complete block design with treatments consisting of oat, barley, and rye cover crops in combination with low or standard (0.9 or 1.5 lb [AI]/ac) of Counter 15G at planting time. Oat cover plots were seeded at the following rates: 0 (control), 0.5, 1.0, or 1.5 bu per acre. Barley and rye plots were seeded at appropriately converted rates to establish the same rate (in seed number rather than seed volume per unit of plot area) as those in the oat plots since a disparity existed in kernel size between oat and the other grains. Therefore, barley and rye seeding rates are presented as oat-bushel-equivalents (OBE). Cereals were sown immediately before sugarbeets were planted (May 30). Application of the substantially reduced seeding rates was facilitated by using 20-oz beverage containers that were modified by drilling five equally-spaced 3/8-inch holes into their bases. For each application, the pre-measured amount of seed was poured into the container and was then uniformly sprinkled across a plot in approximately three passes. The grain was incorporated into the soil by using a motorized walk-behind garden tiller. On May 31 the plot received 0.16 inches of rainfall which created excellent conditions for cover crop and sugarbeet seed germination. Additional trace amounts of rain were received thereafter until June 11 at which time 0.33 inches of rainfall were recorded for the site. Thus soil moisture conditions were favorable for good performance from soil insecticides in the study. Cereal covers were allowed to grow for about 4 weeks and were then sprayed with Poast herbicide at a rate of 0.4 lb (AI)/ac plus methylated seed oil (1.5% v/v) on July 2 to kill off the grasses in all cover crop treatments. This application was made about two weeks later than had been planned due to a combination of inclement weather events and other logistical problems.

Results of this experiment are presented in Table 6. Very light feeding injury was also manifested in replicate one of this experiment; therefore, data reflect only the findings from replicates two, three, and four. The treatment combination of Counter 15G at 1.5 lb (AI)/ac with barley as a cover at 1.5 OBE/ac resulted in the highest level of SBRM control (1.57 damage rating; 0 to 9 scale). Also, in considering total sucrose yield, this treatment was not statistically outperformed by the top-yielding treatment (Counter 15G at 1.5 lb [AI]/ac with rye as a cover at 1.5 OBE/ac) from which a yield of 6366 lb of recoverable sugar was obtained. The yields from those higher seeded treatments are somewhat surprising. As alluded to earlier, the cover crop burn-down application of Poast herbicide was made two weeks later than was planned. Thus, the cover crops were providing substantial competition for sunlight interception and soil moisture/nutrients with the young beet plants. Albeit, the only treatments that provided sucrose yields or levels of root protection that were significantly different from the untreated check were those that received a planting-time soil insecticide. It is important to note that these plots were established at a very late planting date (May 30). Thus, both beet and cereal plants would have been very young (5-9 days emerged) at the time of our highest SBRM fly activity in the plot area. Therefore, the cover crop canopy was not fully developed. This may explain the lack of cover crop impact on root protection from SBRM feeding injury. Finally, it should be noted that these are the results of our first year of seeding the cover crops at such low rates. From the data we have collected thus far, we cannot conclude that a positive impact on sugarbeet root protection or yield in relation to SBRM injury will be likely when oat, barley, or rye are seeded at 0.5, 1.0, or 1.5 bu (or OBE) per acre. Further research on these seeding rates is planned for the 2002 growing season.

Table 6. Impact of cereal cover crops and soil insecticides on management of sugarbeet root maggot larvae, St. Thomas, ND, 2001.

Treatment/ formulation	Rate lb (AI/ac)	Placement[a]	Cover Crop	Cover Rate (bu/ac)	Recoverable sucrose (lb/ac)	Yield (T/ac)	Sucrose (%)	Damage rating (0-9)	Gross return ($/ac)
Counter 15G	1.5	B	Rye	1.5	6366 a	21.5 a	16.4 a	2.23 d-g	608
Counter 15G	1.5	B	Rye	0.5	6229 a	20.1 ab	17.0 a	2.57 c-f	627
Counter 15G	1.5	B	Oat	0.5	6191 ab	19.9 abc	17.0 a	2.40 c-g	626
Counter 15G	1.5	B	Barley	0.5	6121 ab	19.4 a-d	17.1 a	2.13 efg	627
Counter 15G	1.5	B	Oat	1.5	6118 ab	20.5 ab	16.6 a	1.83 fg	592
Counter 15G	1.5	B	None	-	6066 abc	19.0 a-e	17.4 a	2.30 c-g	630
Counter 15G	1.5	B	Rye	1.0	6010 a-d	18.8 a-f	17.4 a	2.53 c-f	627
Counter 15G	1.5	B	Barley	1.0	5929 a-d	18.6 a-g	17.3 a	2.13 efg	617
Counter 15G	1.5	B	Barley	1.5	5866 a-e	18.7 a-g	17.1 a	1.57 g	598
Counter 15G	1.5	B	Oat	1.0	5857 a-e	19.1 a-e	16.9 a	2.43 c-g	584
Counter 15G	0.9	B	Oat	0.5	5732 a-f	19.5 a-d	16.3 a	2.57 c-f	543
Counter 15G	0.9	B	Oat	1.0	5488 a-g	17.1 b-j	17.5 a	2.73 b-f	574
Counter 15G	0.9	B	Oat	1.5	5487 a-g	17.6 b-h	17.1 a	2.13 efg	556
Counter 15G	0.9	B	None	-	5287 a-h	17.3 b-i	16.8 a	2.90 b-e	523
Check	-	-	Oat	1.5	5115 b-h	16.5 c-j	16.9 a	6.37 a	516
Counter 15G	0.9	B	Rye	1.0	4990 c-h	16.5 c-j	16.7 a	2.57 c-f	489
Counter 15G	0.9	B	Barley	1.5	4916 d-h	16.3 d-j	16.6 a	2.93 b-e	480
Counter 15G	0.9	B	Barley	1.0	4805 e-h	17.1 b-j	15.9 a	3.07 bcd	427
Check	-	-	Rye	1.0	4780 e-h	15.4 f-j	17.0 a	6.43 a	483
Check	-	-	Rye	0.5	4772 e-h	15.7 e-j	16.8 a	6.73 a	471
Check	-	-	Barley	1.0	4676 fgh	15.3 g-j	16.6 a	6.37 a	464
Check	-	-	Oat	1.0	4672 fgh	15.7 e-j	16.4 a	6.63 a	448
Check	-	-	Barley	0.5	4628 fgh	15.3 g-j	16.6 a	6.90 a	453
Check	-	-	Oat	0.5	4612 gh	14.8 hij	17.0 a	6.10 a	467
Check	-	-	Rye	1.5	4545 gh	14.5 hij	17.0 a	6.17 a	465
Check	-	-	None	-	4444 gh	16.3 d-j	15.5 a	6.63 a	380
Counter 15G	0.9	B	Rye	1.5	4392 gh	14.1 ij	17.1 a	3.20 bc	445
Counter 15G	0.9	B	Barley	0.5	4376 h	14.3 hij	16.9 a	3.50 b	434
Check	-	-	Barley	1.5	4315 h	13.9 j	16.9 a	6.47 a	436
Counter	0.9	B	Rye	0.5	4242 h	13.9 ij	16.8 a	3.03 b-e	419

Means within a column sharing the same letter are not significantly ($P > 0.05$) different (LSD).
[a]B = Band

Granular Incorporation and Postemergence Insecticides:

This study was also carried out at our St. Thomas site. The purpose of this trial was to evaluate the effectiveness of incorporation of postemergence soil insecticide granules. The experiment was planted (May 18) along the end of the field where soils had to be worked while somewhat wet. Thus, as mentioned in earlier sections of our report, replicate one had a poor SBRM infestation level and had to be excluded from our analysis. Soon after planting, a rain shower amounting to 0.32 inches fell on the plots on May 20. Thus, conditions were favorable for seed germination and activation of the planting-time soil insecticides. Insecticide treatments involved Counter 15G applied at standard and high (1.5 and 1.8 lb [AI]/ac, respectively) application rates without a postemergence material, and Counter at the low (0.9 lb [AI]/ac) rate followed by Thimet 20G applied at 1.5 lb (AI)/ac by using one of the following rotary tine incorporation methods: (1) front and rear; (2) rear only; or (3) non-incorporated. All insecticide treatments were compared with an untreated check (no insecticide), and the experiment was arranged in a randomized complete block design. The concept of having rotary tines in front of the granular drop zone was to break up the crust slightly and produce holes around beet plants for insecticide to fall into. Our theory was that the rear tines might accordingly do a more thorough job of incorporating the postemergence insecticide. In making the applications, we observed that this method will work well if there is a hard crust on the soil surface. However, difficulties can arise with the tines collecting clods and plugging with mud if the soil is too wet. The tine wheels can even stop rotating causing major problems in the affected row by pulling out or destroying seedlings. Postemergence granules were applied on June 7 and within 4 days 0.33 inches of rain fell. Thus, the rainfall should have served to provide excellent incorporation of the postemergence treatments.

This trial had a fairly heavy SBRM infestation level as was demonstrated by the average damage rating of 6.97 on the 0 to 9 rating scale (Table 7). Our results showed that there was no statistical difference between incorporated and non-incorporated postemergence granules. The best control when considering damage ratings was provided by Counter at the low (0.9 lb (AI)/ac labeled rate at planting in combination with a rear-incorporated application of Thimet (mean damage rating of 1.37). However, all insecticide treatments provided significant levels of root protection when compared with the root injury ratings from the untreated control plots. In comparing total recoverable sucrose, Counter 15G at the low (0.9 lb (AI)/ac labeled rate at planting in combination with a dual- (front and rear) incorporated application of Thimet yielded the highest, which was significantly greater than the standard (1.5 lb [AI]/ac) application of Counter without a postemergence rescue application. Additionally, with the exception of the standard rate of Counter (without a rescue application of Thimet), the insecticide treatments resulted in significant yield enhancements. One important factor that may have impacted our results was the 0.33-inch rainfall which occurred shortly (4 days) following our postemergence insecticide applications. It has been noted that if rain occurs shortly after granular application mechanical incorporation is not as crucial. Therefore, any otherwise detectable differences among incorporation methods or even between incorporated and non-incorporated treatments may have been obscured. This trial will be pursued in future years to evaluate these treatments under various environmental conditions.

Table 7. Effect of granule incorporation on performance of postemergence insecticides for controlling sugarbeet root maggot larvae, St. Thomas, ND, 2001.

Treatment/ formulation	Rate lb (AI/ac) Planting-time[a]	Rate lb (AI/ac) Post-emergence[a,b]	Placement[c]	Recoverable sucrose (lb/ac)	Yield (T/ac)	Sucrose (%)	Damage rating (0-9)	Gross return ($/ac)
Counter 15G +	0.9	-	B					
Thimet 20G	-	1.5 ICFR	B	6931 a	21.6 a	17.5 a	2.27 b	723
Counter 15G +	0.9	-	B					
Thimet 20G	-	1.5 NC	B	6640 ab	19.8 ab	18.0 a	1.93 bc	723
Counter 15G +	0.9	-	B					
Thimet 20G	-	1.5 ICR	B	6528 ab	20.0 ab	17.7 a	1.37 c	692
Counter 15G	1.8	-	B	6027 ab	18.6 abc	17.6 a	2.43 b	635
Counter 15G	1.5	-	B	5660 bc	17.2 bc	17.8 a	1.77 bc	605
Check	-	-	-	4971 c	16.0 c	17.0 a	6.97 a	500

Means within a column sharing the same letter are not significantly ($P > 0.05$) different (LSD).
[a] Postemergence granules applied June 7, 2001 Peak Fly = June 13, 2001
[b]NC = Not incorporated; ICFR = Incorporated with Front & Rear Tines; ICR = Incorporated with Rear Tines
[c]B = Band

Impact of Planting Date on Insecticide Efficacy:

This experiment carried out to determine the impact of planting/insecticide application date on performance of registered soil insecticides in controlling the sugarbeet root maggot. A major objective was also to attempt to elucidate the reason for extremely variable levels of performance at SBRM control by Temik 15G in the Red River Valley. The site chosen for this test was St. Thomas, ND. Treatments were arranged in a split-plot design (four replicates) with planting date serving as the main plot effect and insecticide as the sub-plot. Insecticide treatments involved 15G formulations of Counter, Lorsban, and Temik, all applied at the same rate of 1.5 lb (AI)/ac, as well as an untreated check. Our initial plan involved three planting dates; however, due to the extremely wet spring that plagued planting efforts for many producers in the Valley, we were not able to establish the early planting date. Therefore, our findings are restricted to comparisons of mid- and late-planted (May 16 and 29) treatments.

Results of this experiment are presented in Table 8. An excellent SBRM infestation occurred in the plots, as was demonstrated by the average damage ratings in the mid- and late-planted untreated control plots (7.05 and 6.95, respectively). Also, all insecticide treatments resulted in statistically reduced damage ratings when compared with that incurred in the untreated check plots. In examining beet damage rating means, we found that performance of Counter 15G was significantly better by using the late planting/application date. No significant impact of planting date on total recoverable sucrose yield was observed with Counter. Similarly, Temik resulted in statistically better root ratings in later-planted plots; however, yield was significantly lower in the late-planted plots that were treated with this material. No difference in root protection was observed among planting/application dates for Lorsban 15G, although the mid-planted plots treated with this material produced an enormous improvement (6,306 versus 3,916 lb) in total recoverable sucrose yield in comparison to the late-planted plots. The only treatments that failed to result in significantly higher sucrose yields than the untreated check were late-plantings with Lorsban 15G and Temik 15G at the insecticide component.

Much of these findings, especially regarding yield, correspond well with observations from previous years with higher yields being achieved in earlier-planted beets. However, it is interesting that neither yield nor damage rating was significantly impacted by planting date in the untreated controls of our study. This finding, in combination with demonstrated improvements in Counter and Temik efficacy by applying them later, suggests that post-application persistence of these two insecticides is probably a major factor behind a disparity in control among planting/application dates. However, these results are from only one year of data. Also, since we were lacking the early-plant cohort of treatments, further study is needed. We plan on continuing pursuit of this study in future years.

Table 8. Impact of planting/application date on performance of registered planting-time soil insecticide treatments for management of sugarbeet root maggot larvae, St. Thomas, ND, 2001.

Planting Date	Treatment/ formulation	Rate lb (AI/ac)	Placement[a]	Recoverable sucrose (lb/ac)	Yield (T/ac)	Sucrose (%)	Damage rating (0-9)	Gross return ($/ac)
Mid (May 16)	Lorsban 15G	1.5	B	6306 a	23.3 a	15.3 a	1.85 e	534
Mid (May 16)	Temik 15G	1.5	B	6004 a	22.0 a	15.4 a	4.93 b	515
Mid (May 16)	Counter 15G	1.5	B	5690 ab	21.8 a	15.0 a	3.38 c	457
Late (May 29)	Counter 15G	1.5	B	4732 bc	17.9 b	15.1 a	2.70 d	388
Late (May 29)	Temik 15G	1.5	B	4456 bcd	16.9 b	15.0 a	3.25 cd	364
Late (May 29)	Lorsban 15G	1.5	B	3916 cd	18.9 b	12.2 a	1.50 e	184
Mid (May 16)	Check	-	-	3601 cd	16.9 b	12.5 a	7.05 a	183
Late (May 29)	Check	-	-	3344 d	12.9 c	14.8 a	6.95 a	267

Means within a column sharing the same letter are not significantly ($P > 0.05$) different (LSD).
[a]B = Band

Foliar Experimental Insecticide Trial:

This trial was planted May 17, 2001 at St. Thomas. A major objective of the experiment was to evaluate several foliar treatments for control of adult sugarbeet root maggot flies. Secondarily, we wanted to evaluate the concept of applying foliar treatments at intervals that would coincide with microrate herbicide application timing. Since adults are very mobile, individual plot size was greatly enlarged to avoid confounding effects from possible inter-plot movement of flies. Treatment plots were each 35 ft long by 33 ft (three 6-row passes) wide and an additional untreated buffer zone of 11 ft (six rows) was placed between plots. The experiment was arranged in a randomized completed block design with four replications. Planting-time granular treatments were applied in a 7-inch band over the row and application rates of the granules were regulated by using Noble metering units mounted on a John Deere 71 Flex planter. Postemergence foliar liquid treatments were applied in a band over the row, and delivery was achieved by using a CO_2 cannister spray system mounted on a tool bar built by the NDSU Service Center.

Treatment combinations of Asana were designed to determine the most efficacious regimen of applying a seasonal total application rate of 0.05 lb (AI)/ac. Thus, the combinations included a single application of 0.05 lb, a dual split of 0.025 lb, and a three-way split of 0.012, 0.025, and 0.012 lb (AI)/ac. We went a step further with Mustang 0.8EW treatments, and actually tank-mixed the product with a standard microrate combination that consisted of the following: Betamix (0.5 pt/ac), Upbeet (1/8 oz), Stinger (2.6 oz), Select (2 oz), plus methylated seed oil at a reduced concentration of 0.75% (v/v). The concentration of oil in the tank mix was undertaken to avoid the likelihood of phytotoxic crop response due to addition of the oil-containing insecticide to the microrate. A microrate-only control was included (in addition to the true untreated control) in which the standard 1.5% (v/v) concentration of methylated seed oil was used.

Root damage ratings from the untreated check plots averaged a 6.13 on the 0 to 9 scale (Table 9). Thus, a fairly good root maggot infestation was present in this plot area. The treatment that provided the best combination of a low damage rating and high yield was Lorsban 15G (1.0 lb [AI]/ac) at planting plus Lorsban 4E (1 lb rate) postemergence produced the lowest damage rating (3.33) in the experiment and an excellent yield (6,964 lb recoverable sucrose/ac). Interestingly, Lorsban 4E applied postemergence without the planting-time application resulted in mean damage rating and sucrose yield values were not significantly different from the dual (Lorsban 15G at plant plus Lorsban 4E postemergence). The three-way split (0.012, 0.025 and 0.012 lb [AI]/ac) microrate-timed application of Asana provided a superior level of root protection to that of both the two-way (0.025 lb x 2) and the single (0.05 lb) treatments. Also, the three-way split application was the only Asana treatment combination that resulted in significantly lower damage ratings than the Lorsban 15G at-plant-only treatment. Relatively poor performance was achieved by using triple applications of Mustang at either 0.009 or 0.022 lb rates. In fact, none of the foliar Mustang treatments resulted in damage rating or sucrose yield values that were statistically different from the untreated control. It is important to note that, as indicated in Table 9, the stand-alone postemergence application of Lorsban 4E, all Mustang entries, and the microrate-only treatment did not receive a planting-time soil insecticide. Further work will be necessary to determine whether enhancing the efficacy of these products is possible and also to fully explore the concept of coinciding and tank-mixing SBRM fly control materials with microrate herbicide treatments. Due to less-than-acceptable performance by Mustang in this trial as a foliar material for fly control, NDSU extension will not recommend its use for that purpose unless more favorable levels of efficacy can be achieved by development of a more appropriate application methodology or rate is developed and labeled for use. Notwithstanding, these results are the product of only one year of foliar testing with is product.

Table 9. Performance evaluation of foliar insecticide treatments (standard postemergence & microrate-timing) for management of adult and larval stages of the sugarbeet root maggot, St. Thomas, ND, 2001.

Treatment/ formulation	Rate lb (AI/ac)		Placement[c]	Recoverable sucrose	Yield	Sucrose	Damage rating	Gross return
	Planting-time	Postemergence[a,b]		(lb/ac)	(T/ac)	(%)	(0-9)	($/ac)
Lorsban 4E	---	1.0	B	7036 a	22.8 a	16.8 a	3.80 fg	704
Lorsban 15G +	1.0	---	B					
Lorsban 4E	---	1.0	B	6964 a	22.8 a	16.9 a	3.33 g	692
Lorsban 15G +	1.0	---	B					
Asana 0.66EC	---	0.025	B					
Asana 0.66EC	---	0.025	B	6276 ab	19.3 bc	17.4 a	4.68 de	664
Lorsban 15G	1.0	---	B	6270 ab	20.3 ab	17.0 a	5.13 cd	630
Lorsban 15G +	1.0	----	B					
Asana 0.66EC	---	0.05	B	5806 b	19.2 bc	16.8 a	5.33 bcd	569
Lorsban 15G +	1.0	---	B					
Asana 0.66EC	---	0.012	B					
Asana 0.66EC	---	0.025	B					
Asana 0.66EC	---	0.012	B	5659 bc	18.1 bc	17.2 a	4.45 ef	577
Check	---	---	---	5646 bc	19.4 b	16.3 a	6.13 a	528
Lorsban 15G	1.5	---	B	5638 bc	17.5 bc	17.3 a	4.00 f	593
Mustang 0.8EW	---	0.009 x 3	B	5526 bc	18.3 bc	16.7 a	6.00 a	542
Mustang 0.8EW	---	0.022 + MR x 3	B	5496 bc	18.6 bc	16.3 a	6.40 a	524
Mustang 0.8EW	---	0.009 + MR x 3	B	5318 bc	18.4 bc	16.1 a	5.78 abc	494
Mustang 0.8EW	---	0.022 x 3	B	5313 bc	17.2 bc	17.0 a	6.15 a	533
Micro-Rate only	---	MR x 3	B	4761 c	16.2 c	16.4 a	5.88 ab	453

Means within a column sharing the same letter are not significantly ($P > 0.05$) different (LSD).
[a]Postemergence liquids applied June 12, 21, & 26, 2001 Peak Fly = June 13, 2001
[b]MR = Micro-Rate Herbicide
[c]B = Band

Location:	**St. Thomas, ND, Pembina County**	
Crop:	Sugarbeets	
Variety:	Van der Have 66140	
Plot Size:	Six 35-ft long rows, 4 Center rows treated	
Experimental Design:	Randomized complete block, 4 replicates	
Soil Name:	Silt Loam	
% OM, pH:	5.1% OM, 7.9% pH	
Previous Crop:	Potatoes - 2000	
Soil Preparation:	Kongskilde Triple K Field Cultivator worked once	
Herbicide:	Poast (0.4# AI/ac) + MSO (1.5%), July 2, 2001 - Cover Crop Experiment Betamix (0.5 pt/A) + Upbeet (1/8 oz/A) + Stinger (2.6 fl oz/A) + Select (2 fl oz/A) + MSO (1.5% v/v), June 1, 2001 Betamix (0.5 pt/A) + Upbeet (1/8 oz/A) + Stinger (2.6 fl oz/A) + Select (2 fl oz/A) + MSO (1.5% v/v), June 8, 2001 - No Select was applied to the Cover Crop Experiment. Did not spray the Dow, Dupont, FMC (DDF) Experiments Betamix (0.5 pt/A) + Upbeet (1/8 oz/A) + Stinger (2.6 fl oz/A) + Select (2 fl oz/A) + MSO (1.5% v/v), June 22, 2001 - Did not spray the DDF or Cover Crop	
ExperimentsFungicide:	Eminent (13 oz/ac), August 3, 2001	
Insecticide:	Noble applicators, granules 5" band (B), modified in furrow (M), spoon (S), 3" band over open seed furrow (TB), microtube directly in-furrow(M-tube); post granules, 4" band Postemergence liquids, 7" band	
Planting Depth:	1 1/4"	
Planting Date:	May 16, 2001	Registered, Planting Date (mid) Experiments
	May 17, 2001	Placement Methods, Planting-time vs Post granule studies, Postemergence Foliar
	May 18, 2001	Incorporation studies
	May 21, 2001	FMC Experiment
	May 22, 2001	Bio-control experiment
	May 29, 2001	Planting Date (late)
	May 30, 2001	Cover-crop Experiment
Post Treatments:	June 07, 2001	Post Granules; Planting-time vs Post, Incorporation
	June 12, 2001	Lorsban 4E; Planting-time vs Post granules Lorsban 4E, Asana, & Mustang; Postemergence Foliar
	June 21, 2001	Lorsban 4E; Planting-time vs Post granule studies Lorsban 4E, Asana, & Mustang; Postemergence Foliar
	June 26, 2001	Lorsban 4E, Asana, & Mustang; Postemergence Foliar
Rainfall:	May 16, 2001	0.10"
	May 20, 2001	0.42"
	May 23, 2001	0.39"
	May 27, 2001	0.28"
	May 31, 2001	0.16"
	Total/May	**1.35"**
	June 01, 2001	0.06"
	June 06, 2001	0.02"
	June 07, 2001	0.06"
	June 08, 2001	0.02"
	June 11, 2001	0.33"
	June 12, 2001	0.32"
	June 13, 2001	0.31"
	June 14, 2001	0.23"
	June 15, 2001	0.25"
	June 17, 2001	0.11"
	June 18, 2001	0.73"

	June 20, 2001	0.09"
	Total/June	**2.53"**
	July 02, 2001	0.08"
	July 09, 2001	0.04"
	July 16, 2001	1.16"
	July 18, 2001	1.39"
	July 21, 2001	0.10"
	July 27, 2001	2.46"
	July 31, 2001	1.36"
	Total/July	**6.59"**
	Total/August	**1.49"**
	Total/September	**0.47"**
Damage Ratings:	July 25, 26, 30, and August 1, 2, 6, 7, 8, 2001	
Harvest:	September 25, 26, 2001	
Harvest Sample:	2 center rows x 35' long - 70' total	

Location:	**Crookston, MN, Polk County**	
Crop:	Sugarbeet	
Variety:	Beta 2088	
Plot Size:	Six 35-ft long rows, 4 center rows treated	
Experimental Design:	Randomized complete block, 4 replicates	
Soil Name:	Wheatville Loam	
Previous Crop:	Wheat - 2000	
Soil Preparation:	Alloway Seedbedder	
Herbicide:	Betamix 0.5 pt/A, Upbeet 1/8 oz/A, Stinger 1.2 oz/A, Poast 5.3 oz/A, Meth oil 2.0 pt/A, May 21, 2001	
	Betamix 0.5 pt/A, Upbeet 1/8 oz/A, Poast 5.3 oz/A, Meth oil 1.0 pt/A, June 8, 2001	
	Betamix 0.5 pt/A, Upbeet 1/8 oz/A, Stinger 1.2 oz/A, Poast 5.3 oz/A, Meth oil 1.5 pt/A, June 17, 2001	
Fungicide:	Eminent 13 oz/A, August 6, 2001	
	Topsin M 0.5 lb/A + Supertin 5 oz/A, August 20, 2001	
Insecticide:	Noble applicators, granules banded (B) 5" band, modified in-furrow (M)	
Planting Depth:	1 1/2"	
Planting Date:	May 10, 2001	Registered Experiment
Rainfall:	May 12, 2001	0.04"
	May 16, 2001	0.15"
	May 20, 2001	0.45"
	May 21, 2001	0.02"
	May 22, 2001	0.30"
	May 23, 2001	0.20"
	May 26, 2001	0.01"
	May 27, 2001	0.53"
	May 31, 2001	0.47"
	Total/May	**2.17"**
	June 01, 2001	0.02"
	June 06, 2001	0.15"
	June 11, 2001	0.13"
	June 13, 2001	0.23"
	June 14, 2001	0.15"
	June 15, 2001	0.05"
	June 18, 2001	0.32"
	June 20, 2001	0.13"
	Total/June	**1.16"**
	July 02, 2001	0.16"
	July 06, 2001	0.06"
	July 14, 2001	0.65"
	July 16, 2001	0.03"
	July 18, 2001	0.05"
	July 19, 2001	1.07"
	July 20, 2001	0.20"
	July 21, 2001	0.15"
	July 22, 2001	0.50"
	July 27, 2001	0.42"
	July 29, 2001	0.24"
	July 31, 2001	3.11"
	Total/July	**6.64"**

Total/August	**2.50"**
Total/September	**2.55"**

Damage Ratings:	July 24, 2001
Harvest:	September 24, 2001
Harvest Sample:	2 center rows x 35' long - 70' total