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# No-till drilling cover crops after wheat harvest and their influence on next season's corn

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## Introduction

Over the past five years, Michigan has seen a 22 percent decline in wheat acres (Mich. Ag Stats, 2000-01). This decline is primarily because the markets for wheat have not been competitive with those for other field crops. Wheat is a very important rotational crop. Integrating wheat or rye into a corn-soybean rotation can increase corn yield by 10 percent (Copeland, personal communication, 1997). A small grain can also disrupt winter annual weed populations. Developing a more diverse crop rotation that includes a small grain will disrupt pest cycles and enhance soil quality.

We have known for a long time that growing one continuous crop ultimately results in yield reductions, pest problems and high fertility needs. For example, continuous corn requires a soil insecticide, herbicides and a high amount of nitrogen each year. If grown continuously, soybeans will likely develop a soybean cyst nematode problem. Because of this, most field crop farmers in Michigan have adopted a corn-soybean rotation system. Evidence now suggests that two-year rotations may not be long enough to break all pest cycles, however. Recent long-term two-crop rotations of corn and soybean have resulted in the development of variant behavior in female western rootworm beetles. These beetles will deposit eggs into standing soybean fields. When corn is planted in this soybean field next season, western corn rootworms (CRW) are ready and waiting. A corn-soybean rotation used to confuse the CRW, but now the CRW has adapted to this rotation. The end result is that farmers may need to use a soil insecticide even with a two-year corn-soybean rotation.

Using small grains as a third crop in a rotation provides farmers a better long-term soil, insect, weed and disease management system. Wheat is seeded after the Hessian fly-free date, usually into soybean stubble. Wheat and rye are winter annuals that are established in the fall and mature in Michigan in July. Because these small grains are seeded in the fall and harvested in midsummer, a window of opportunity exists to seed cover crops and further increase crop diversity.

Many farmers used to frost seed red clover into wheat. This seeding practice usually occurs in March when the ground is frozen in the morning

Todd Martin

*No cover crop drilled into wheat, control treatment showing weed population.*

Todd Martin

*Oilseed radish no-till drilled into wheat stubble in October, 1999.*

Todd Martin

*Crimson clover no-till drilled into wheat stubble, October, 1999.*

and thaws in the afternoon—the freeze-thaw action shallow incorporates the clover seed in the soil. Most of the initial growth of the red clover plant is root development. The wheat grows aggressively in the spring and early summer, shading the red clover's top growth. In July, wheat is harvested, and the red clover now receives full sunlight and, with adequate moisture, grows. At KBS we have demonstrated that frost-seeded red clover can reduce common ragweed populations (Mutch et al., 2003). Red clover, a biennial that acts like a perennial, allows the farmer to mow weeds and clover, which decreases weed populations and stimulates red clover growth.

Many farmers stopped seeding red clover when herbicides became available for wheat. The same herbicides that control broadleaf weeds also controlled the red clover. Therefore, red clover frost-seeded acreage has dramatically declined.

Because small grains are harvested in mid-July, farmers can usually no-till cover crops into the harvested fields. A study was initiated in late summer 1999 to evaluate four cover crops no-till drilled into harvested wheat stubble and their influence on weeds, nitrogen and corn yield.

In 1999, wheat was harvested July 6 and the straw was baled. On July 8, four cover crops and a control (no cover crop) were established. Crimson clover, oilseed radish, hairy vetch and soybeans were seeded at 15, 20 and 30 pounds per acre (lb./A) and 1 bushel/A, respectively. The cover crops grew and a biomass sample was taken October 20. Weeds and cover crops were separated, dried and weighed. Two biomass samples from 4 square feet were taken for each treatment.

**Table 1A. Fall biomass of cover crops compared with weed biomass, 1999[a].**

| Cover Crop | Biomass (lbs/A) | Weeds (lbs/A) |
|---|---|---|
| Oilseed radish | 2943 a | 44 b |
| Hairy vetch | 2644 a | 157 b |
| Crimson clover | 1917 b | 349 b |
| Soybeans | 808 c | 442 b |
| Control | 0 d | 2483 a |
| LSD @ 0.05 | 657 | 575 |

[a]Means within columns followed by the same letter are not significantly different at the 0.05 level by the least significantly different (LSD) test.

**Table 1B. Spring biomass of cover crops compared with weed biomass, 2000[a].**

| Cover Crop | Biomass (lbs/A) | Weeds (lbs/A) |
|---|---|---|
| Oilseed radish | 0 c | 113 c |
| Hairy vetch | 5199 a | 0 c |
| Crimson clover | 5962 b | 38 c |
| Soybeans | 0 c | 322 b |
| Control | 0 c | 728 a |
| LSD @ 0.05 | 908 | 206 |

[a]Means within columns followed by the same letter are not significantly different at the 0.05 level by the least significantly different (LSD) test.

Oilseed radish and hairy vetch resulted in the highest cover crop biomass in the fall. All cover crop treatments reduced weed biomass compared with the control (no cover crop) (Table 1A).

Spring biomass samples showed that hairy vetch and crimson clover (both legumes) had doubled their fall biomass weights (Table 1B).

Corn was planted into the cover crop treatments May 8 at 28,000 plants/A. The field was prepared by a chisel plow and disked. A broadcast herbicide treatment of 2.1 qt. of Bicep II Magnum™ was used to control weeds. The corn plots received nitrogen at either 0, 60 or 120 lb./A. Ammonium nitrate was sidedressed to evaluate the nitrogen effect of the cover crops.

In spring 2000, a presidedress nitrogen test (PSNT) was taken for each cover crop treatment.

### Table 2. 2000 nitrogen credits determined by PSNT[a].

| Cover Crop | Nitrogen Credit (lbs/A) |
|---|---|
| Hairy vetch | 101 a |
| Crimson clover | 68 b |
| Radish (OSR) | 38 c |
| Soybeans | 20 c |
| Control | 20 c |
| LSD @ 0.05 = 25.39 | |

[a]Means within columns followed by the same letter are not significantly different at the 0.05 level by the least significantly different (LSD) test.

Hairy vetch provided the greatest N credit. Crimson clover had a significantly greater N credit than oilseed radish, soybean or the control (Table 2).

Corn was harvested and yield of the plots with the cover crops and three nitrogen rates compared.

### Table 3. Precipitation at KBS.

| Month | Year 2000 (inches) | Year 2001 (inches) |
|---|---|---|
| May | 7.6 | 6.1 |
| June | 2.7 | 3.7 |
| July | 3.1 | 1.4 |
| August | 5.0 | 3.6 |
| September | 4.3 | 1.8 |
| Total | 22.7 | 16.6 |

## Discussion

The growing season of 2000 was excellent for corn growth. Timely rainfall provided exceptional corn yield on this sandy loam soil (Table 3).

The highest yield (185 bu./A) resulted when 120 lb. N/A was applied to the oilseed radish (OSR) cover crop treatment. Yield in this treatment was significantly greater than with 0 lb. N/A and OSR;

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*Hairy vetch no-till drilled in wheat stubble, October, 1999.*

with 0, 60 and 120 lb. N/A with soybean, and with 0 and 60 lb. N/A and the no cover control. There was no significant yield difference between the 120 lb. N/A OSR treatment and all N rates applied to the hairy vetch treatment. The PSNT test results (Table 2) indicate an N credit of 101 lb./A for hairy vetch and 68 lb./A for crimson clover; 120 lb. N/A with no cover crop resulted in significantly lower yield than 120 lb. N/A with OSR as a cover crop. Legume cover crops such as hairy vetch or crimson clover have excellent growth, and N rates on corn can be reduced without significant yield loss (Table 4).

There was no significant difference in yield for the hairy vetch and crimson clover treatments at the three N levels. When 120 lb. N/A was added, the yield of corn planted into oilseed radish was significantly increased over 0 and 60 lb. N/A. The control and soybean cover treatments responded to nitrogen levels of 60 and 120 lb. N/A (Table 5).

To evaluate how the corn plant utilized nitrogen throughout the growing season, end-of-season stalk nitrate samples were taken for each of the treatments.

Stalk nitrate-N levels are divided into three categories: low (less than 700 ppm), optimal (700-2000 ppm) and excessive (greater than 2000 ppm). The low range indicates that greater N availability would have resulted in higher yields. The optimum range indicates that N availability was within the range needed to maximize profits. The excessive range means that N availability exceeded crop need (Silva, 2000). The higher end of the optimum range (2000) is more appropriate when N fertilizer

### Table 4. Corn yield comparison across all cover crop and nitrogen rates, 2000[a].

| Cover crop | Nitrogen Rate (lbs/A) | | |
|---|---|---|---|
| | 0 | 60 | 120 |
| Oilseed radish | 148 e | 165 abcde | 185 a |
| Hairy vetch | 174 abc | 173 abc | 182 ab |
| Crimson clover | 165 abcde | 165 abcde | 162 bcde |
| Soybean | 118 f | 150 de | 155 cde |
| Control | 118 f | 149 de | 169 abcd |
| LSD @ 0.05 = 20.6 | | | |

[a]Means within columns followed by the same letter are not significantly different at the 0.05 level by the least significantly different (LSD) test.

### Table 5. Corn yield as influenced by cover crop species and nitrogen rate, 2000[a].

| Cover crop | Nitrogen Rate (lbs/A) | | |
|---|---|---|---|
| | 0 | 60 | 120 |
| Oilseed radish | 148 b | 164 b | 185 a |
| Hairy vetch | 174 a | 173 a | 182 a |
| Crimson clover | 164 a | 165 a | 162 a |
| Soybean | 118 b | 150 a | 155 a |
| Control | 118 b | 149 a | 169 a |
| LSD 0.05 = 19.5 | | | |

[a]Means within columns followed by the same letter are not significantly different at the 0.05 level by the least significantly different (LSD) test.

### Table 6. Corn stalk nitrate residual (ppm) samples comparing cover crop/nitrogen application, 2000[a].

| Cover crop | Nitrogen Rate (lbs/A) | | |
|---|---|---|---|
| | 0 | 60 | 120 |
| Oilseed radish | 13 f | 786 ef | 2503 d |
| Hairy vetch | 3572 cd | 7354 a | 6238 ab |
| Crimson clover | 29 f | 2501 de | 4923 bc |
| Soybean | 9 f | 27 f | 449 f |
| Control | 11 f | 14 f | 725 f |
| LSD @ 0.05 = 1726 | | | |

[a]Means within columns followed by the same letter are not significantly different at the 0.05 level by the least significantly different (LSD) test.

is relatively cheap and grain prices are relatively high. The lower end of the optimum range (700) is most appropriate when N fertilizer is relatively expensive and grain prices are relatively low (Silva, 2000).

All hairy vetch cover crop treatments resulted in excessive stalk nitrate levels. Crimson clover resulted in excessive stalk nitrate levels when 60 and 120 lb. N/A were applied. However, a low stalk nitrate level resulted when no N fertilizer was applied (Table 6).

The same cover crop treatments were no-till seeded in summer 2000 into a harvested wheat field. Cover crops were seeded July 18, 2000. Two biomass samples from 4 square feet were taken November 2, 2000.

Oilseed radish provided the highest biomass production. There was no significant difference between hairy vetch and crimson clover. Soybean and no cover control were significantly lower in biomass than crimson clover, hairy vetch and oilseed radish. The highest weed biomass was collected in the control treatment. Weeds were lowest in the oilseed radish and hairy vetch treatments.

Spring biomass was not collected in 2001 because winterkill injury to all cover crops resulted in no spring biomass production.

PSNT levels were lower in 2001 than in 2000. Hairy vetch resulted in the highest nitrate level in 2001. It was less than half the N credit in 2000. This may be related to the cover crop being winterkilled and having no regrowth in the spring of 2001.

Corn was planted May 7, 2001, and 1.6 qt. Bicep II Lite™ and 0.5 qt. atrazine were broadcast sprayed. Buctril™ was sprayed at 1.5 lb./A to control common lambsquarters. Three N rates were applied June 26 (0, 60 and 120 lb. N/A as described in the 2000 growing season).

### Table 7. Fall, comparing cover crop to weed biomass, 2000[a].

| Cover Crop | Biomass (lbs/A) | Weeds (lbs/A) |
|---|---|---|
| Oilseed radish | 5273 a | 324 c |
| Hairy vetch | 2791 b | 643 c |
| Crimson clover | 2423 b | 1404 b |
| Soybeans | 269 c | 1827 ab |
| Control | 0 d | 2233 a |
| LSD @ 0.05 | 701.7 | 522.1 |

[a]Means within columns followed by the same letter are not significantly different at the 0.05 level by the least significantly different (LSD) test.

### Table 8. PSNT for several cover crop treatments, 2001[a].

| Treatment | Nitrogen Credit (lbs/A) |
|---|---|
| Hairy vetch | 48 a |
| Soybeans | 41 ab |
| Crimson clover | 38 bc |
| Oilseed radish | 36 bc |
| Control | 30 c |
| LSD @ 0.05 = 10.09 | |

[a]Means within columns followed by the same letter are not significantly different at the 0.05 level by the least significantly different (LSD) test.

### Table 9. Corn yield comparison across all cover crop and nitrogen rates, 2001[a].

| Cover crop | Nitrogen Rate (lbs/A) | | |
|---|---|---|---|
| | 0 | 60 | 120 |
| Oilseed radish | 107 bc | 110 abc | 105 c |
| Hairy vetch | 110 abc | 106 c | 111 abc |
| Crimson clover | 118 abc | 108 abc | 115 abc |
| Soybean | 108 abc | 124 a | 109 abc |
| Control | 111 abc | 112 abc | 122 ab |
| LSD @ 0.05 = 16.1 | | | |

[a]Means within columns followed by the same letter are not significantly different at the 0.05 level by the least significantly different (LSD) test.

The growing season of 2001 saw long periods of no rainfall, which resulted in lower corn yields (Table 3) across all cover crop treatments. The highest corn yield resulted when 60 lb. N/A was applied to the soybean cover crop treatment. Yield from the soybean treatment was significantly higher than that of the oilseed radish at 0 and 120 lb. N/A, and the hairy vetch treatment at 60 lb. N/A (Table 9).

Corn yield with all cover crops except soybean had no significant differences with N fertilizer at 0, 60 and 120 lb./A. The soybean cover crop had significantly higher corn yield at 60 lb. N/A than with no nitrogen (Table 10). The lack of a nitrogen response is attributable to the dry growing conditions in 2001.

Again in 2001, all hairy vetch cover crop treatments resulted in excessive nitrate levels in the stalk. Also, crimson clover treatments had excessive stalk nitrate levels at 60 and 120 lb. N/A, similar to 2000. Excessive stalk nitrate level resulted when 120 lb. N/A was applied to OSR treatments, too. A similar trend of stalk nitrate accumulation occurred in 2000, even though PSNT and yield were lower in 2001.

## Conclusion

PSNT tests indicated that legume cover crops such as hairy vetch and crimson clover provided 101 and 68 lb. N/A for corn in 2000 when they were no-till drilled following wheat harvest. In 2000, these two cover crops overwintered and almost doubled their fall biomass in the spring. In 2001, the same cover crop treatments winterkilled and therefore had no substantial growth in the spring, and PSNT tests showed reduced nitrate levels. All cover crops tested reduced weed populations, compared with bare soil controls in all years of establishment.

Corn yield was higher in 2000 than in 2001. Timely rainfall in 2000 enhanced corn yields, and a lack of rainfall during the 2001 season reduced corn yield.

No-till drilling legume cover crops such as hairy vetch and crimson clover following

### Table 10. Corn yield as influenced by cover crop species and nitrogen rate, 2001[a].

| Cover crop | Nitrogen Rate (lbs/A) | | |
|---|---|---|---|
| | 0 | 60 | 120 |
| Oilseed radish | 107 a | 110 a | 105 a |
| Hairy vetch | 110 a | 106 a | 111 a |
| Crimson clover | 118 a | 108 a | 115 a |
| Soybean | 108 a | 124 b | 109 ab |
| Control | 111 a | 112 a | 122 a |
| LSD @ 0.05 = 15.3 | | | |

[a]Means within columns followed by the same letter are not significantly different at the 0.05 level by the least significantly different (LSD) test.

### Table 11. Cornstalk nitrate residual (ppm) samples comparing cover crops and nitrogen applications, 2001[a].

| Cover crop | Nitrogen Rate (lbs/A) | | |
|---|---|---|---|
| | 0 | 60 | 120 |
| Oilseed radish | 35 d | 1146 cd | 2944 bc |
| Hairy vetch | 3046 bc | 4471 ab | 5389 a |
| Crimson clover | 694 d | 2149 ce | 4407 ab |
| Soybean | 50 d | 517 d | 1187 cd |
| Control | 120 d | 247 d | 1733 cd |
| LSD @ 0.05 = 2191 | | | |

[a]Means within columns followed by the same letter are not significantly different at the 0.05 level by the least significantly different (LSD) test.

wheat harvest provides an opportunity for farmers to reduce N rates without significantly reducing yield. Oilseed radish, a non-legume broadleaf cover crop, provided the most fall biomass and the lowest weed weights, but supplemental N was needed for higher corn yields. Soybeans resulted in the lowest biomass fall production both years, and supplemental N was needed for higher corn yields.

Cover crops can serve as an important production tool for farmers. No-till drilling cover crops after wheat harvest will reduce weed populations and N rates for corn the following season.

## References

Mutch, D. R., T. E. Martin and K. R. Kosola. 2003. Red clover (Trifolium pratense) suppression of common ragweed (Ambrosia artemisiifolia). Weed Technology, vol. 17:181-185.

Silva, G. H. 2000. End-of-season cornstalk nitrate N test. AoE Field Crops Team On-Farm Research and Demonstration, pg. 15, Feb. 2000.



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