**Objectives:**

 Objective 1. To determine the effect of white mustard and winter camelina on SCN population densities both in late fall after establishment but before frost and in the following year after soybean has been harvested

Objective 2. To determine the effect of cover crops on soil cover and nutrient accumulation

Objective 3. To determine the effect of cover crops on soybean yield and quality.

**Achievements:**

***Objective 1***
Soybean cyst nematode populations had an interesting fluctuation over time.  No differences were observed among cover crop treatments or varieties in the soil collected after the cover crops establishment in the fall of 2018 or in the spring of 2019 at either location (Table 1).

The SCN population density increased from spring to fall in the plots planted to the susceptible variety which had significantly greater SCN egg densities than plots planted to the resistant variety at both locations.

The winter camelina treatment had significantly lower SCN-egg densities in plots planted to the SCN susceptible variety compared with the no-cover check plots in Prosper but not in Crookston. In plots planted to the SCN-resistant variety, both cover crops treatments had lower SCN numbers than the no-cover check plots at both locations. This response may indicate that cover crops can aid the SCN-resistant variety to keep SCN in check.  Even though in plots planted to the resistant variety, SCN population densities increased 2- to 5-fold from spring to fall in Prosper. This is worrisome, indicating that SCN-resistant varieties on their own may not be capable of stopping SCN reproduction completely, resulting in increased SCN population densities over time. In contrast, in Crookston, the SCN-resistant variety was able to suppress SCN reproduction in all treatments. As in Prosper there is a trend to have a greater SCN suppression in plots that had the winter camelina or mustard cover crop treatments in the resistant variety.

These results are similar to those observed in a cover crops interseeding study that is part of a ND Soybean Council funded project. In this project, we also observed that in plots planted to the SCN-susceptible variety, camelina interseeded into V6-stage soybeans, SCN population densities were suppressed compared with the no-cover check treatment, but as in this study cover crops whether planted in the season previous to soybean or interseeded into V6 soybeans aid the SCN resistant variety in suppressing SCN population growth. In a greenhouse study, it was shown both winter camelina and brown mustard suppressed SCN by 60% and 51%, respectively (Acharya et al., 2019), which also supports the results and trends observed in these experiments. More research is needed to confirm these results, but given the great variability in SCN distribution in the soil the results obtained are quite promising.

**Table 1. Soybean cyst nematode population densities at Prosper and Crookston  before planting the cover crops in the fall 2018, in the spring of 2019 before planting soybean and fall 2019 after harvesting soybean averaged across plots planted to two soybean varieties [susceptible (S) and resistant (S)]**

|  |  |  |  |
| --- | --- | --- | --- |
|   | Fall 18 | Spring 19 | Fall 19 |
| Cover crop | S | R | S | R | S | R |
|   | -------------------------------SCN eggs/100 cm3-------------------------------- |
|   | Crookston |
| Winter camelina | 850 | 1000 | 850 | 362 | 4912b | 1587a |
| Brown mustard | 1600 | 325 | 925 | 875 | 8412a | 1212a |
| Check | 1225 | 875 | 1075 | 550 | 7387a | 2087a |
|    LSD(0.05) | NS | NS | 2791 |
|    Mean variety | 1225 | 721 | 950 | 596 | 6904a | 1629b |
|   | Prosper |
| Winter camelina | 2887 | 2612 | 2675 | 1800 | 8762a | 212a |
| Brown mustard | 2175 | 2237 | 3012 | 2000 | 3900b | 100a |
| Check | 3187 | 3787 | 1875 | 2350 | 4200b | 1037a |
|    LSD (0.05) | NS | NS | 3040 |
|    Mean variety | 2750 | 2879 | 2520 | 2050 | 5621a | 450b |

 ***Objective 2***
Soil nitrate (NO3-N) was significant lower in winter camelina compared with the check and brown mustard, in Crookston (Table 2). Winter camelina survives the winter and is a good NO3-N scavenger. This characteristic makes camelina an interesting cover crop to reduce soil NO3-N leaching in the fall and spring.

**Table 2.  Soil NO3-N in spring and fall 2019 averaged across two soybean varieties in Prosper and Crookston**

|  |  |  |
| --- | --- | --- |
|   | Prosper | Crookston |
| Cover crop | Spring | Fall | Spring | Fall |
|   | Soil NO3-N (lbs/acre) |
| Winter camelina | 17.1 | 29.8 | 26.5 | 37.6 |
| Brown mustard | 19.9 | 32.9 | 52.4 | 31.0 |
| Check | 20.4 | 28.2 | 35.8 | 26.9 |
| LSD(0.05) | NS | NS |  2.1 | NS |

 Soil samples were taken from 0-24 inches deep.

***Objective 3***
Soybean seed yield was lower in the susceptible variety compared with the resistant variety, averaged across all cover crop treatments in Prosper (Table 3).  In Crookston, the susceptible variety had lower yield than the resistant variety but the difference was not significant. No differences in seed yield between the check and the plots that had cover crops were observed.
Protein content did not differ between both varieties and cover crop treatments while oil content was slightly higher in the susceptible variety averaged across treatments (Table 3).

**Table 3. Seed yield, crude protein and oil content of SCN resistant (R) and susceptible (S) soybean varieties**

|  |  |  |  |
| --- | --- | --- | --- |
|   | Seed yield (bu/acre) | Protein content (%) | Oil content (%) |
| Cover crop | S | R | S | R | S | R |
|   | Prosper |
| Winter camelina | 35.4 | 41.9 | 32.3 | 32.2 | 18.5 | 18.1 |
| Brown mustard | 35.2 | 42.2 | 32.5 | 31.9 | 18.3 | 18.2 |
| Check | 35.3 | 43.2 | 32.3 | 32.5 | 18.5 | 17.9 |
| LSD(0.05) | 6.3 | NS | 0.3 |
| Mean variety | 35.3b | 42.4a | 32.3 | 32.2 | 18.4 | 18.1 |
|   | Crookston |
| Winter camelina | 34.4 | 33.5 | . | . | . | . |
| Brown mustard | 29.3 | 44.0 | . | . | . | . |
| Check | 26.6 | 42.1 | . | . | . |   |
| LSD (0.05) | NS | . | . | . | . |
| Mean variety | 30.1a | 39.9a | . | . | . |   |

**Publication(s)/Symposium:**

Peer-reviewed publication Acharya, K., G. Yan, and M.T. Berti. 2019. Can camelina, crambe, and brown mustard reduce soybean cyst nematode populations? Ind. Crops. Prod. 140:111637. Acharya, K., G. Yan, and M.T. Berti. 2020. Evaluation of diverse cover crops as hosts of two populations of soybean cyst nematode, Heterodera glycines. Crop Protection doi:1016/j.cropro.2020.105205 The research in these publications was funded mainly by the North Dakota Soybean Council but it was the work that prompt this research in the field funded by MN soybean growers. Presentations in conferences or to growers 1. Berti, M.T. 2020. Cover crops North Dakota Report. Midwest Cover Crop Council Conference. Kansas City, MO 10-12 February 2020. 2. Berti, M.T. 2019. Managing soybean cyst nematode with cover crops. Prairie Grains Conference Grand Forks, 11-12 December 2019. Invited 3. Berti, M.T. 2019. Using cover crops to manage soybean cyst nematode. Cover crops field day September 17, Fargo, ND. 4. Berti, M.T., 2019. Importance of integrating cover crops into cropping systems. First International Cover Crops Conference, Lanzhou, China 20-26 September. Invited speaker. 5. Wick, A., M. Berti, J. Ikley, D. Franzen. 2019. Soil health tours: Cover crops on prevented planting 17-18 June, 2019, Casselton, Valley City, Gwinner and Jamestown, ND. The preliminary results of this project were discussed at these talks. 6. Peltier, A.J. and M.T. Berti, July 17, 2019. SCN Management: Thinking outside the box. University of Minnesota Northwest Research & Outreach Center Crops & Soils Day. 7. Peltier, A.J. July 17, 2019. SCN Management: Thinking outside the box. KRJB radio interview. 8. Peltier, A.J. July 17, 2019. SCN Management: Thinking outside the box. Red River Farm Network (syndicated) radio interview.