**Management of Soybean Aphids and Interaction with Soybean Cyst Nematode**

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**Situation Statement:**

This applied research will evaluate the different pest management strategies to determine the ‘best’ strategy for management of soybean aphids in North Dakota. Secondly, it will exam the interaction between soybean cyst nematode and soybean aphids, two key pests of soybean. Results will provide producers with ‘best’ pest management recommendations for each pest alone, or when both pests occur together.

**Objectives and Goals:**

The overall goals of the project were to conduct applied pest management research on soybean aphids and soybean cyst nematode (SCN), two major soybean production pests in North Dakota, and convey the results and subsequent management recommendations to soybean producers through Extension outreach activities so that producers have the knowledge needed to successfully manage these pests.

Specifically, the objectives were to:

1. Examine the efficacy of an insecticidal seed treatment, timings of foliar-applied insecticides (including a biorational insecticide), seed treatment/foliar application timings, and a *Rag1* aphid-resistant variety
2. Compare SCN reproduction in SCN susceptible and resistant varieties under different managed soybean aphid population levels

**Results and Findings:**

**Objective 1:**

Soybean trials were planted at cooperator fields near Emerado on May 26, near Harwood on May 27 and at the Casselton Agronomy farm on May 27. Plots were harvested at Emerado on October 2, and at Harwood and Casselton on October 9. At all locations, plots were arranged in a randomized complete block design with four replications. Plots were 10 feet wide (four 30-inch rows) by 25 feet long and planted at a target population of 150,000 plants per acre. The varieties used were Peterson Farms Seed 12R007 (group 00.7 maturity) at Emerado and 12R05 (group 0.5 maturity) at Harwood and Casselton. A Syngenta group 1 *Rag1* variety was used at all locations. Treatments and application rates are listed in Table 1. Because of recent questions about using foliar-applied sugar and the sugar-based product sucrose octanoate for soybean aphid control, these treatments were added this year in addition to conventional insecticides.

 Soybean aphids were sampled weekly by selecting 10 random plants from the center two rows of each plot and calculating an average number of aphids per plot. These values were used to calculate cumulative aphid days (CAD) after each sampling date. Sampling dates, insecticide application dates and associated plant growth stages are given in Table 2. All data were analyzed using SAS statistical software.

Aphid pressure was heavy at Emerado and Harwood, with populations approaching or exceeding 20,000 CAD. The economic threshold (ET) of 250 aphids per plant equates to approximately 4,500 CAD. At both of these locations, aphids reached the ET in the third week of July, about two weeks earlier than usual. Aphid pressure at Casselton was much lighter and just barely reached the ET by the second week of August. Treatment means for CAD and yield are presented in Table 3.

 In general, all foliar-applied conventional insecticides kept aphids from exceeding economic levels regardless of application timing. This is reflected in the treatment means for CAD and yield. Foliar applications of sugar and sucrose octanoate were not significantly different from the untreated checks for CAD and yield regardless of application timing. The exception was the R1 sugar treatment at Harwood, which had significantly fewer CAD and a higher yield than the untreated checks. This is likely due to the fact that two of the four plots had low post-treatment aphid counts, while the other two plots had high post-treatment counts. At Casselton, aphid numbers were too low to make inferences about treatment efficacy. Even so, the relative uniformity of yields across treatments suggests that foliar insecticide applications should be made only when the ET has been reached – there is no advantage to spraying early.

 The use of Cruiser Maxx (thiamethoxam) seed treatment kept aphids from reaching the ET at Emerado, but not at Harwood where CAD and yield were not significantly different from the untreated checks. Harwood experienced cool, wet weather prior to and immediately after planting, and this may have reduced the efficacy of the seed treatment. There were no significant differences between Cruiser Maxx + Warrior II (lambda-cyhalothrin) applied at ET and Warrior II alone applied at ET for yield at all three locations. These data suggest that while use of thiamethoxam as a seed treatment may provide control of soybean aphids in certain situations, its use in controlling soybean aphids is not necessary and is an added expense that producers can avoid.

 There were no significant differences for yield between Warrior II applied at R1 and Warrior II applied at ET at Emerado and Harwood. At Casselton, the yield difference between these two treatments was significant. While early foliar insecticide applications may seem inexpensive and convenient when tank mixing with a herbicide, we do not recommend this practice because soybean aphid natural enemies can be killed and later-season aphid infestations can and still do reach economic levels, requiring a second application. Again, a well-timed foliar insecticide application at the economic threshold will provide control of soybean aphid and should not result in a yield loss.

 The *Rag1* treatments kept soybean levels below economic injury levels. At Harwood, all *Rag1* treatments did slightly exceed the ET but had significantly fewer CAD than the untreated checks. Yields among the *Rag1* treatments were not significantly different at all locations. At Emerado, the *Rag1* treatments had significantly higher yields than all other treatments, but this is not surprising since the *Rag1* variety was maturity group 1 and the variety used in the other treatments was maturity group 00.7.

**Objective 2:**

For the soybean aphid/SCN study, trials were planted in late May at cooperator fields near Absaraka and Hankinson. Plots were arranged in a randomized complete block design with split-plots. Soybean varieties were the whole plots and soybean aphid treatment timings were the subplots. Two soybean varieties were used – one SCN-resistant and one SCN-susceptible. The SCN-resistant variety was Peterson Farms Seed 15R05N, and the susceptible variety was Peterson Farms Seed 12R05. The two varieties were selected based on SCN resistance and similar maturity and yield performance in prior varietal trials. Three soybean aphid treatment timings were used – an aphid-free (AF, multiple foliar insecticide applications), a single foliar application at ET, and no foliar insecticide treatment (UT, untreated). The foliar insecticide used was Warrior II (lambda-cyhalothrin) applied at 1.6 fl oz per acre. All seed was treated with Apron Maxx fungicide at a rate of 5 fl oz per cwt.

 SCN was sampled in early June just after planting, and again in late September just prior to harvest. Sampling was conducted by taking 12-inch deep soil cores from 10 random locations within the center two rows of each subplot, and combining the subplot cores to obtain a single SCN value (eggs + juveniles per 100 cc of soil) for each subplot. Soybean aphids were sampled weekly by selecting 10 random plants from the center two rows of each subplot and calculating an average number of aphids per subplot. These values were used to calculate cumulative aphid days (CAD) after each sampling date. Sampling dates, insecticide application dates and associated plant growth stages are given in Table 4. All data were analyzed using SAS statistical software.

 Treatment means for June (initial) SCN, September (final) SCN, CAD and yield at both locations are presented in Table 5. At Absaraka, SCN levels were very low in June and decreased to almost zero in September. Soybean aphid numbers began building in mid-June, but a severe thunderstorm with wind, heavy rain and small hail on July 27 washed the aphids from the plants and the population never recovered. Treatment means were not significantly different for SCN in June and September, CAD and yield

 At Hankinson, overall SCN levels were low, but generally increased from June to September. Soybean aphid numbers built up to just short of the ET. The ET was met in some of the plots requiring foliar application at ET, and all ET plots were sprayed at that time. For variety regardless of aphid population level, the September SCN level was significantly greater in the susceptible variety than in the resistant variety. SCN levels increased significantly (four to sixfold) from June to September in the susceptible variety, regardless of aphid population level (Figure 1). In the resistant variety, SCN levels in the AF treatment had a very slight decrease from June to September. SCN levels in the ET treatment had a 1.3x increase from June to September, while the UT treatment showed a 2.4x increase (Figure 1). CAD values for aphid population levels in the resistant variety ranged from 89 in the AF treatment to 1,901 in the UT treatment. This increase in SCN with a concomitant increase in soybean aphid numbers in the resistant variety is consistent with the findings of McCarville et al. (2014), who found an increase in SCN reproduction under low densities of soybean aphids in their resistant varieties. However, McCarville et al. (2014) also observed a decrease in SCN reproduction with increasing soybean aphid densities on their susceptible varieties, which we did not observe in our trial. There were no significant differences for yield, likely because CAD or SCN levels were not high enough to impact yield.

**Table 1. Soybean aphid management treatments and application rates, 2015.**

|  |  |
| --- | --- |
| **Treatment Number** | **Treatment** |
| 1 | Naked Seed (check) |
| 2 | Apron Maxx (fungicide check) |
| 3 | Cruiser Maxx |
| 4 | Cruiser Maxx + Warrior II at ET |
| 5 | Apron Maxx + Warrior II at R1 |
| 6 | Apron Maxx + Warrior II at ET |
| 7 | Apron Maxx + Sugar at R1 |
| 8 | Apron Maxx + Sugar at ET |
| 9 | Apron Maxx + Sucrose Octanoate at R1 |
| 10 | Apron Maxx + Sucrose Octanoate at ET |
| 11 | Rag1 Naked Seed |
| 12 | Rag1 + Apron Maxx |
| 13 | Rag1 + Cruiser Maxx |

Apron Maxx applied at 5 fl oz/cwt

Cruiser Maxx applied at 3 fl oz/cwt

Warrior II applied at 1.6 fl oz/acre

Sugar applied at 10% v/v

Sucrose Octanoate applied at 1% v/v

**Table 2. Sampling dates, plant growth stages and application dates at Emerado, Harwood and Casselton in 2015.**

|  |  |  |
| --- | --- | --- |
| **Emerado** | **Harwood** | **Casselton** |
| **Sampling****Date** | **Growth****Stage** | **Spray****Dates** | **Sampling****Date** | **Growth****Stage** | **Spray****Dates** | **Sampling****Date** | **Growth****Stage** | **Spray****Dates** |
| 7/8 | V5 |  | 7/6 | V5 |  | 7/6 | V5 |  |
| 7/14 | R1 | 7/14 (R1) | 7/13 | R1 | 7/14 (R1) | 7/13 | R1 | 7/14 (R1) |
| 7/21 | R2 | 7/22 (ET) | 7/20 | R1/R2 | 7/21 (ET) | 7/20 | R1/R2 |  |
| 7/28 | R3 |  | 7/27 | R2 |  | 7/27 | R2 |  |
| 8/4 | R3/R4 |  | 8/5 | R3 |  | 8/5 | R3 |  |
| 8/11 | R4 |  | 8/10 | R3/R4 |  | 8/10 | R3/R4 | 8/11 (ET) |
| 8/19 | R5 |  | 8/18 | R4 |  | 8/18 | R4 |  |
| 8/26 | R6 |  | 8/25 | R5 |  | 8/25 | R5 |  |

**Table 3. Treatment means for cumulative aphid days (CAD) and yield (bu/acre) at Casselton, Emerado and Harwood in 2015.**

|  |  |  |
| --- | --- | --- |
| **Casselton** | **Emerado** | **Harwood** |
| **Treatment** | **CAD1** | **Yield1** | **Treatment** | **CAD1** | **Yield1** | **Treatment** | **CAD1** | **Yield1** |
| Warrior II R1 | 415 ef | 64.9 a | Rag1 Naked Seed | 1,063 c | 53.0 a | CM + Warrior II ET | 3,749 bc | 54.9 a |
| Rag1 Apron Maxx | 628 def | 62.2 ab | Rag1 Cruiser Maxx | 922 c | 52.8 a | Warrior II ET | 729 c | 54.4 a |
| Suc Octanoate R1 | 2,991 bc | 60.6 abc | Rag1 Apron Maxx | 5,985 bc | 49.4 a | Rag1 Apron Maxx | 7,523 b | 53.3 a |
| Rag1 Naked | 1,709 c-f | 60.6 abc | Warrior II R1 | 1,110 c | 41.4 b | Rag1 Naked Seed | 6,626 b | 51.4 ab |
| Rag1 Cruiser Maxx | 278 f | 60.5 abc | Warrior II ET | 6,913 b | 41.3 b | Rag1 Cruiser Maxx | 7,195 b | 51.3 ab |
| CM + Warrior II ET | 2,430 cd | 60.0 abc | Cruiser Maxx | 2,202 bc | 40.8 b | Warrior II R1 | 417 c | 51.1 ab |
| Sugar ET | 2,989 bc | 59.2 a-d | CM + Warrior II ET | 1,574 bc | 37.3 b | Sugar R1 | 9,195 b | 43.2 b |
| Suc Octanoate ET | 3,607 abc | 58.3 a-d | Sugar ET | 17,719 a | 29.9 c | Cruiser Maxx | 24,394 a | 29.6 c |
| Apron Maxx | 4,675 ab | 54.9 b-e | Suc Octanoate R1 | 15,572 a | 27.9 c | Suc Octanoate ET | 24,716 a | 29.1 c |
| Cruiser Maxx | 2,407 cde | 54.3 b-e | Naked Seed | 16,093 a | 27.8 c | Suc Octanoate R1 | 21,677 a | 28.0 c |
| Warrior II ET | 3,193 abc | 53.5 cde | Sugar R1 | 13,304 a | 26.5 c | Sugar ET | 22,739 a | 27.9 c |
| Sugar R1 | 5,125 a | 51.5 de | Apron Maxx | 12,984 a | 25.5 c | Naked Seed | 22,229 a | 27.4 c |
| Naked Seed | 4,744 ab | 48.2 e | Suc Octanoate ET | 16,151 a | 25.5 c | Apron Maxx | 25,749 a | 27.4 c |

1Means within a column that share the same letter are not significantly different (P < 0.05).

**Table 4. Sampling dates, plant growth stages and application dates at Absaraka and Hankinson in 2015.**

|  |  |
| --- | --- |
| **Absaraka** | **Hankinson** |
| **Sampling****Date** | **Growth****Stage** | **Spray****Dates** | **Sampling****Date** | **Growth****Stage** | **Spray****Dates** |
| 7/7 | R1 | 7/13 (Aphid Free) | 7/7 | R1 | 7/13 (Aphid Free) |
| 7/27 | R2/R3 | 7/27 (Aphid Free) | 7/27 | R2/R3 | 7/27 (Aphid Free) |
| 8/3 | R3 |  | 8/3 | R3 |  |
| 8/12 | R4 |  | 8/12 | R4 | 8/12 (ET) |
| 8/17 | R5 |  | 8/17 | R5 |  |
| 8/24 | R5/R6 |  | 8/24 | R5/R6 |  |

**Table 5. Treatment means for SCN (eggs + juveniles/100 cc soil) in June and September, cumulative aphid days (CAD) and yield (bu/acre) at Absaraka and Hankinson, 2015.**

|  |  |
| --- | --- |
| **Absaraka** | **Hankinson** |
| Treatment1 | **SCN****June2** | **SCN September2** | **CAD2** | **Yield2** | **Treatment1** | **SCN****June2** | **SCN September2** | **CAD2** | **Yield2** |
| S 12R05 AF | 96 a | 0 a | 196 a | 45.6 a | 12R05 AF | 430 b | 2,323 b | 185 d | 52.0 a |
| S 12R05 ET | 76 a | 112 a | 423 a | 49.3 a | 12R05 ET | 581 ab | 3,043 a | 2,342 a | 48.3 a |
| S 12R05 UT | 52 a | 0 a | 817 a | 46.2 a | 12R05 UT | 430 b | 1,987 c | 1,569 b | 49.1 a |
| R 15R05N AF | 40 a | 12 a | 177 a | 52.9 a | 15R05N AF | 515 ab | 462 e | 89 e | 54.9 a |
| R 15R05N ET | 76 a | 8 a | 475 a | 51.8 a | 15R05N ET | 813 a | 1,088 d | 844 c | 52.2 a |
| R 15R05N UT | 60 a | 8 a | 515 a | 48.6 a | 15R05N UT | 636 ab | 1,542 c | 1,901 ab | 50.9 a |

1S = susceptible SCN variety; R = resistant SCN variety; AF = Aphid Free; ET = Economic Threshold; UT = Untreated

2Means within a column that share the same letter are not significantly different (P < 0.05).

**Figure 1. June (initial) and September (final) SCN levels for susceptible (12R05) and resistant varieties (15R05N), Hankinson, 2015.**

