Summary
During 2011, the performance of insecticides on the soybean aphid, *Aphis glycines* (SBA), was evaluated at the University of Minnesota Southwest Research and Outreach Center near Lamberton, MN. Twelve (12) insecticides and two untreated controls were compared with in a randomized block design with four replications. The insecticides evaluated were: pyrethroids (alpha-cypermethrin, Baythroid XL, Hero, Tundra EC, and two rates of Warrior II); a neonicotinoid (Belay); an organophosphate (Lorsban Advanced); pyrethroid plus neonicotinoid premixes (Endigo ZC, Leverage 360, Brigadier); and a pyrethroid plus organophosphate tank mix (Baythroid XL + Lorsban Advanced). The insecticide treatments were applied on August 3, 2011 to R4 stage soybeans. The SBA population was approximately 250 aphids/ plant and evenly distributed throughout the trial area at this time.

Throughout the trial, the two untreated controls had higher numbers of SBA/plant than all insecticide treatments. By August 5, two days after application, all insecticides except alpha-cypermethrin and Baythroid XL had fewer aphids than the controls.

Increasing and visible moisture stress on soybeans occurred after insecticide application and was related to soil type differences. At 7 and 14 days after application all insecticides had fewer aphids than untreated controls but populations were variable and non-normally distributed. By 20 days after application, the two untreated controls had accumulated over 9,000 and 12,000 aphid days. All insecticides greatly reduced cumulative aphid-days (CAD) compared to untreated. Among insecticide treatments, alpha-cypermethrin, Belay and Baythroid XL had the greatest CAD. Hero, Baythroid XL + Lorsban Advanced, Tundra EC, Lorsban Advanced, Leverage 360, Endigo ZC and Brigadier had the fewest CAD.

In spite of the moderate Cumulative aphid days in untreated controls, yield differences were not observed at the 5% level. Moisture stress and an early frost were yield limiting in this trial.

Background
The soybean aphid (SBA) is the most damaging insect pest of Minnesota soybeans. It was first identified during the late summer of 2000 in SE MN. SBA subsequently spread throughout the soybean growing areas of MN during the 2001 growing season. With the exception of 2004, Southwest Minnesota has had yield reducing populations of SBA every years since 2003 growing season, with 2003 and 2008 being the most widespread and severe. While most products have performed adequately, poor performance has been occasionally reported. This trial was designed to look at aphid control and resultant yield differences between insecticide products and a single case rate. The products in this trial represent a range in insecticide class, and soybean aphid control.
Methods
This trial was located at the University of Minnesota, Southwest Research and Outreach Center, Lamberton, MN. Site, experimental design, treatments, and application methods are presented in Table 1. The growing season was characterized by very late planting and wet soil conditions until late July when warm temperatures and a lack of rainfall caused moisture stress during seed fill. The late planting moved soybean reproductive stages approximately 2 weeks later than historically typical. A killing frost occurred on September 14th frost to R6.5 stage soybeans, ended seed fill and reduced yield. Weather details can be found at http://swroc.cfans.umn.edu/Weather/weather.htm.

The trial was placed within a field of Pioneer 92Y30 soybeans planted May 22 with a six row, 30 inch planter (John Deere 7200 Max Emerge II). Alleys were cut into the bulk planted field the day before insecticide application.

The trial site was characterized by later than typical aphid colonization that rapidly increased. Populations were reflective of neighboring fields in the geographic area.

Insecticides and timings were evaluated in a randomized block design with four replications. Two untreated control plots were included within each replication to detect and if need be correct for non-uniform aphid populations associated with the large size of this trial. Insecticide applications were made using an offset boom sprayer (R& D Sprayers, Opelousas, LA) modified to run on compressed air. The design of this experiment should have favored soybean aphid re-colonization of treated plots from untreated rows on either side of the four treated rows untreated soybeans adjacent to the trial. Site and application information is given in Table 1.

Endigo ZC at 3.5 fl. oz., Brigadier at 4.0 fl.oz., Leverage 360 at 2.8 fl. oz. plus 0.25% V/V Class Act non-ionic surfactant, Warrior II at 1.0 and 1.6 fl. oz, Belay at 3 .0 fl. oz plus 0.25% V/V Class Act non-ionic surfactant, Baythroid XL at 2.4 fl. oz., Baythroid XL at 2.0 fl. oz. plus Lorsban 4E at 8.0 fl. oz, alpha- cypermethrin at 4.0 fl. oz., Tundra EC at 5.0 fl. oz., Hero at 5 fl. oz. and Lorsban Advanced at 16 fl. oz. were applied on August 3. The insecticide treatments were applied to an average of 250 soybean aphids/plant and R4 stage soybeans.

Aphid populations at a given sample period were assessed as aphids counted on a whole plant and based on a sample of five plants for each plot (4 plants for each plot pre-treatment counts).

Yields were taken from the center two rows of each plot using an Almaco plot combine and adjusted to 13% moisture.
Table 1. Site and application information

County: Redwood, MN
Nearest town: Lamberton, MN
Soil type: Normania loam
Fertility: Soil test values (2009)
23 ppm P
150 ppm K
5.7 pH
3.7 % O.M.

Previous Crop: 2009 Soybean, 2010 Corn
Tillage: Fall 2009 Disk Chisel Spring 2011 Field cultivator 1X
Row spacing: 30"
Cultivar: Pioneer 92Y30
Seeding rate: 160,000 seeds/acre planted 1.5" deep into a wet seedbed
Planting date: June 3, 2011
Weed control: Pre Outlook 1.25 pts 6/03/11
Post Cornerstone Plus 32 fl oz 7/06/11
Post Fusilade 3 fl oz 7/06/11
Hand weed 8/02/11, 8/15/2011
Harvested: October 6, 2011

Design: Randomized complete block with 4 replications
Plot size: 15’ x 30’ The center 4 of 6 rows (10’) were treated, the center 2 of 6 rows were sampled for aphid populations and harvested for yield.

Application information:
Date: August 3, 2011
Temperature: 75 F
RH 55 %
DP 68.6 F
Wind conditions: 0-2 mph
Crop stage at application: R4
Crop height at application: 31 inches

Insecticide treatments were applied with a Tractor mounted offset boom sprayer (R&D Sprayers), 8002XR flat fan nozzles on 15-inch spacing, 20 gallons/acre and 40 PSI pressure with boom 18” above soybean canopy.

Results and discussion
Aphid control and yield results by treatment are presented in Table 2.
Increasing and visible moisture stress on soybeans was related to soil type differences and occurred after insecticide application. Wilting was observed in areas of the trial during periods of high temperature. These areas corresponded to coarse textured sub soils. SBA population reductions were observed in untreated border rows and control plots as well as insecticide treated plots of the stressed areas. Reduced host plant quality is presumed to be the reason that the spatial distribution of SBA populations became increasingly aggregated as the trial progressed.
Throughout the trial, the two untreated controls had higher numbers of SBA/plant than all insecticide treatments. By August 5, two days after application, all insecticides except alpha-cypermethrin and Baythroid XL had fewer aphids than the controls. An aphid emigration event from R4.5 stage soybeans occurred at 7 to 14 days after treatment. This led to aphid population data that could not be reasonably transformed to normality and mean separations are not given for the 7, 14 and 20 days after application aphid counts. The neonicotinoid treatment (Belay) was approaching the 250 SBA/plant economic threshold at the August 23 (20 days after application) rating. With the possible exception of Baythroid XL and alpha-cypermethrin, populations did not rebound in the other insecticide treatments.

All insecticides greatly reduced cumulative aphid-days (CAD) compared to untreated controls. Among insecticide treatments, alpha-cypermethrin, Belay and Baythroid XL had the greatest CADs. Hero, Baythroid XL + Lorsban Advanced, Tundra EC, Lorsban Advanced, Leverage 360, Endigo ZC and Brigadier had the fewest CAD. These were late, rapidly developing SBA populations. Therefore, few aphid-days were accumulated in the R3 and early R4 stages before insecticides were applied.

The two untreated controls had accumulated over 9,000 and 12,000 aphid-days from August 3 to August 23 (0 - 20 days after application or late R4 to mid-R5 stages of soybean). Additional aphid-days accumulated after August 23 but individual plots were not sampled. However, cursory observations indicated that SBA aphid populations declined in areas with moisture stress but remained relatively constant in those plots with less moisture stress until September. SBA populations gradually declined during September with some SBA remaining until after the September 14 frost. Spider mites were not observed in this trial until the second week of September and are not suspected to have influenced yield.

In spite of the moderate CAD in untreated controls, yield differences were not observed at the 5% level. Good growing conditions until mid-August might have allowed soybeans to tolerate SBA feeding without yield loss. A more likely explanation is that moisture stress and an early frost were more yield-limiting than SBA in this trial.

**Acknowledgments**
This trial was supported in part by Bayer Crop Science, FMC corporation, Syngenta Crop Protection and Valent U.S.A. Corporation. Thanks to Jeff Irlbeck and Shane Nepperman for their assistance.

*Alpha-cypermethrin
BASF Corporation

Belay®
Valent U.S. A. Corporation

Baythroid® XL
Bayer Crop Science

Brigadier®
FMC corporation
Endigo ZC®
Syngenta Crop Protection, Inc.

Lorsban® Advanced
Registered trademark of Dow AgroSciences LLC

Leverage® 360
Registered trademark of Bayer Crop Science

Tundra® EC
Winfield Solutions

Warrior II with Zeon Technology®
Registered trademark of Syngenta Crop Protection, Inc.

*not labeled on soybean

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<td>1. UNTREATED CHECK 1</td>
<td></td>
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<td>348.8 a</td>
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<td>3. Alpha-cypermethrin&lt;sup&gt;4&lt;/sup&gt;</td>
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<td>4.0 fl oz/a</td>
<td>218.4 a</td>
<td>204.6 b</td>
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<td>0.3</td>
<td>9.1</td>
<td>1488.8 b</td>
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<td>4. BELAY® Clothianidin NIS (Class Act) 0.25 % v/v</td>
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<td>3.0 fl oz/a</td>
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<td>63.5 cd</td>
<td>14.3</td>
<td>18.7</td>
<td>244.5</td>
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<td>5. BAYTHROID® XL Beta-cyfluthrin</td>
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<td>2.4 fl oz/a</td>
<td>216.9 a</td>
<td>178.2 bc</td>
<td>6.8</td>
<td>0.1</td>
<td>10.8</td>
<td>1358.4 b</td>
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<td>6. BAYTHROID® XL Beta-cyfluthrin LORSBAN® ADVANCED chlorpyrifos</td>
<td></td>
<td></td>
<td>2.0 fl oz/a</td>
<td>261.9 a</td>
<td>0.0 h</td>
<td>0.1</td>
<td>0.0</td>
<td>0.1</td>
<td>262.5 cd</td>
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<td>7. BRIGADIER&lt;sup&gt;®&lt;/sup&gt; bifenthrin + imidacloprid</td>
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<td></td>
<td>4.0 fl oz/a</td>
<td>318.3 a</td>
<td>11.6 ef</td>
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<td>0.0</td>
<td>0.1</td>
<td>388.2 cd</td>
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<td>8. ENDIGO ZC&lt;sup&gt;®&lt;/sup&gt; Lambda-cyhalothrin + thiamethoxam</td>
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<td>9. LEVERAGE&lt;sup&gt;®&lt;/sup&gt; 360 imidacloprid + Beta-cyfluthrin NIS (Class Act) 0.25 % v/v</td>
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<td>175.3 a</td>
<td>0.9 gh</td>
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<td>0.1</td>
<td>181.0 d</td>
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<td>11. LORSBAN® ADVANCED chlorpyrifos</td>
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<td>16.0 fl oz/a</td>
<td>272.2 a</td>
<td>0.2 gh</td>
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<td>5.0 fl oz/a</td>
<td>250.1 a</td>
<td>3.7 fg</td>
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<td>0.0</td>
<td>0.0</td>
<td>272.3 cd</td>
<td>40.5 a</td>
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<td>13. WARRIOR II with Zeon Technology&lt;sup&gt;®&lt;/sup&gt; Lambda-cyhalothrin</td>
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<td>1.0 fl oz/a</td>
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<td>0.0</td>
<td>0.0</td>
<td>426.3 c</td>
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<td>14. WARRIOR II with Zeon Technology&lt;sup&gt;®&lt;/sup&gt; Lambda-cyhalothrin</td>
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<td></td>
<td>1.6 fl oz/a</td>
<td>252.3 a</td>
<td>28.5 de</td>
<td>0.4</td>
<td>0.0</td>
<td>0.2</td>
<td>426.3 c</td>
<td>40 a</td>
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LSD (P=0.05) | N.S. | 0.54 | 143.45 | 124.71 | 333.13 | 0.31 | N.S. | Standard Deviation | 66.6 | 0.3 | 100.38 | 87.27 | 233.11 | 0.22 | 2.57 |
| CV | 26.6 | 29.6 | | | | | | Grand Mean | 250.41 | 153.92 | 1.29 | 37.4 | 36.06 | 130.86 | 2026.9 | 2.82 | 39.69 |
| Treatment Prob(F) | 0.063 | 0.0001 | 0.0025 | 0.0003 | 0.0001 | 0.0001 | 0.0724 | Means followed by same letter do not significantly differ (P=0.05, LSD) | Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL. |<sup>1</sup> Mean separations and other statistics based on log transformed data |<sup>2</sup> Data could not be transformed to normality. Mean separations not performed |<sup>3</sup> DA-A are days after insecticide application on August 3. |<sup>4</sup> Not labeled on soybean