MISSISSIPPI SOYBEAN PROMOTION BOARD
PROJECT NO. 13-2017 (YEAR 2)
2017 ANNUAL REPORT

TITLE: Influence of Cover Crops on Early Season Insect Pest Dynamics in Mississippi Soybeans

INVESTIGATORS: Angus Catchot, Professor of Extension, Mississippi State University, 662 418-8163, acatchot@ext.msstate.edu, **Jeff Gore**, Associate Research Professor, Mississippi State University, 662 820-9969, jgore@drec.msstate.edu, **Trent Irby**, Assistant Extension Professor, Mississippi State University, 662 418-7842, tirby@ext.msstate.edu

INTRODUCTION

The use of winter cover crops before soybean cultivation has been an increasing trend in Mississippi. Winter cover crops provide many agronomic benefits including the prevention of soil erosion, increases in water infiltration into soil, soil organic matter increases, soil compaction reductions, reductions in nutrient losses through leaching, suppression and reduction of early-season weeds and weed biomass, and increases in nitrogen supplies. Cover crops also provide suitable habitat for beneficial insects that can potentially inhabit the following crop.

Insect pest problems have been associated with some cover crops before soybean. In Mississippi and other regions of the Midsouth, pea leaf weevil has infested soybean following legume winter cover crops such as hairy vetch and Austrian winter peas. Foliar insecticidal applications can control pea leaf weevil in soybean, but adult weevils continue to emerge from cover crop residue, resulting in costly multiple applications. Neonicotinoid seed treatments can provide protection from these pests.

REPORT OF ACTIVITIES

OBJECTIVE I: POTENTIAL INSECT PEST PROBLEMS IN SOYBEAN FOLLOWING COVER CROPS AND POTENTIAL MANAGEMENT STRATEGIES

MATERIALS AND METHODS

An experiment was conducted in the 2016 and 2017 growing seasons to determine the influence of winter cover crops and early season insect control strategies on soybean yield in two Mississippi locations. The R. R. Foil Plant Science Research Center in Starkville, MS served as a location in the "Hills" region of MS located on the East side of the state, and the Mississippi State University Delta Research and Extension Center in Stoneville, MS served as a location in the "Delta" region of MS located on the West side of the state.

Field trials were established on 8-row plots. Plots at the "Hills" location were planted on 38-in.-wide rows, whereas plots at the "Delta" location were planted on 30-in.-wide rows. Other differences in the site locations were that the "Delta" soybean plots were irrigated, and the "Hills" location was not. Soil type of the "Hills" location was a clay loam, and the "Delta" location had a sandy loam soil type.

Treatments were arranged factorially in a randomized complete block design. Each randomization of treatments was replicated four times at each location. Factor A consisted of two cover treatments and

Factor B consisted of six control method treatments. **The two cover treatments were a cover crop blend of Austrian winter pea or hairy vetch, tillage radish, and triticale, and an unplanted treatment where plots were allowed to naturally infest with winter weeds. Control treatments were an untreated control where only fungicide was applied to soybean seed, a foliar application of Karate Z (lambda-cyhalothrin, 1.5 fl. oz./ac) applied with the herbicide burndown application, soybean seed treated with the neonicotinoid seed treatment CruiserMaxx (thiamethoxam, 0.0778 mg/seed) in 2016 and Gaucho (imidacloprid, 0.2336 mg/seed) in 2017, the Karate Z burndown application plus the neonicotinoid seed treatment, an in-furrow application of Capture LFR (bifenthrin, 8 oz./1000 row ft.) applied during the planting of soybean seed, and a 50% increased seeding rate of 165,000 plants/acre.** All soybean seed was treated with the fungicide ApronMaxx RTA (mefenoxam and fludioxonil, 0.0092 mg/seed).

The cover crop treatment was planted and incorporated into the soil during the month of October before each growing season. The blended seed was broadcast over plots at an even distribution. A glyphosate application of 50 fl. oz./acre was used as a burndown application to kill the cover crops and winter weeds and, was applied four weeks prior to soybean planting as were the termination-timed insecticide applications.

Soybean (Asgrow 4835) was planted during May at a seeding rate of 111,000 plants/acre except for the increased seeding rate treatment. At the V3 growth stage, pea leaf weevil, three-cornered alfalfa hopper, and bean leaf beetle were counted per meter of row for each treatment combination. Soybean plants matured and were mechanically harvested and yields were recorded for each treatment combination. Data were analyzed using PROC GLIMMIX of SAS 9.4.

RESULTS AND DISCUSSION

There were no significant differences between cropping systems for total insect pests (Figure 1). Significantly fewer insect pests were observed in plots treated with insecticides at planting compared to the untreated control, the higher plant population, and the termination-timed application (Figure 2).

There were no significant interactions between cover types or between control methods for mean soybean yield across all site years (Figure 3). No significant differences were observed between cropping systems with regards to mean soybean yield over all site years (Figure 4). Over all site years, neonicotinoid seed treatments provided a significant yield increase of 3.49 bu per acre compared to the untreated control (Figure 5).

Pests were controlled by insecticide seed treatments but were unaffected by cropping system in this research trial. Plot size may have limited the ability to observe pest and yield differences among cropping systems due to potential movement of pests across the cropping system treatment plots.

EXECUTIVE SUMMARY—OBJECTIVE 1

Across two years of experiments, the following occurred.

- There was no difference in the number of insect pests between fallow (natural infestation of winter weeds) and planted cover crop systems.

- Treatments that included a neonicotinoid seed treatment added to planted soybean seed had the lowest number of insect pests in the two cropping systems.
- Yields were equivalent from all treatments within each cropping system, and between cropping systems.
- Over all site years, neonicotinoid seed treatments provided a significant yield increase of 3.5 bu/acre vs. the untreated control which received only a fungicide seed treatment.

Figure 1: Total insect pests (visual counts) for each cropping system (p>0.05).

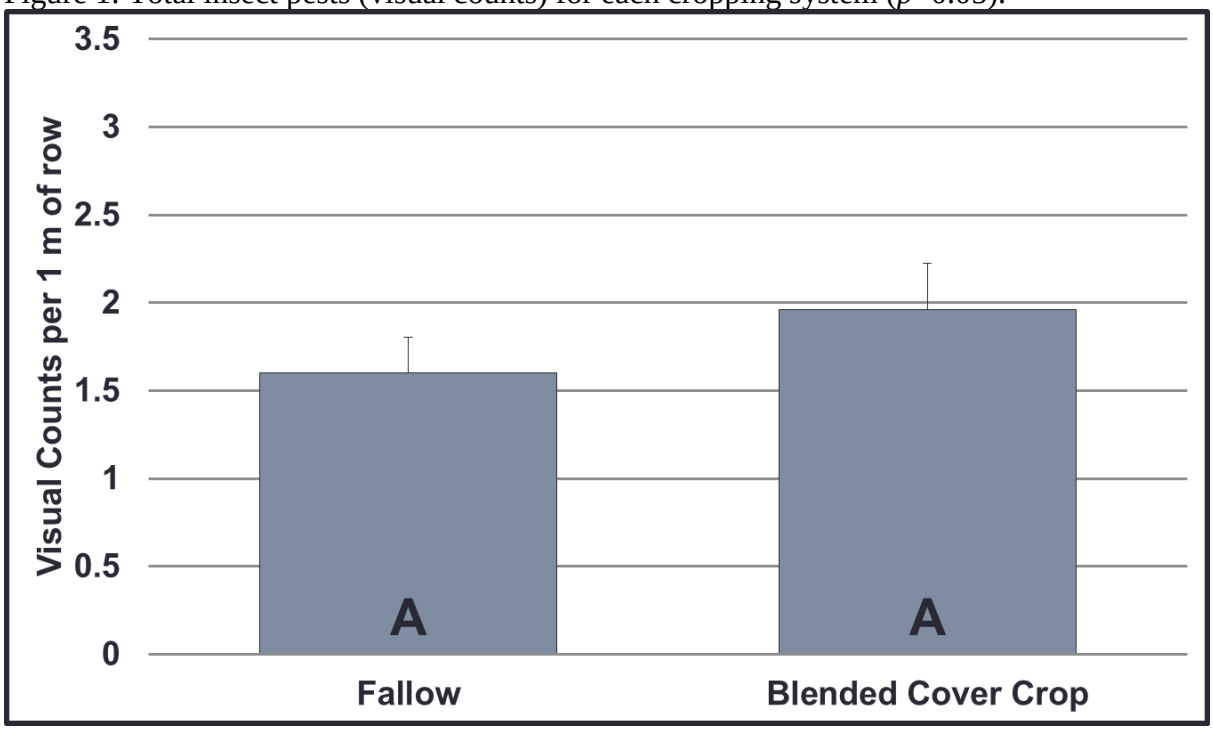


Figure 2: Total insect pests (visual counts) for each control method (p<0.05).

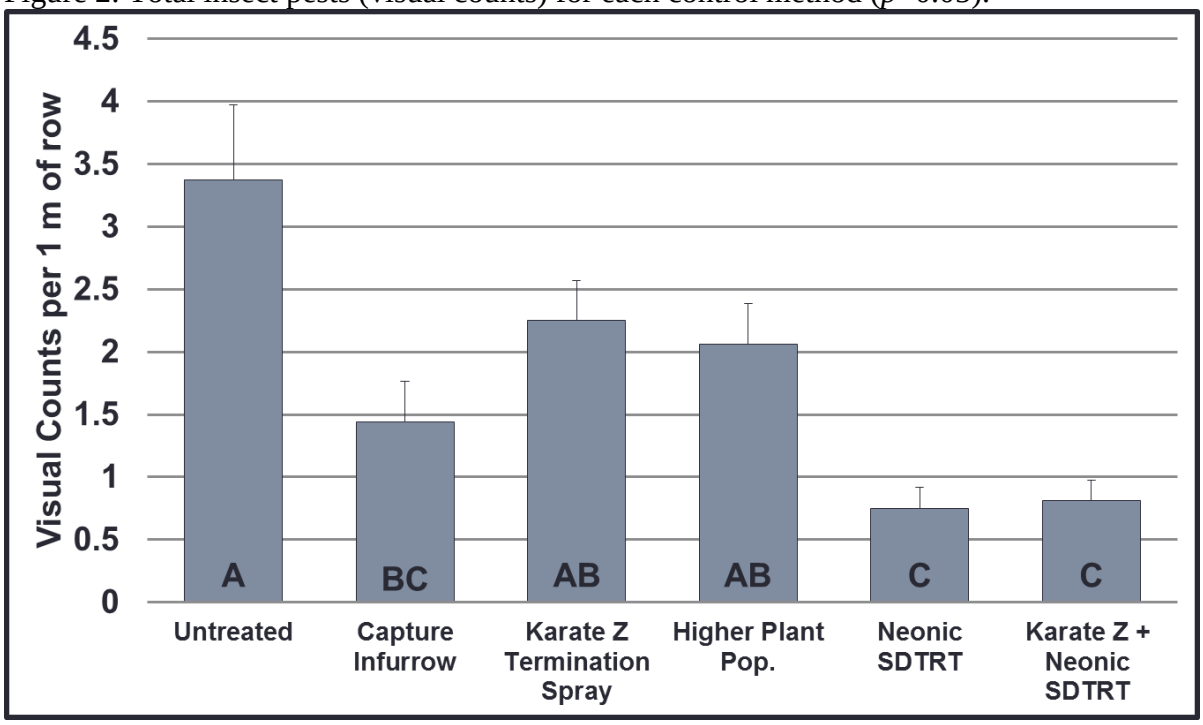


Figure 3: Yields for each control treatment in each cropping system (p>0.05).

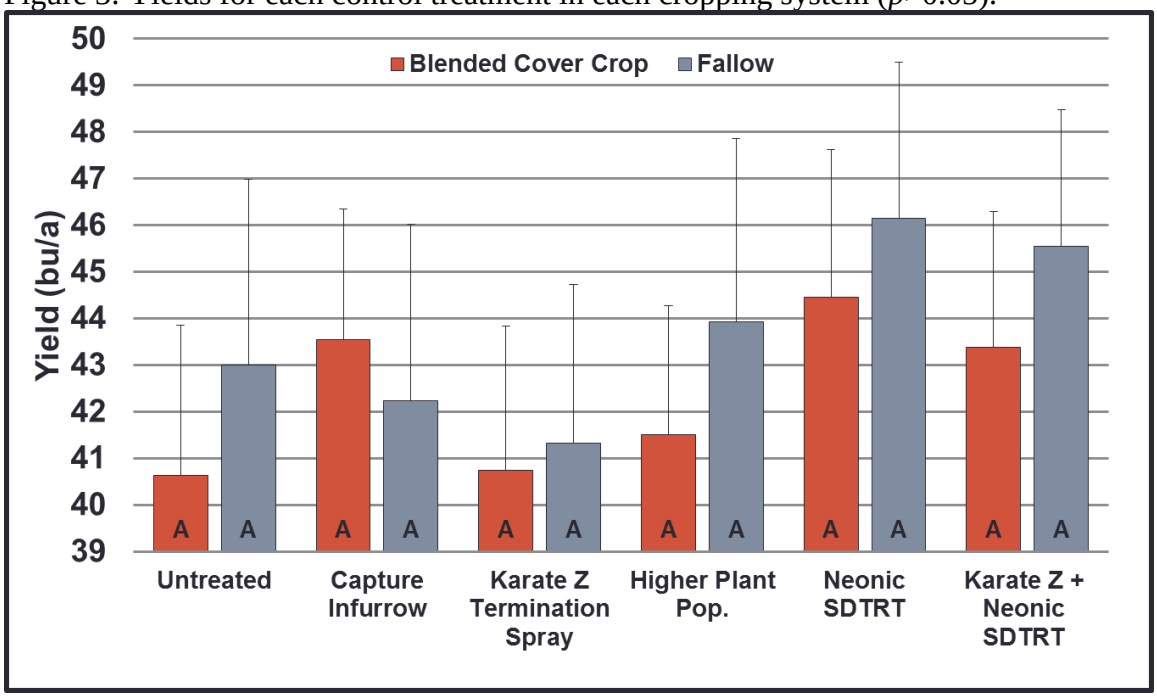


Figure 4: Yields for each cropping system (p>0.05).

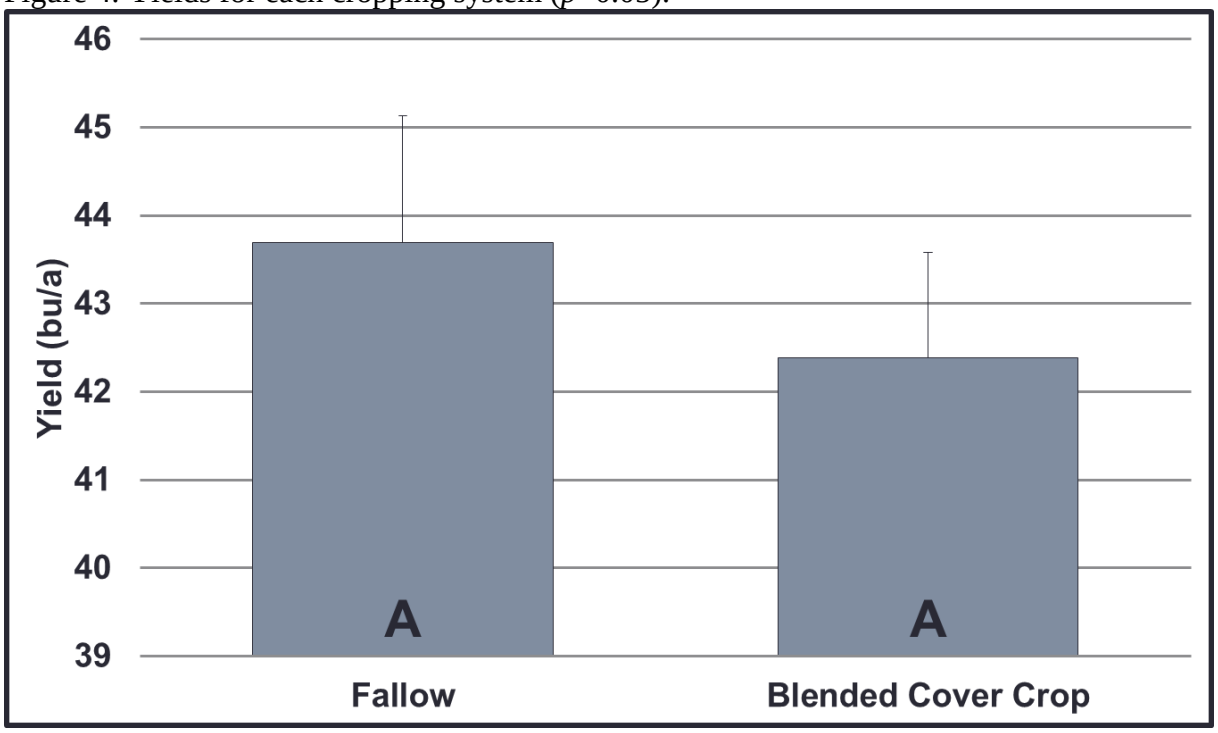
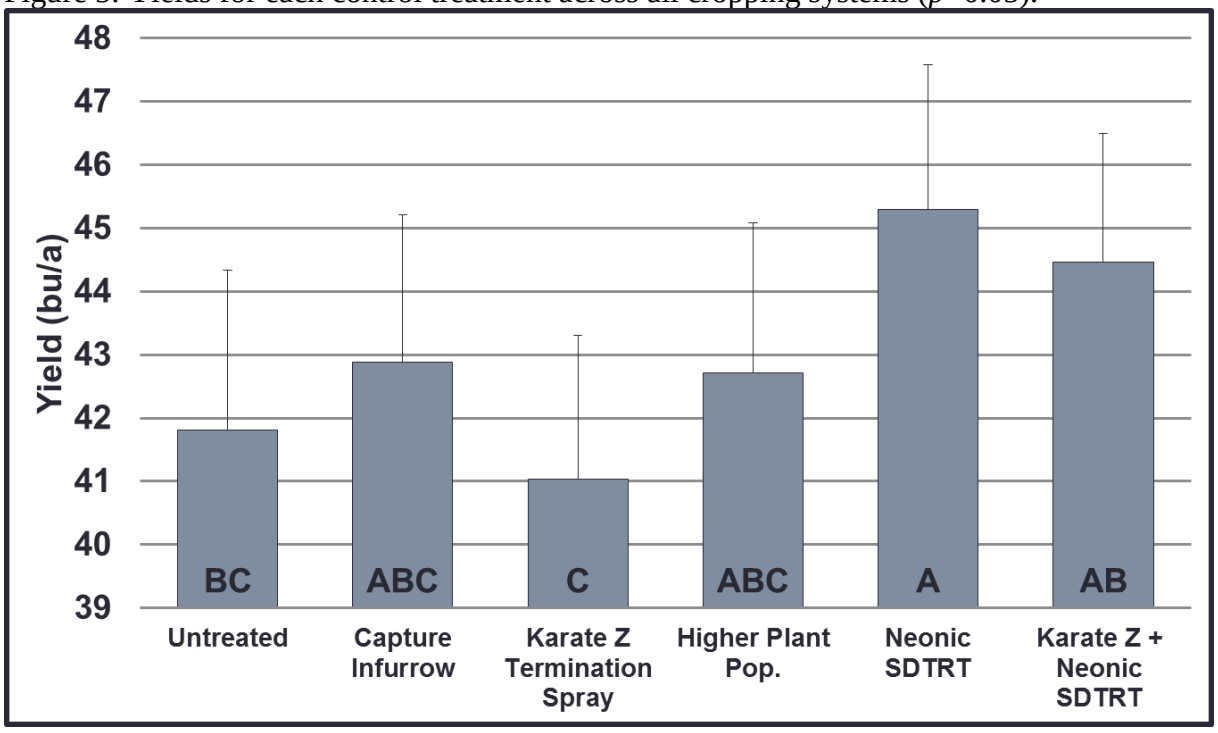


Figure 5: Yields for each control treatment across all cropping systems (p<0.05).



OBJECTIVE II: EFFECTS OF COVER CROPS, TERMINATION TIMING, AND NEONICOTINOID SEED TREATEMENTS ON SOYBEAN INSECT PESTS

MATERIALS AND METHODS

An experiment was conducted in the 2016 and 2017 growing seasons to determine the influence of winter cover crops, termination/burndown timings, and seed treatments on soybean yield in two Mississippi locations. The R. R. Foil Plant Science Research Center in Starkville, MS served as a location in the "Hills" region of Miss. located on the East side of the state, and the Mississippi State University Delta Research and Extension Center in Stoneville, MS served as a location in the "Delta" region of Miss. located on the West side of the state.

Field trials were established on 4-row plots measuring 3.86 m wide by 15.24 m long. Treatments were factorially arranged in a randomized complete block design. Each randomization of treatments was replicated four times at each location. **Factor A consisted of three cropping system treatments, Factor B consisted of three termination/burndown timings, and Factor C consisted of insecticidal and non-insecticidal seed treatments.**

The three cropping system treatments were a cover crop blend of Austrian winter pea or hairy vetch, tillage radish, and triticale, a cover crop treatment of wheat, and an unplanted treatment in which plots were allowed to naturally infest with winter weeds. Cover crop termination timings were approximately 6, 4, and 2 weeks prior to planting. The seed treatments used for Factor C were an untreated control where only fungicide was applied to soybean seed and a treatment where soybean seed was treated with the neonicotinoid seed treatment CruiserMaxx (thiamethoxam, 0.0778 mg/seed) in 2016 and Gaucho (imidacloprid, 0.2336 mg/seed) in 2017.

All soybean seed was treated with the fungicide ApronMaxx RTA (mefenoxam and fludioxonil, 0.0092 mg/seed). The cover crop treatments were planted and incorporated into the soil during the month of October before each growing season. The blended seed was broadcast over plots at an even distribution. A glyphosate application of 50 fl. oz./acre was used as a burndown application to kill the cover crops and winter weeds and was applied at the appropriate termination timing for each plot. Soybean (Asgrow 4835) was planted during May at a seeding rate of 111,000 plants/acre. At the V3 growth stage, pea leaf weevil, three-cornered alfalfa hopper, and bean leaf beetle were counted per meter of row for each treatment combination. Soybean plants matured and were mechanically harvested and yields recorded for each treatment combination. Data was analyzed using PROC GLIMMIX of SAS 9.4.

RESULTS AND DISCUSSION

There were no significant differences among cropping systems for total insect pests observed. No significant differences were observed between seed treatments or among termination timings for total insect pests observed. Significantly more three-cornered alfalfa hoppers were observed in untreated soybean following a wheat cover crop than in neonicotinoid-treated soybean seed following a wheat cover crop and neonicotinoid-treated soybean seed from fallow plots and from untreated soybean following the blended cover crop (Figure 6).

Significantly more three-cornered alfalfa hoppers were observed in soybean following a late termination timing than in an early termination timing (Figure 7). There were no significant interactions among cover types, termination timings, or seed treatments for mean yield of soybean across all site years.

Soybean following the blended cover crop had a significantly higher yield than soybean following a wheat cover crop or left fallow (Figure 8). Over all site years, neonicotinoid seed treatment provided a very small but significant yield increase of 1.19 bu/acre when compared to the untreated control (Figure 9). There were no differences between termination timings in regards to mean yield of soybean. Neonicotinoid seed treatments provided protection from pests such as the three cornered alfalfa hopper. Plot size may have limited the ability to observe pest and yield differences among cropping systems due to potential movement of pests across the cropping system treatment plots.

EXECUTIVE SUMMARY—OBJECTIVE 2

- There were no differences among cropping systems, between seed treatments, or among termination timings for total insect pest numbers.
- The wheat cover crop followed by planting soybean seed that had not been treated with the neonicotinoid seed treatment had the greatest number of three-cornered alfalfa hoppers (TCAH).
- The treatment with the termination timing closest to soybean planting had a greater number of TCAH than did the earliest termination time.
- Differences in soybean yield among the three cover crop treatments were very small (~2 bu/acre) across the two years of the study.
- Over all site years, the neonicotinoid seed treatment resulted in a very small (~1 bu/acre) yield increase compared to the treatment with untreated soybean seed.
- Cover crop termination timing in relation to soybean planting did not significantly affect soybean yield.

Figure 6: Three cornered alfalfa hopper (visual counts) for each cover type and seed treatment (p<0.05).

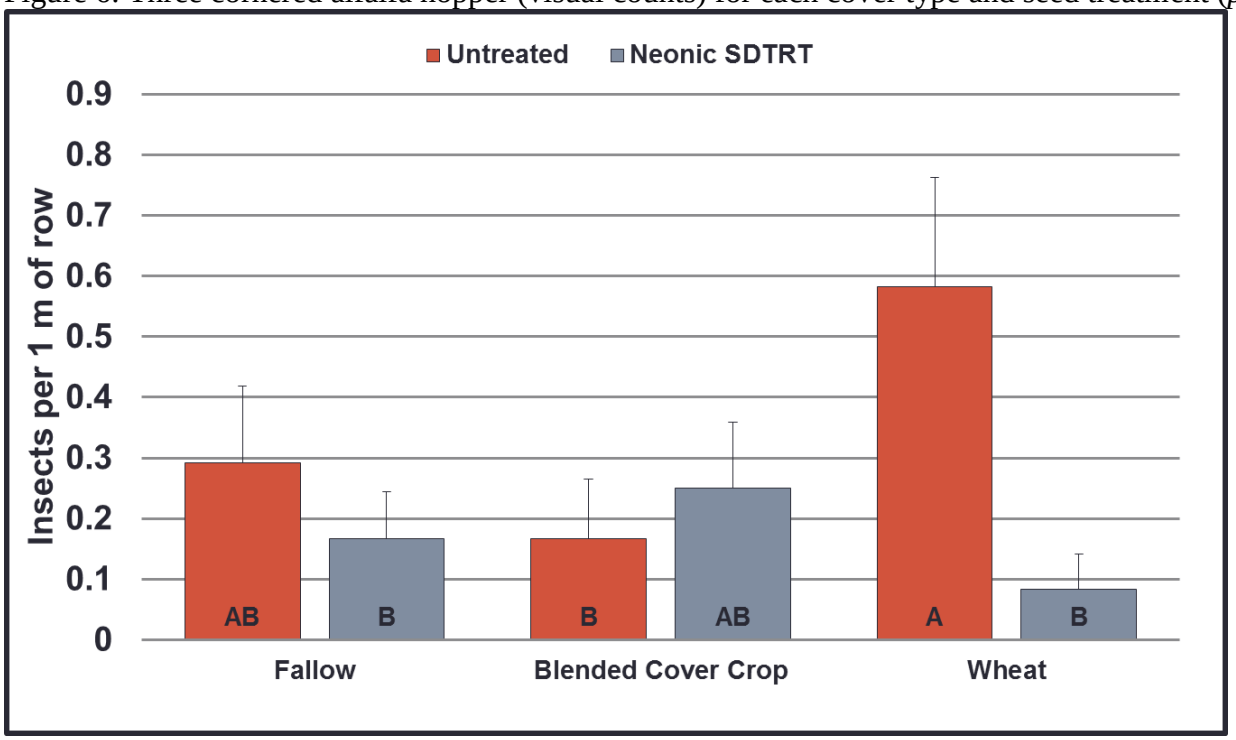


Figure 7: Three cornered alfalfa hopper (visual counts) for each termination date (p<0.05).

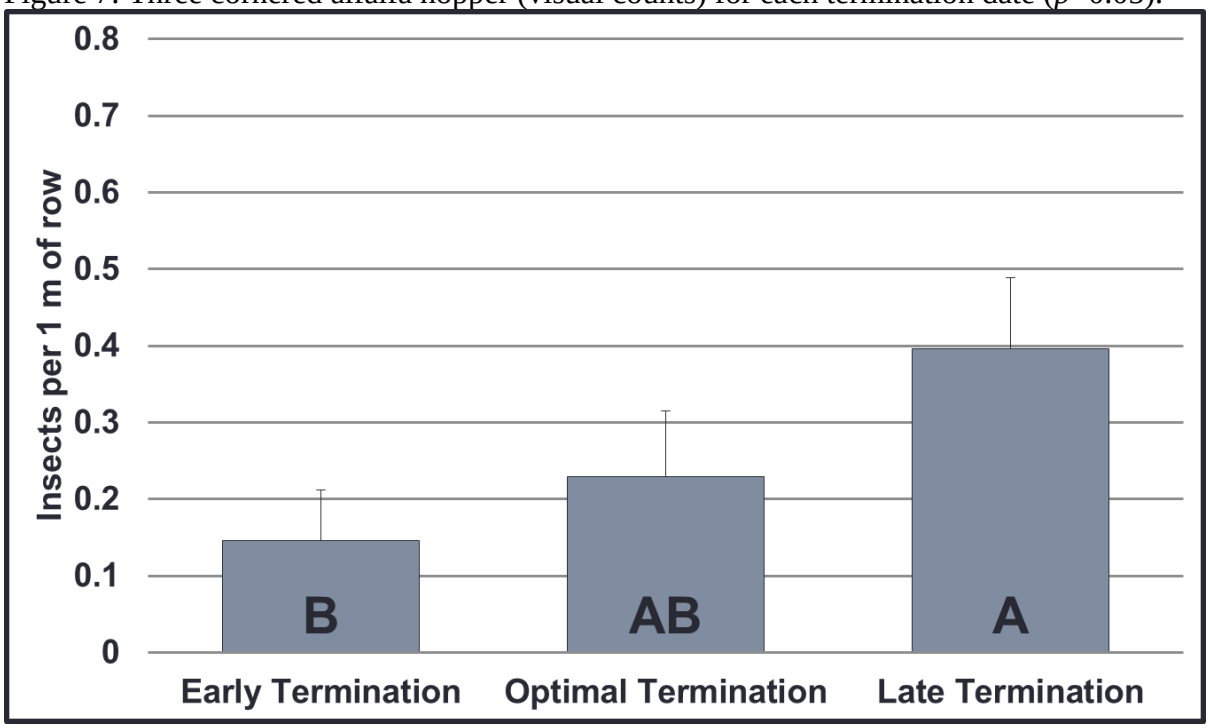


Figure 8: Soybean yields following each cover type (p<0.05).

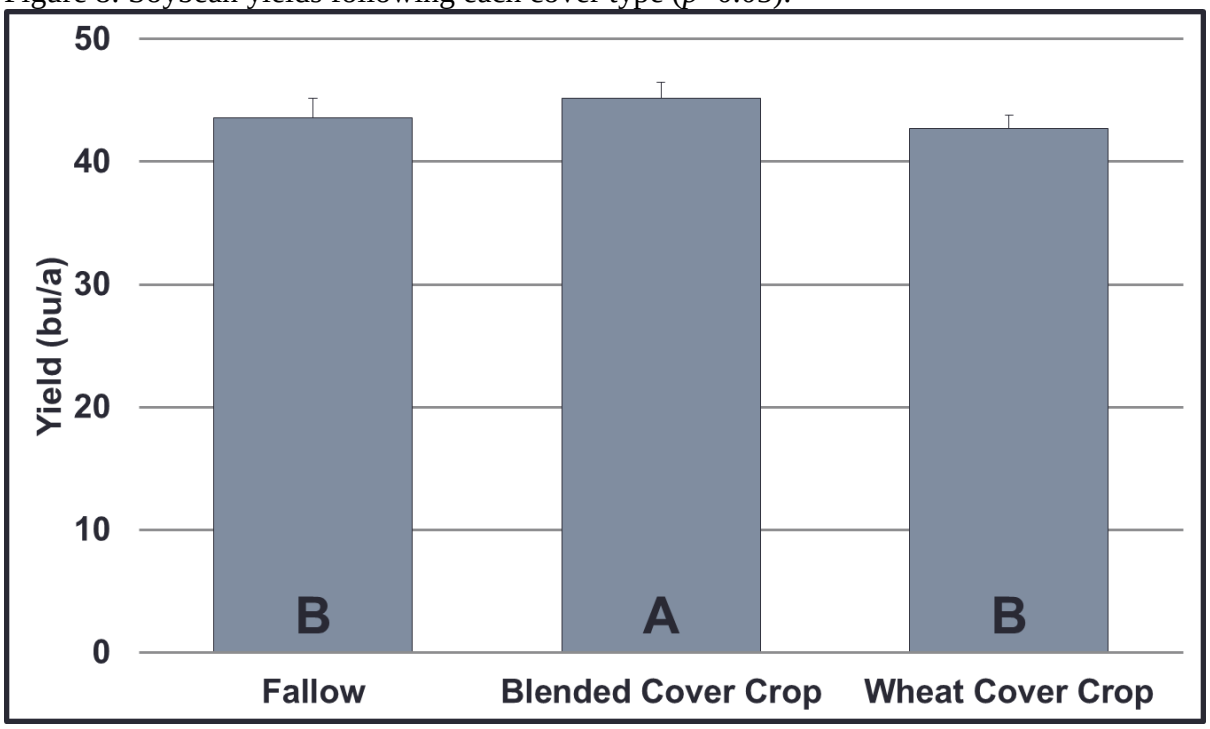
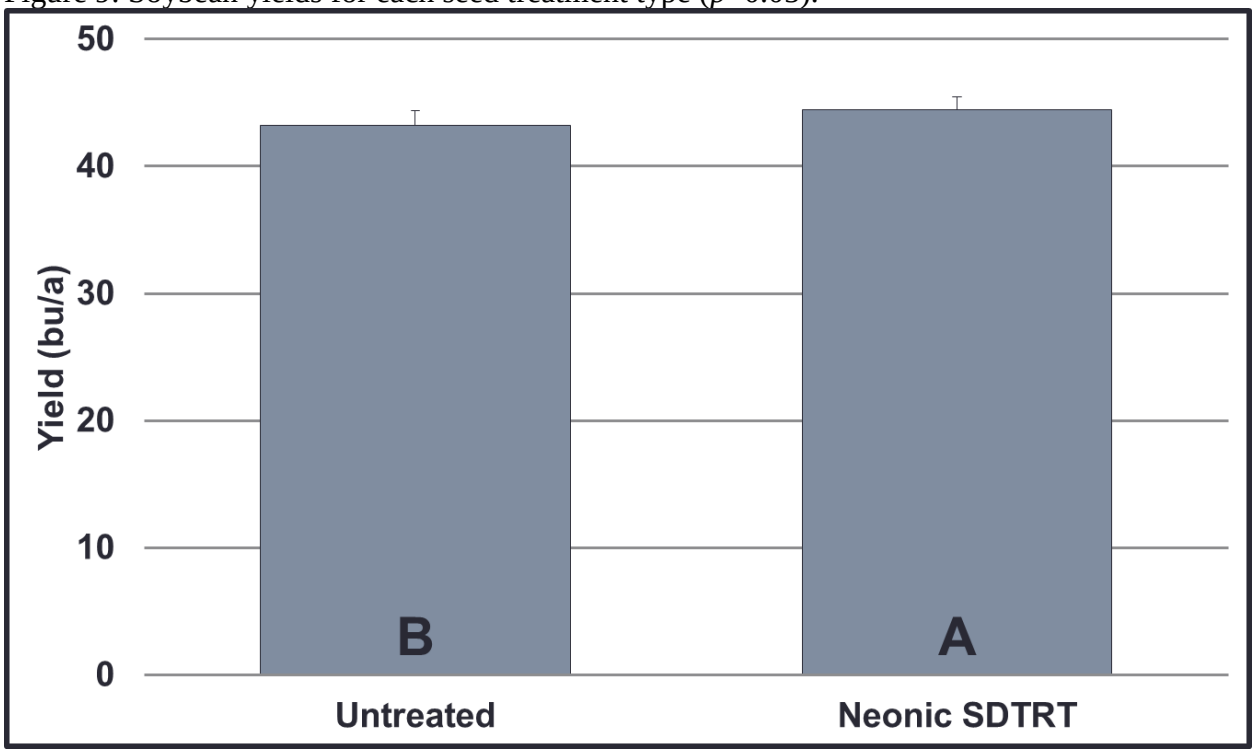


Figure 9: Soybean yields for each seed treatment type (p<0.05).



OBJECTIVE III: ARTHROPOD FAUNA AND AGRONOMIC EFFECTS OF COVER CROP-SOYBEAN GROWING SYSTEMS IN MISSISSIPPI

MATERIALS AND METHODS

An experiment was conducted in the 2016 and 2017 growing seasons to determine the influence of winter cover crops on arthropod diversity and the agronomic effects on soybean in two Mississippi locations. The R. R. Foil Plant Science Research Center in Starkville, MS served as a location in the "Hills" region of Miss. located on the East side of the state, and the Mississippi State University Delta Research and Extension Center in Stoneville, MS served as a location in the "Delta" region of Miss. located on the West side of the state. Field trials were established on 8-row plots measuring 7.72 m wide by 15.24 m long. Treatments were established in a randomized complete block design. Each randomization of treatments was replicated four times at each location.

Each field trial consisted of six cover treatments that included a cover crop blend of Austrian winter pea or hairy vetch, tillage radish, and triticale, a cover crop treatment of wheat, a cover crop treatment of only Austrian winter pea, a cover crop treatment of only triticale, a cover crop treatment of hairy vetch, and an unplanted treatment in which plots were allowed to naturally infest with winter weeds. All soybean seed was treated with the fungicide ApronMaxx RTA (mefenoxam and fludioxonil, 0.0092 mg/seed), and no insecticidal seed treatment was used. The cover crop treatment was planted and incorporated into the soil during October. The blended seed was broadcast over plots at an even distribution. A glyphosate application of 50 fl. oz./acre was used as a burndown application to kill the cover crops and winter weeds 4 weeks prior to planting. Plots were additionally rolled in Stoneville after the termination application before planting. Soybean (Asgrow 4835) was planted during May at a seeding rate of 111,000 plants/acre.

Soybean sampling was accomplished by visually counting pests using pitfall trapping and sweep net sampling. At the V3 growth stage, pea leaf weevil, three cornered alfalfa hopper, and bean leaf beetle were counted per meter of row for each treatment combination. Pitfall traps were placed on row 4 of each 8-row plot. Each plot contained two pitfall traps separated by a 24 in. steel guide vane. The individual pitfall traps were supported by an 8-in.-long piece of 6-in.-diameter PVC pipe that was buried to the top so that the pipe opening was flush with the ground. A wide mouth pint mason jar filled approximately one-fourth of the way full with a 50/50 mixture of propylene glycol and 70% ethanol was placed into each PVC pipe. Each pitfall trap was then capped with a 4-in. powder funnel and steel metal top. Pitfall traps were sampled weekly during soybean development.

Sweep netting was performed using a standard sweep net on row 5 of each plot. A total of 25 sweeps were performed and then the contents of the net were emptied into a 1-gallon plastic bag, labeled, and stored in a freezer. **Sweeping was performed at the R1, R2, and R3 growth stages at each location.** In addition to the 6-treatment cover crop study, pitfall trapping and sweep netting were conducted in the neonicotinoid and untreated plots for both cover treatments in the field from Objective 1.

Arthropods sampled with sweep nets and pitfall traps were identified and sorted to family. Abundance data were separated into major families (>1% of the total arthropods caught) and minor families (<1% of the total arthropods caught) for each study. These data will be converted into diversity parameters including the Shannon-Weaver diversity index, family richness, and family evenness and analyzed for differences among treatments and growth stages sampled.

Soil from plots in the 6-treatment cover crop study was sampled and analyzed for nematode abundance. Soybean plants matured and were mechanically harvested and yields recorded for each cover crop treatment. Data was analyzed using PROC GLIMMIX of SAS 9.4.

RESULTS AND DISCUSSION

Significantly more insect pests were observed at the V3 growth stage in soybean plots that followed legume cover crops than in soybean plots that were not previously planted with a cover crop or planted behind a wheat cover crop (Figure 10). Over all site years, treatments, and growth stages for pitfall traps and sweep net samples, a total of 30,168 arthropods were collected, sorted, and identified to 9 orders and 63 families of insects and spiders.

Pitfall traps placed in soybeans following different cover crops yielded 15 major families (Table 1) and 31 minor families (Table 2). Sweep net samples conducted in soybeans following different cover crops yielded 15 major families (Table 3) and 23 minor families (Table 4). Pitfall traps placed in treated and untreated soybean plots following different cover treatments yielded 12 major families (Table 5) and 30 minor families (Table 6). Sweep net samples conducted in treated and untreated soybean plots following different cover treatments yielded 11 major families (Table 7) and 25 minor families (Table 8).

Once diversity parameters are calculated, analyses can be conducted for the variables in each study. Significant differences were observed between cover types in regards to mean reniform nematode abundance over all site years (Figure 11). Significant differences were observed between cover types in regards to mean soybean yield over all site years (Figure 12). Soybean plots planted behind a natural infestation of winter weeds yielded significantly higher than soybean planted behind all cover crops tested.

EXECUTIVE SUMMARY—OBJECTIVE 3

- There were more insect pests at the V3 growth stage in soybean plots that followed legume cover crops than in soybean plots that were not previously planted with a cover crop or planted behind a wheat cover crop.
- The fallow treatment (naturally infested with winter weeds) had higher reniform nematode numbers than cover crop treatments.
- Soybean yield following the fallow treatment was greater than yield following cover crop treatments.

Table 1: Major Families Collected in Pitfall Traps over all Cover Types, Siteyears, and Growth Stages (>1% of the Overall Total Catch).

Insect Families	Number	% of Total Catch
Formicidae	3,997	27.56%
Gryllidae	1,228	8.47%
Staphylinidae	1,015	7.00%
Carabidae	1,008	6.95%
Anthicidae	611	4.21%
Phoridae	595	4.10%
Latridiidae	308	2.12%
Cydnidae	270	1.86%
Elateridae	235	1.62%
Acrididae	232	1.60%
Sciaridae	199	1.37%
Nitidulidae	158	1.09%
Anisolabididae	158	1.09%
Araneae Families	**Number**	**% of Total Catch**
Lycosidae	2,757	19.01%
Linyphiidae	860	5.93%

Table 2: Minor Families Collected in Pitfall Traps over all Cover Types, Siteyears, and Growth Stages (<1% of the Overall Total Catch).

Insect Families	Number	% of Total Catch
Curculionidae	138	0.95%
Scarabaeidae	130	0.90%
Platygastridae	78	0.54%
Noctuidae	74	0.51%
Ulidiidae	70	0.48%
Blissidae	61	0.42%
Tetrigidae	59	0.41%
Chrysomelidae	55	0.38%
Pompilidae	43	0.30%
Membracidae	30	0.21%
Corylophidae	23	0.16%
Mycetophagidae	19	0.13%
Geocoridae	14	0.10%
Reduviidae	15	0.10%
Cicadellidae	9	0.06%
Coccinelidae	7	0.05%
Miridae	4	0.03%
Pentatomidae	5	0.03%
Anthocoridae	4	0.03%
Stratiomyidae	4	0.03%
Coreidae	3	0.02%
Dolichopodidae	3	0.02%
Sarcophagidae	3	0.02%
Chrysopidae	3	0.02%
Platystomatidae	2	0.01%
Rhyparochromidae	1	0.01%
Tridactylidae	1	0.01%
Tipulidae	1	0.01%
Byrrhidae	1	0.01%
Mutillidae	1	0.01%
Araneae Families	**Number**	**% of Total Catch**
Theridiidae	12	0.08%

Table 3: Major Families Collected in Sweep Nets over all Cover Types, Siteyears, and Growth Stages (>1% of the Overall Total Catch).

Insect Families	Number	% of Total Catch
Membracidae	1993	43.13%
Miridae	621	13.44%
Chrysomelidae	463	10.02%
Acrididae	352	7.62%
Coccinellidae	167	3.61%
Platystomatidae	129	2.79%
Tephritidae	114	2.47%
Cicadellidae	88	1.90%
Elateridae	80	1.73%
Pentatomidae	72	1.56%
Geocoridae	62	1.34%
Tetrigidae	62	1.34%
Syrphidae	56	1.21%
Curculionidae	51	1.10%
Araneae Families	**Number**	**% of Total Catch**
Oxyopidae	58	1.26%

Table 4: Minor Families Collected in Sweep Nets over all Cover Types, Siteyears, and Growth Stages (<1% of the Overall Total Catch).

Insect Families	Number	% of Total Catch
Reduviidae	29	0.63%
Thyreocoridae	26	0.56%
Nabidae	23	0.50%
Plataspidae	22	0.48%
Dolichopodidae	18	0.39%
Carabidae	17	0.37%
Coreidae	12	0.26%
Chrysopidae	10	0.22%
Gryllidae	8	0.17%
Erotylidae	7	0.15%
Cerambycidae	7	0.15%
Sciomyzidae	7	0.15%
Apidae	6	0.13%
Noctuidae	4	0.09%
Berytidae	2	0.04%
Stratiomyidae	2	0.04%
Ichneumonidae	2	0.04%
Chloropidae	1	0.02%
Araneae Families	**Number**	**% of Total Catch**
Theridiidae	21	0.45%
Tetragnathidae	11	0.24%
Salticidae	7	0.15%
Thomisidae	6	0.13%
Clubionidae	5	0.11%

Table 5: Major Families Collected in Pitfall Traps over all Cover Types, Seed Treatments, Siteyears, and Growth Stages (>1% of the Overall Total Catch).

Insect Families	Number	% of Total Catch
Formicidae	2,826	33.64%
Gryllidae	721	8.58%
Staphylinidae	506	6.02%
Carabidae	502	5.98%
Anthicidae	454	5.40%
Phoridae	319	3.80%
Latridiidae	130	1.55%
Nitidulidae	115	1.37%
Sciaridae	99	1.18%
Cydnidae	94	1.12%
Araneae Families	**Number**	**% of Total Catch**
Lycosidae	1,588	18.90%
Linyphiidae	492	5.86%

Table 6: Minor Families Collected in Pitfall Traps over all Cover Types, Seed Treatments, Siteyears, and Growth Stages (<1% of the Overall Total Catch).

Insect Families	Number	% of Total Catch
Acrididae	81	0.96%
Elateridae	63	0.75%
Curculionidae	57	0.68%
Anisolabididae	56	0.67%
Ulidiidae	48	0.57%
Scarabaeidae	44	0.52%
Blissidae	34	0.40%
Platygastridae	32	0.38%
Chrysomelidae	26	0.31%
Pompilidae	25	0.30%
Membracidae	13	0.15%
Tetrigidae	11	0.13%
Corylophidae	10	0.12%
Geocoridae	10	0.12%
Mycetophagidae	9	0.11%
Reduviidae	6	0.07%
Noctuidae	5	0.06%
Cicadellidae	4	0.05%
Chrysopidae	3	0.04%
Pentatomidae	2	0.02%
Coreidae	2	0.02%
Coccinelidae	1	0.01%
Byrrhidae	1	0.01%
Miridae	1	0.01%
Anthocoridae	1	0.01%
Dolichopodidae	1	0.01%
Tipulidae	1	0.01%
Ichneumonidae	1	0.01%
Araneae Families	**Number**	**% of Total Catch**
Theridiidae	5	0.06%

Table 7: Major Families Collected in Sweep Nets over all Cover Types, Seed Treatments, Siteyears, and Growth Stages (>1% of the Overall Total Catch).

Insect Families	Number	% of Total Catch
Membracidae	1218	46.07%
Miridae	306	11.57%
Chrysomelidae	284	10.74%
Acrididae	204	7.72%
Platystomatidae	83	3.14%
Coccinellidae	73	2.76%
Tephritidae	67	2.53%
Cicadellidae	59	2.23%
Geocoridae	55	2.08%
Elateridae	47	1.78%
Araneae Families	**Number**	**% of Total Catch**
Oxyopidae	33	1.25%

Table 8: Minor Families Collected in Sweep Nets over all Cover Types, Seed Treatments, Siteyears, and Growth Stages (<1% of the Overall Total Catch).

Insect Families	Number	% of Total Catch
Curculionidae	25	0.95%
Reduviidae	23	0.87%
Pentatomidae	17	0.64%
Syrphidae	17	0.64%
Nabidae	14	0.54%
Thyreocoridae	13	0.49%
Tetrigidae	13	0.49%
Carabidae	9	0.34%
Cerambycidae	8	0.30%
Chrysopidae	8	0.30%
Dolichopodidae	7	0.26%
Erotylidae	6	0.23%
Coreidae	4	0.15%
Gryllidae	4	0.15%
Plataspidae	3	0.11%
Sciomyzidae	2	0.08%
Stratiomyidae	2	0.08%
Apidae	2	0.08%
Ichneumonidae	2	0.08%
Noctuidae	1	0.04%
Araneae Families	**Number**	**% of Total Catch**
Theridiidae	14	0.53%
Tetragnathidae	9	0.34%
Thomisidae	6	0.23%
Clubionidae	5	0.19%
Salticidae	1	0.04%

Figure 10: Total insect pests (visual counts) for each cover type (p<0.05).

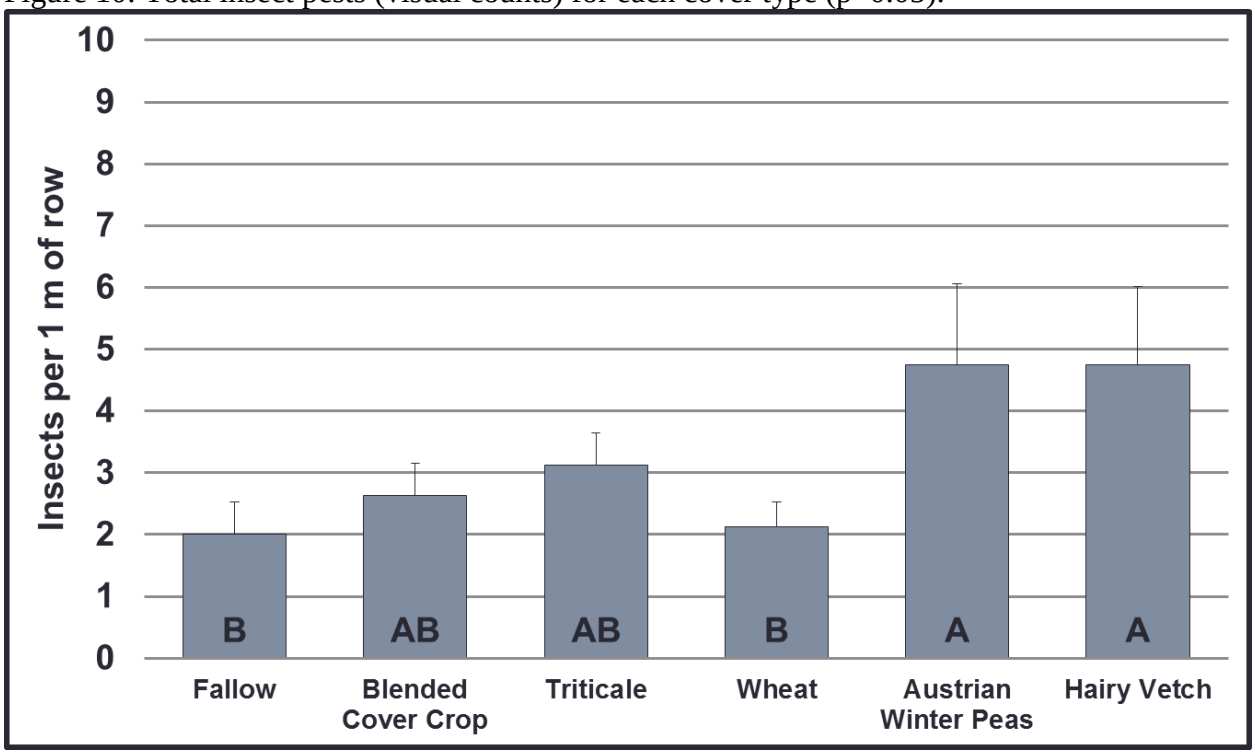


Figure 11: Mean Reniform Nematode Abundance for each Cover Type (p<0.05).

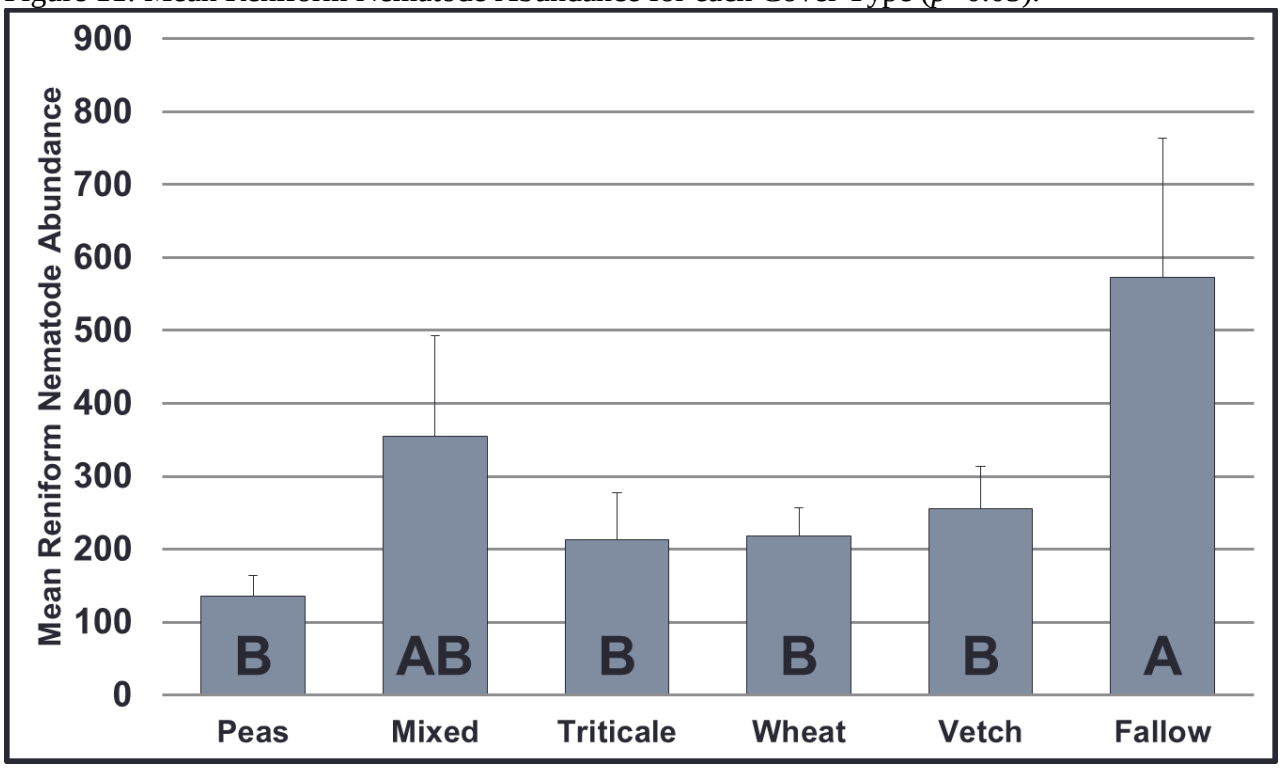


Figure 12: Soybean yield for each cover type (p<0.05).