INFLUENCE OF WINTER ANNUAL COVER CROPS AND INSECT MANAGEMENT STRATEGIES ON INSECT PESTS OF MISSISSIPPI SOYBEAN

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Cover Crops

- Crops grown to “cover” the ground when regular crops are not occupying fields.
- Most planted before winter months and terminated before planting.
- In the Midsouth, the major categories of winter cover crops to consider are either grasses, legumes, or a mixture of the two.
- Provide many agronomic benefits as well as habitat for wildlife, including pollinators, and improved water quality.
- Less than 2% of cropland in the Mississippi River Basin is planted in cover crops, but that percentage is increasing – National Wildlife Federation

Agronomic Benefits

Cover Crops and Pests

- **Cover crops of wheat, rye, and alfalfa and residue cover increased seedcorn maggot and slug infestations in Ohio soybean (Hammond and Stinner 1987).**

- **Bean leaf beetle and Japanese beetle populations increased with the use of a rye cover crop before soybean in Ohio (Smith et al 1988).**

- **Pea leaf weevil outbreak in Mississippi Delta soybean seed treatment trials and Arkansas soybean fields in 2014 following hairy vetch and Austrian winter peas.**

Pea Leaf Weevil (*Sitona lineatus*)

- Defoliating pest associated with soybean following a winter legume cover crop.
- Adult beetles measure 5 mm. long and are gray-brown in color.
- Adults feed on leaves of legumes; larvae feed on nodules.
- Can be controlled with labeled insecticides but continue to emerge from cover crop residue resulting in multiple applications.
- Seed treatments can help prevent total crop loss.

Pea Leaf Weevil Soybean Damage

9

10

11

Pea Leaf Weevil in Arkansas

DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System

New weevil gnawing at Arkansas soybeans

Fast Facts:

Pea weevils confirmed in Arkansas

Pea weevils hitched ride on Austrian field peas used as cover crop

Weevils limited to Phillips County

MARVELL, Ark. -- Arkansas soybean growers are facing a new enemy -- the pea weevil -- an insect that hitched a ride from Europe in a legume used as a cover crop.

So far, the pea weevil's presence is limited to just a few fields south of Marvell in Phillips County where Austrian winter field peas had been used as a winter cover crop. Farmers use cover crops to prevent erosion, hold moisture and add nutrients to the soil. The field peas, being legumes, help add nitrogen to the soil, thanks to a friendly bacteria living in the plant roots that fix nitrogen from the atmosphere.

The pea weevils have also been found in Louisiana and Washington State. In all three instances, **"this pest situation is strictly related to this cover crop,"** said Gus Lorenz, extension entomologist with the University of Arkansas System Division of Agriculture. "We're introducing a problem with the cover crops." "It appears that the weevil is a legume feeder," he said. "The immature form feeds on the nitrogen fixing....

Early Season Pests of Soybean

- **Soil Insects – White grubs, wireworms, lesser cornstalk borer, etc.**

- **Three-cornered alfalfa hopper**
- **Bean Leaf Beetle**

- **Thrips**


B.C. Thrash

Objective 1

Determine the efficacy of various chemical and cultural control practices on insect pests of soybean following cover crops

Materials and Methods

Cover crop treatments:

- Cover crop blend of tillage radish, Austrian winter pea\hairy vetch, and triticale
- Naturally occurring winter vegetation

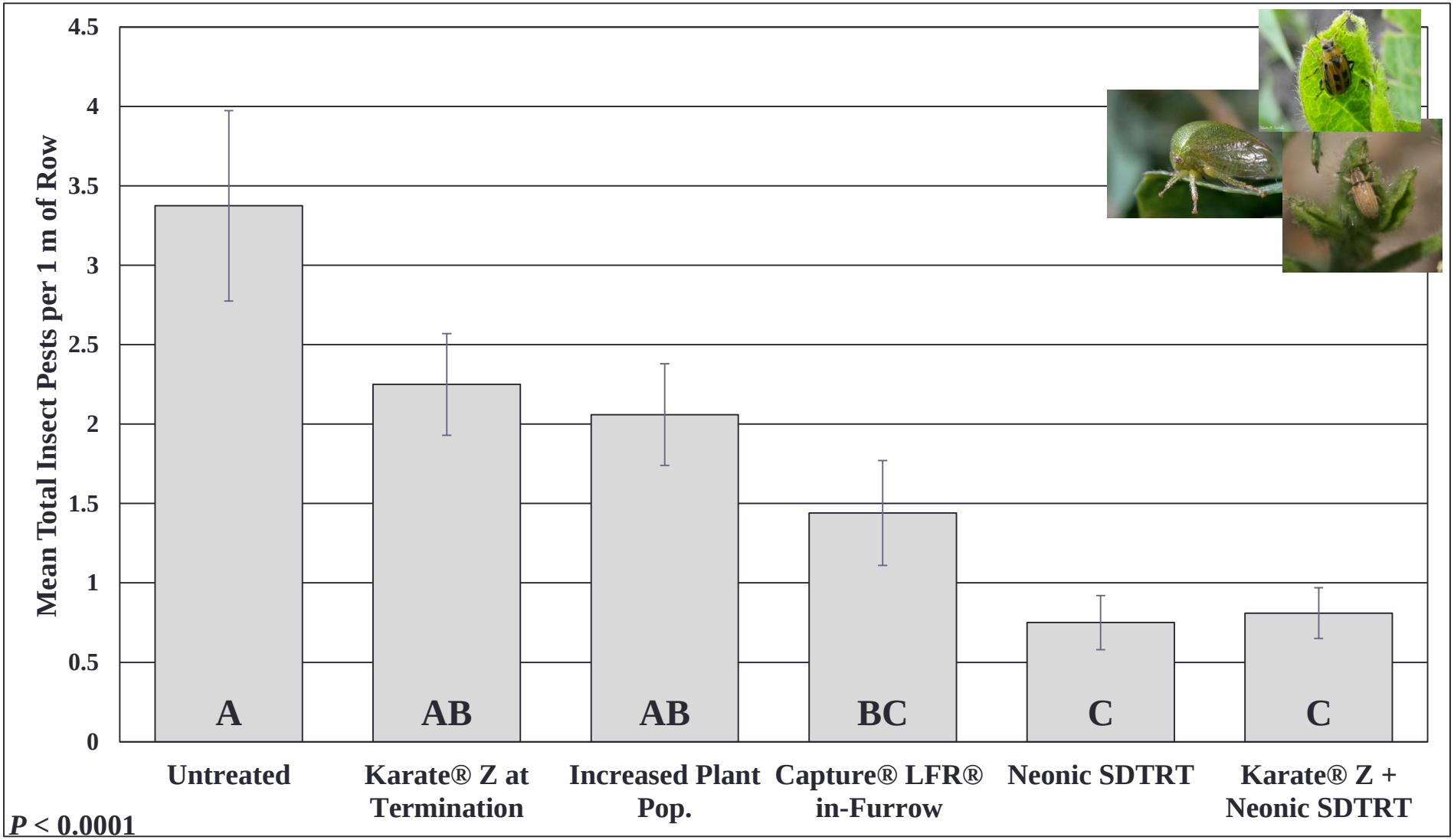
Chemical and cultural control treatments:

Treatment	Application Description
Untreated	Fungicide only treated seed
Karate Z Termination Spray	Foliar application of Karate Z (lambda-cyhalothrin) during cover crop termination
Neonic SDTRT	Neonicotinoid seed treatment on soybean seed at planting
Karate Z + Neonic SDTRT	Foliar application during cover crop termination + seed treatment on soybean seed at planting
Capture Infurrow	In-furrow insecticide spray application of Capture (bifenthrin) at planting
Higher Plant Pop.	Increased seeding rate of 165,000 plants/acre

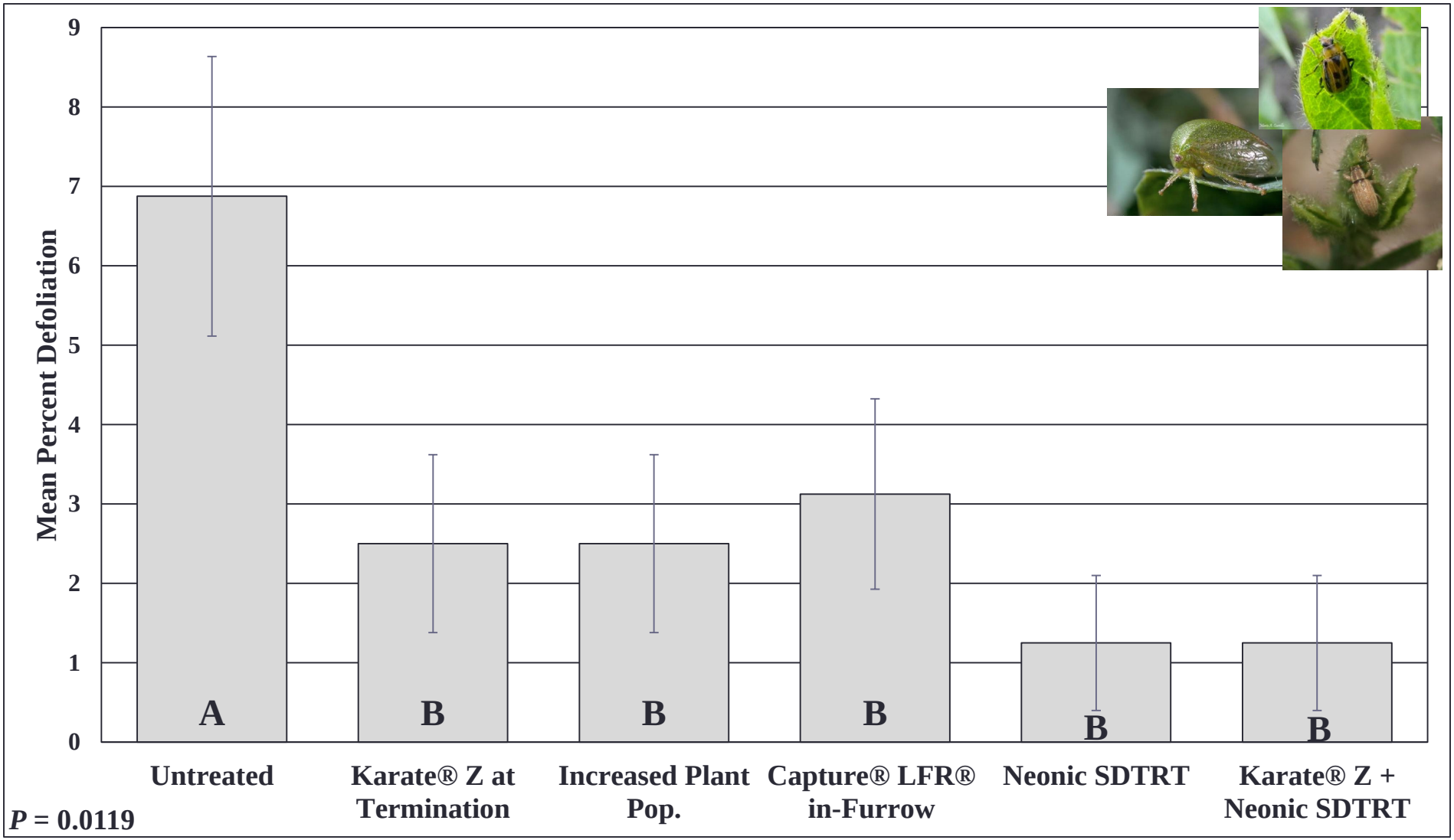
Materials and Methods

- Planted into 8 row plots measuring 7.72 m wide by 15.24 m long.
- 12 treatment combinations replicated 4 times in two Mississippi locations in 2016 and 2017 growing seasons.
- Cover crops terminated four weeks prior to planting with a herbicide application.
- Soybean planted early May.
- Visually scouted for bean leaf beetle, three cornered alfalfa hopper and pea leaf weevil and defoliation damage at V3.
- Plots were harvested and yields recorded.

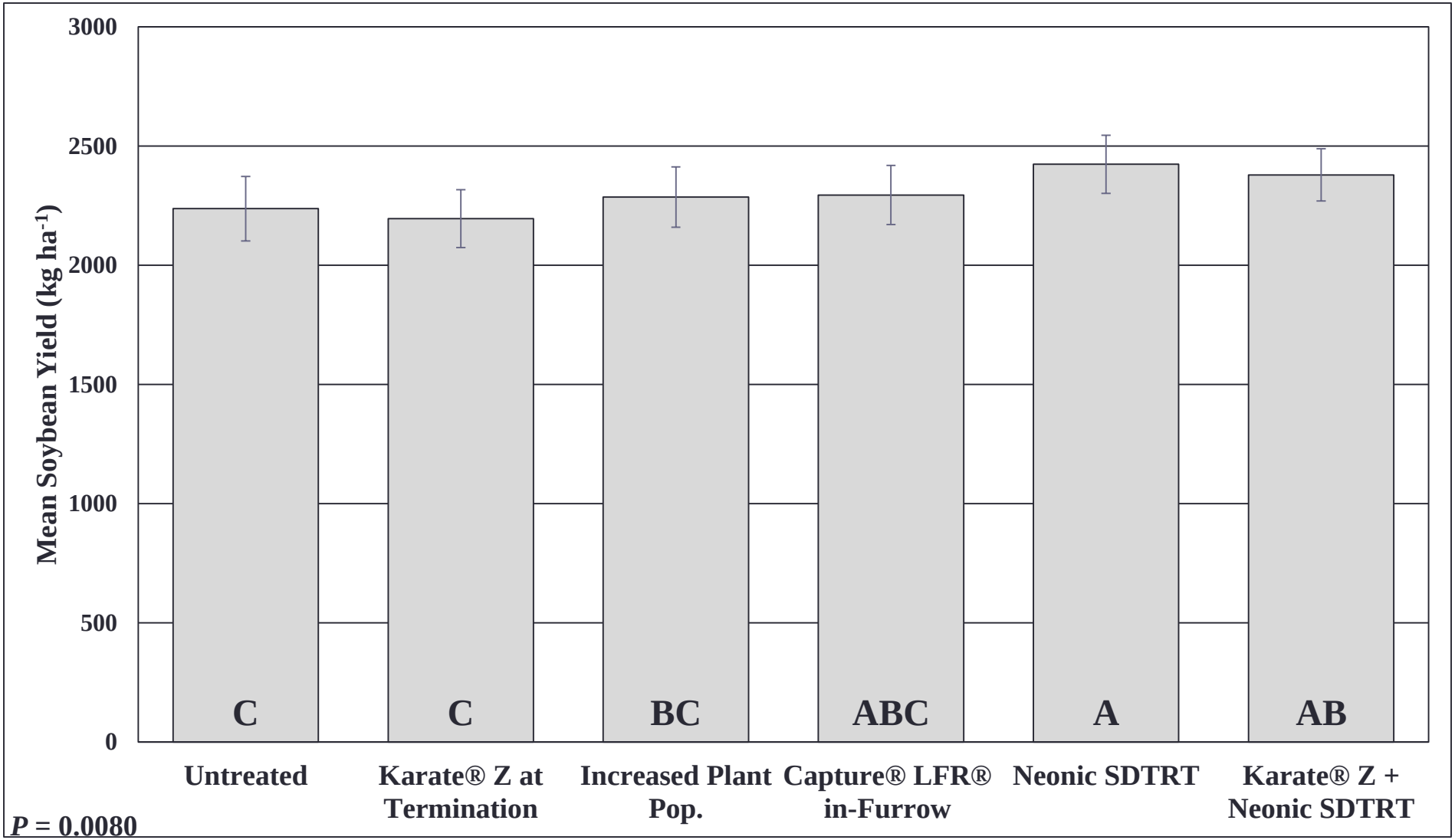
Mean Total Insect Pest Visual Counts for each Control Method



Mean Defoliation Damage for each Control Method



Mean Soybean Yield for each Control Method



Conclusion

- Significantly less insect pests observed in neonicotinoid seed treatment plots than the untreated control plots.
- Significantly less defoliation damage observed in all control methods than in all untreated control plots.
- No significant differences observed between previous cover types with regards to insect pests totals and defoliation damage.
- No significant interactions between previous cover type and control methods with regards to soybean yield.
- No significant difference in yields from natural winter vegetation plots and cover crop plots.
- The neonicotinoid seed treatment increased soybean yield regardless of previous cover type.

Objective 2

Determine how neonicotinoid seed treatments and termination date of cover crops affects insect damage in soybean following cover crops

Materials and Methods

Cover crop treatments:

- Cover crop blend
- Winter wheat
- Natural winter weeds

Soybean seed treatments:

- Neonicotinoid seed treatment
- Fungicide only seed treatment

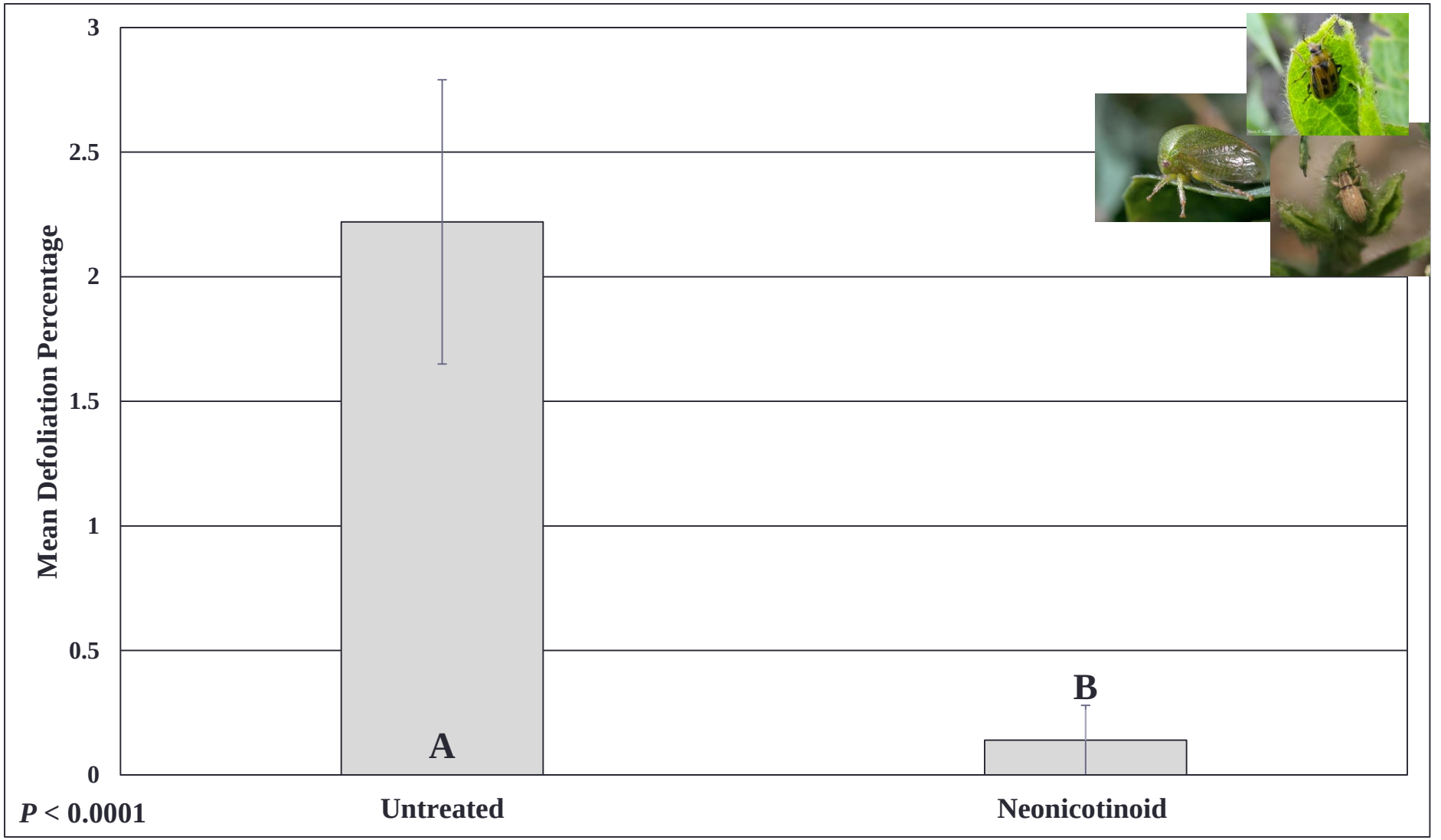
Burndown timing treatments:

Treatment	Application Description	Burndown Window	Planting Window
Early Burndown	6 weeks before planting	March 28 - April 1	May 9-13
Optimal Burndown	4 weeks before planting	April 11-15	May 9-13
Late Burndown	2 weeks before planting	April 25-29	May 9-13

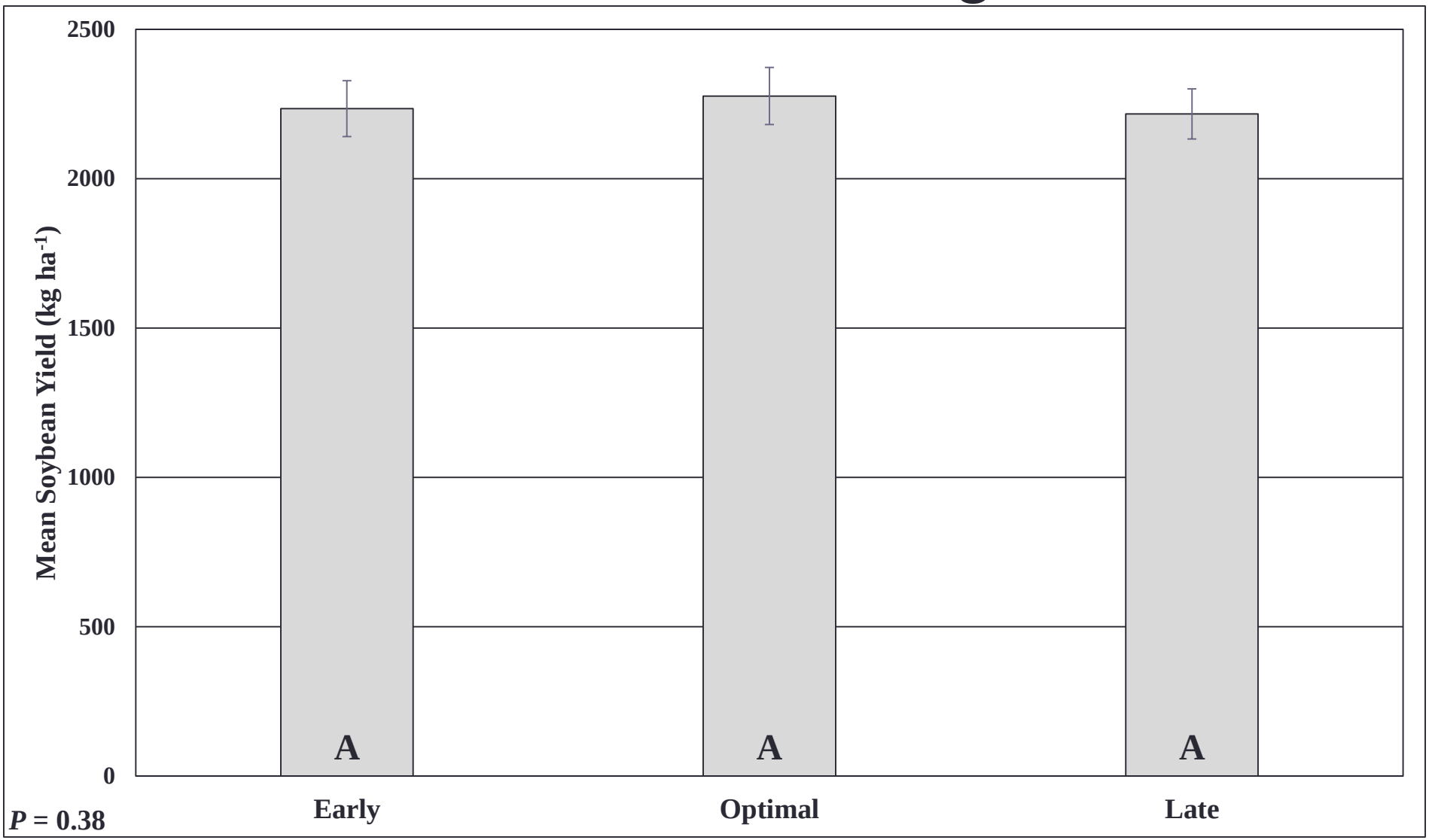
Materials and Methods

- Planted into 4 row plots measuring 3.86 m wide by 15.24 m long.
- 18 treatment combinations replicated 4 times in two Mississippi locations.
- Cover crops will be terminated during the designated termination windows with a herbicide application.
- Asgrow 4835 soybean seed planted in early May.
- Soybean plots were treated at threshold for insect pests once soybean plants reached reproductive growth stages.
- Visually scouted for bean leaf beetle, three cornered alfalfa hopper and pea leaf weevil and defoliation damage at V3.

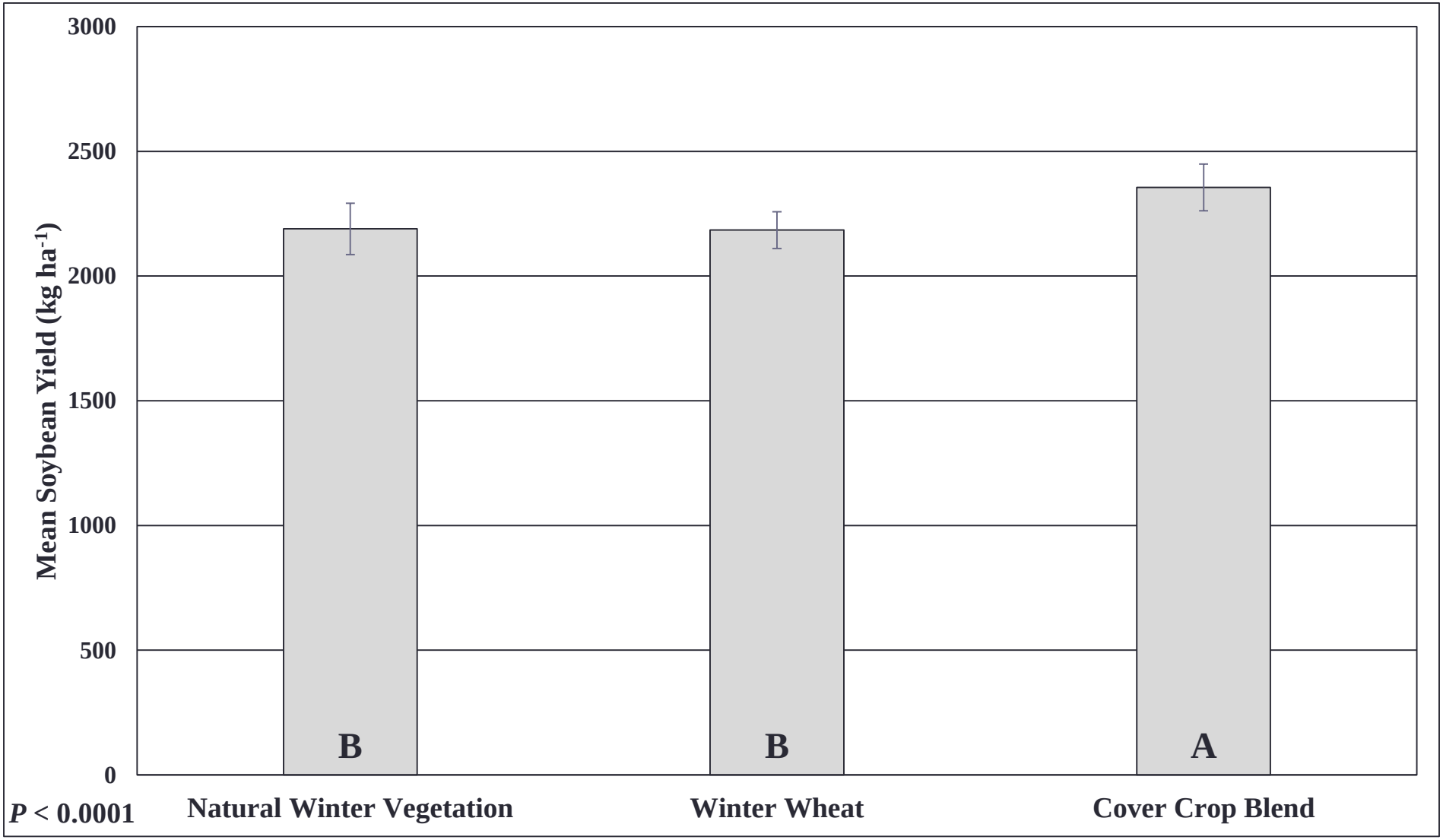
Mean Defoliation Damage for each Seed Treatment



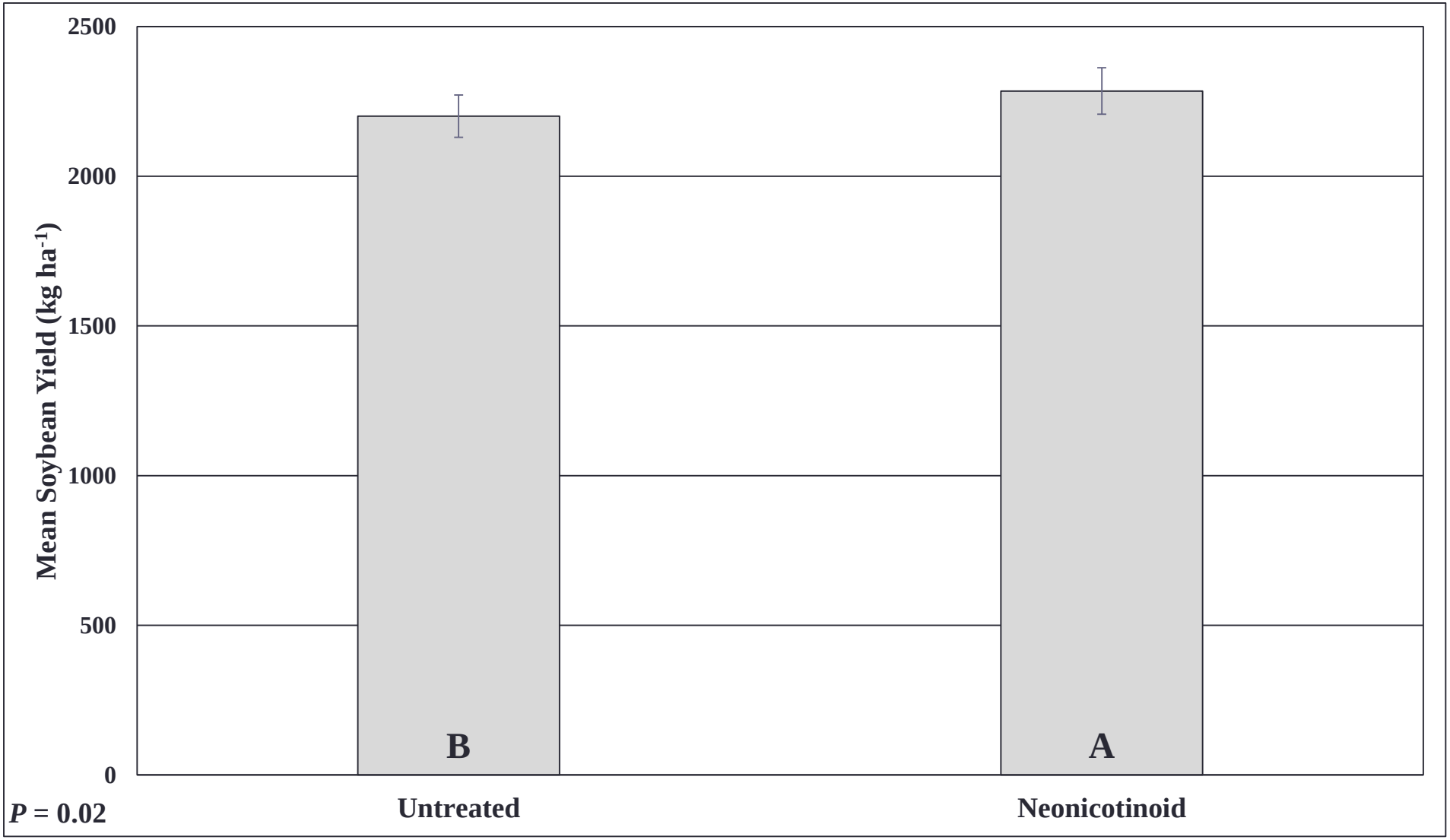
Mean Soybean Yield for each Termination Timing



Mean Soybean Yield for each Previous Cover Type



Mean Soybean Yield for each Seed Treatment



Conclusion

- No significant differences between termination timings for observed pests, defoliation damage, or yield.
- Significantly less defoliation damage in neonicotinoid seed treatment plots than the untreated control plots.
- Soybean planted behind the cover crop blend had a significantly higher yield than soybean planted behind winter wheat and natural winter vegetation.
- Neonicotinoid seed treatments did provide a significant yield increase.

Objective 3

Determine the agronomic and pest effects of various cover crop treatments planted before soybean

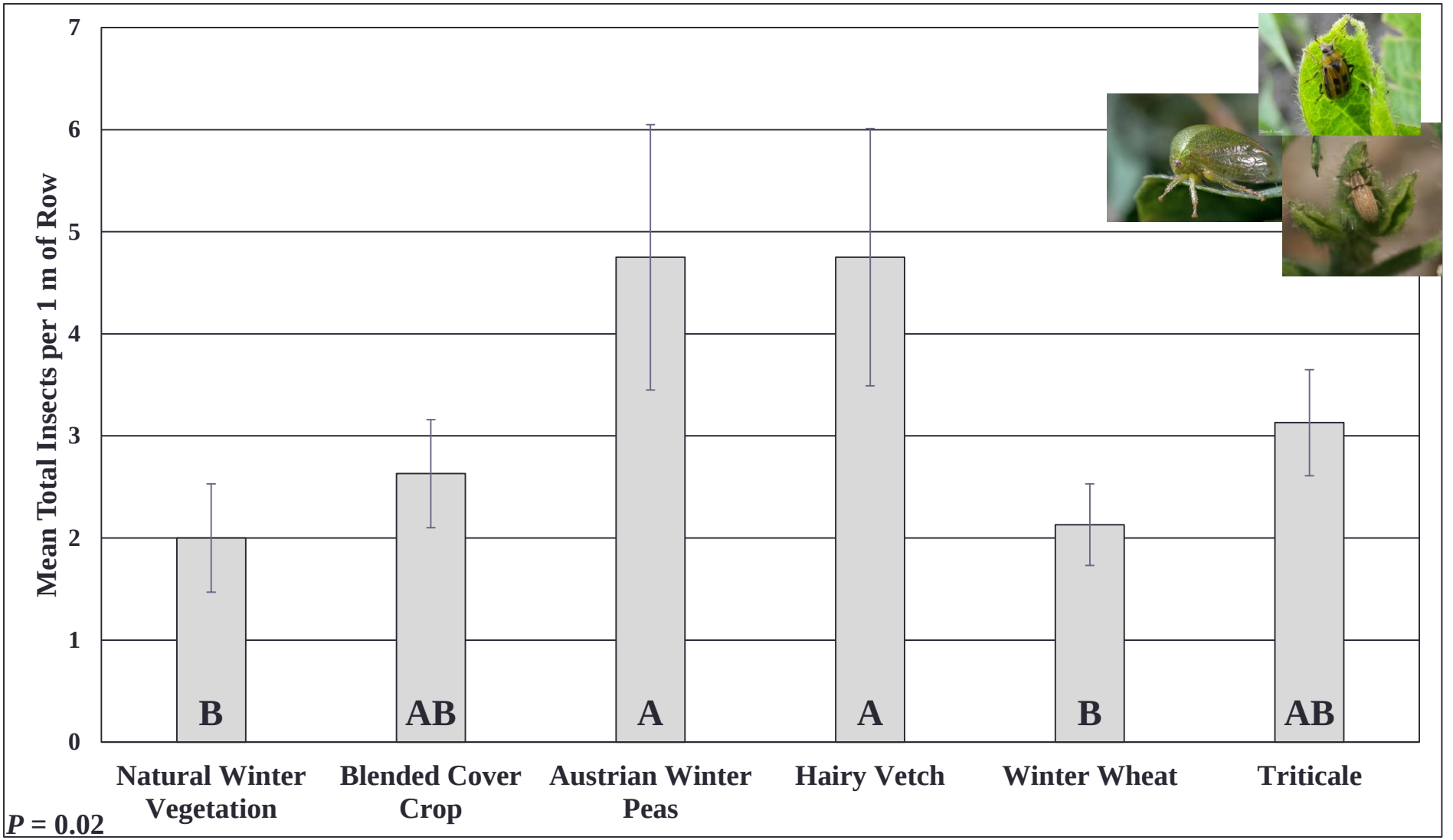
Materials and Methods

- Planted into 8 row plots measuring 7.72 m wide by 15.24 m long.
- 6 previous cover treatments 4 times in two Mississippi locations in 2016 and 2017 growing seasons.
- Cover crops terminated four weeks prior to planting with a herbicide application.
- Soybean planted early May.
- Visually scouted for bean leaf beetle, three cornered alfalfa hopper and pea leaf weevil and defoliation damage at V3.
- Plots were harvested and yields recorded.

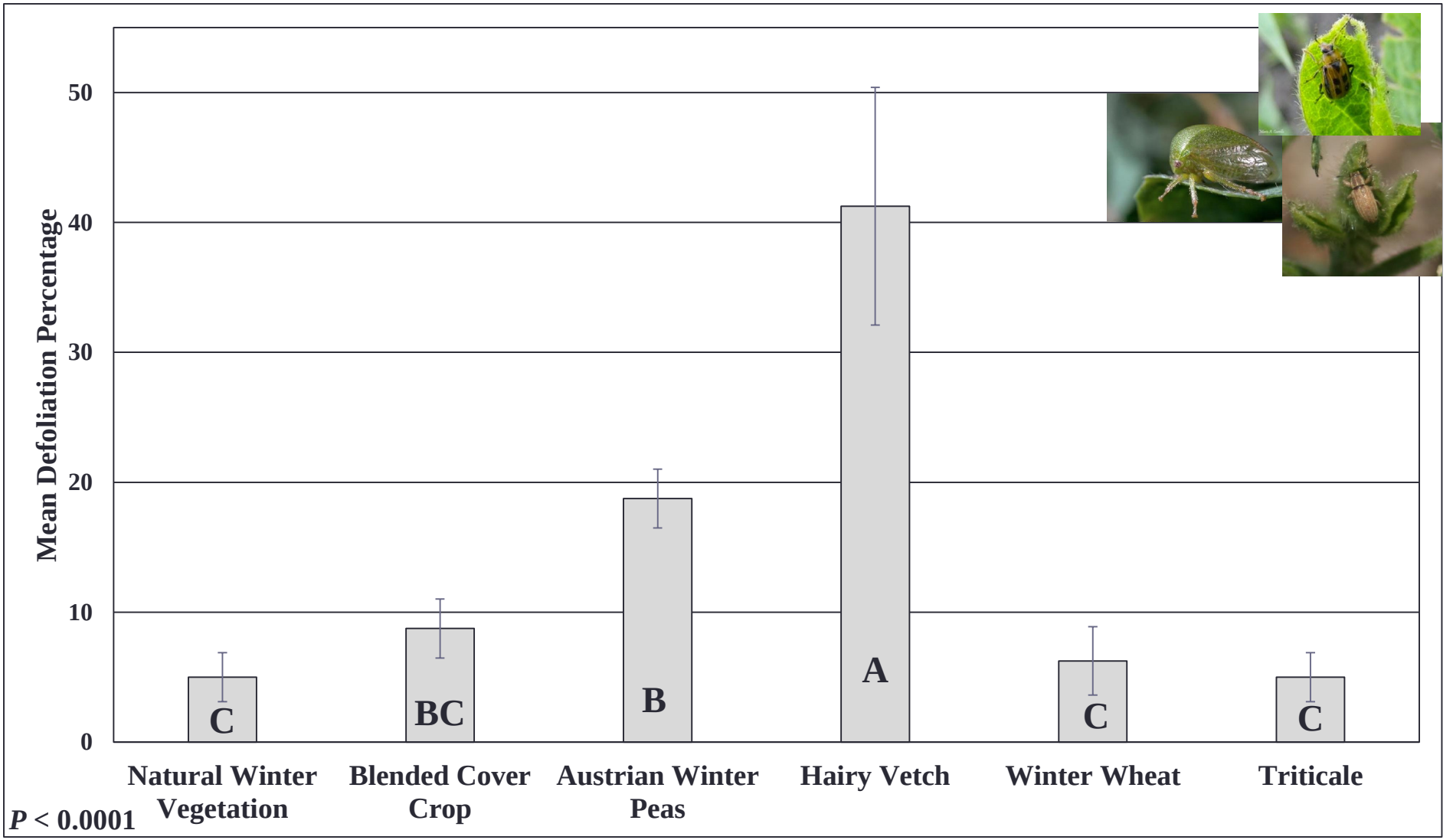
Materials and Methods

- **Cover crop treatments:**
  - **Winter wheat**
  - **Triticale**
  - **Austrian winter pea**
  - **Hairy vetch**
  - **A blend of tillage radish, Austrian winter pea/hairy vetch, and triticale**
  - **Naturally occurring winter weeds**

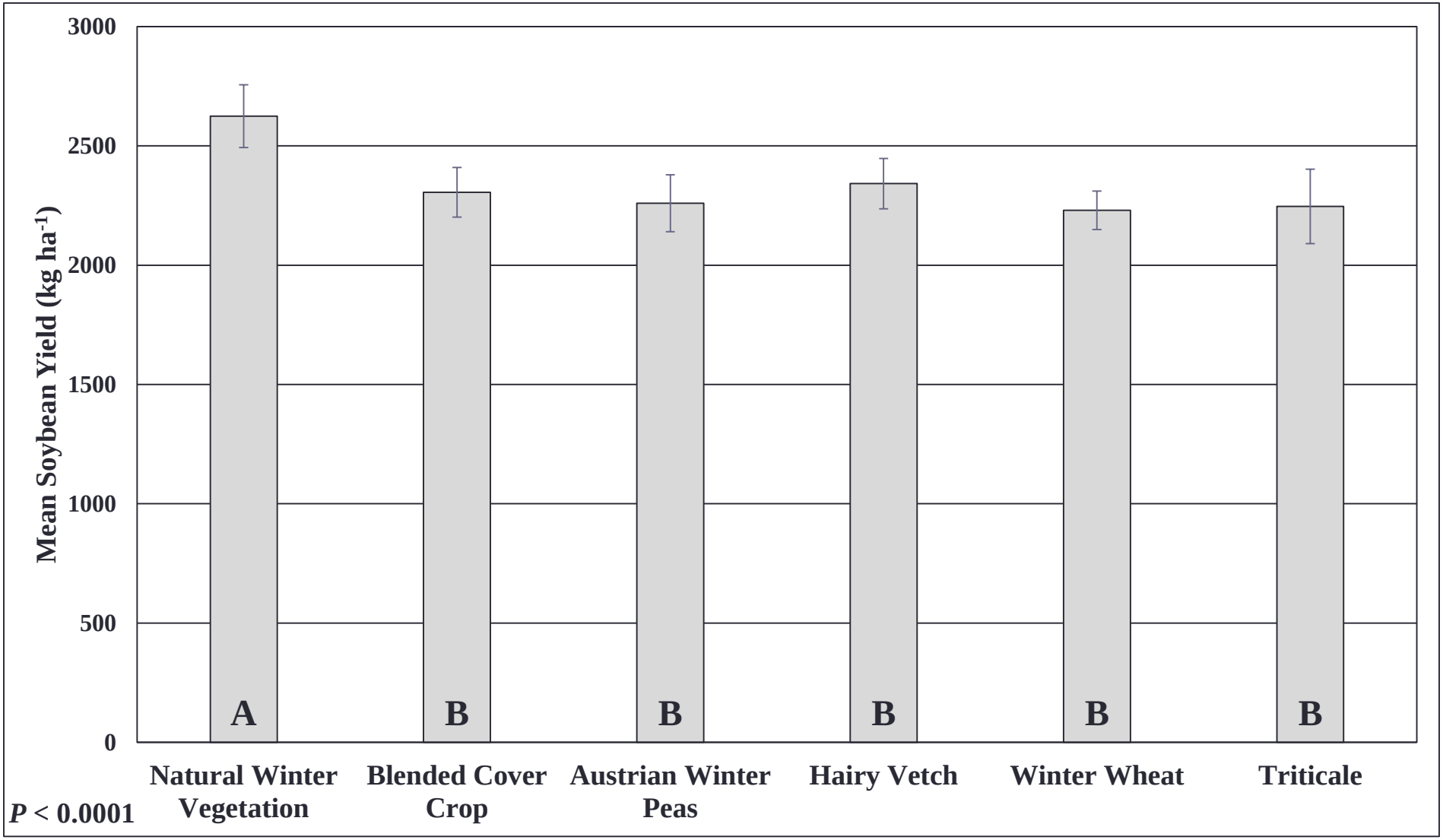
Mean Total Insect Pest Visual Counts for each Previous Cover Type



Mean Defoliation Damage for each Previous Cover Type



Mean Soybean Yield for each Previous Cover Type



Conclusion

- Previous plantings of legume cover crops attracted more insect pests to the soybean planted behind them during early stages.
- These pests caused significant defoliation damage compared to soybean planted behind no cover crop.
- Soybean planted behind no cover crop yielded higher than soybean planted behind all cover crops.

Objective 4

Determine how various cover crop treatments affect arthropod diversity in Mississippi soybean

Materials and Methods

- Asgrow 4835 soybean seed was planted into 8 row plots measuring 7.72 m wide by 15.24 m long.
- 6 treatments replicated 4 times in two Mississippi locations.
- Cover crops were terminated four weeks before planting with a herbicide application.
- Soybean seed was only treated with a fungicide seed treatment.
- Soybean plots were treated at threshold for insect pests once soybean plants reached reproductive growth stages.

Materials and Methods

- **Cover crop treatments:**
  - **Winter wheat**
  - **Triticale**
  - **Austrian winter pea**
  - **Hairy vetch**
  - **A blend of tillage radish, Austrian winter pea/hairy vetch, and triticale**
  - **Naturally occurring winter weeds**

Materials and Methods

- Both cover crops and soybean were sampled for arthropod diversity.
- Sampling methods included:
  - Sweeping cover crops before termination (4 siteyears)
  - Sweeping soybean plots starting at R1 (4 siteyears)
  - Pit-fall trapping soybean plots (3 siteyears)
- All insects and spiders captured were identified to family.
- Capture data was used to determine the mean Shannon Entropy Index and Family Richness of each treatment combination.

Pitfall Trap Results for Cover Crop Study

- 6 Cover Treatments
- 2 Growth Stages: VC & R1

- Total of 14,504 insects and spiders collected from all plots at all locations over both years.
  - Insecta: 10,875 (74.98%)
  - Araneae: 3,629 (25.02%)

- 9 orders, 46 families collected.

Major Families Collected over all Cover Types (>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 Familes	Number	% of Total Catch
Lycosidae	2,757	19.01%
Linyphiidae	860	5.93%

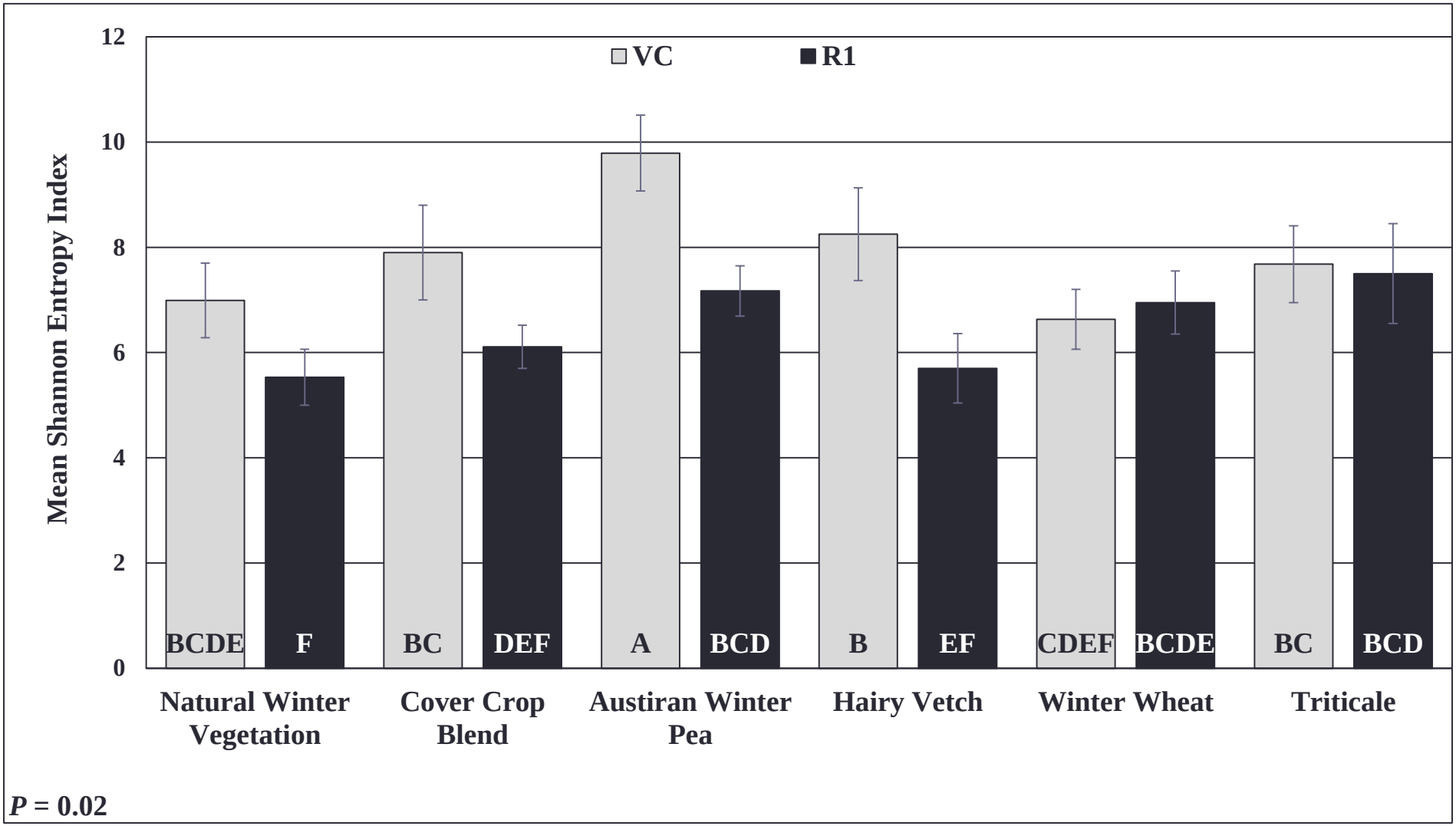
Minor Families Collected over all Cover Types (<1% of the Overall Total Catch)

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%

Insect Families	Number	% of Total Catch
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 Familes	Number	% of Total Catch
Theridiidae	12	0.08%

Mean ENS for the Epigeal Community of each Previous Cover Type and Soybean Growth Stage



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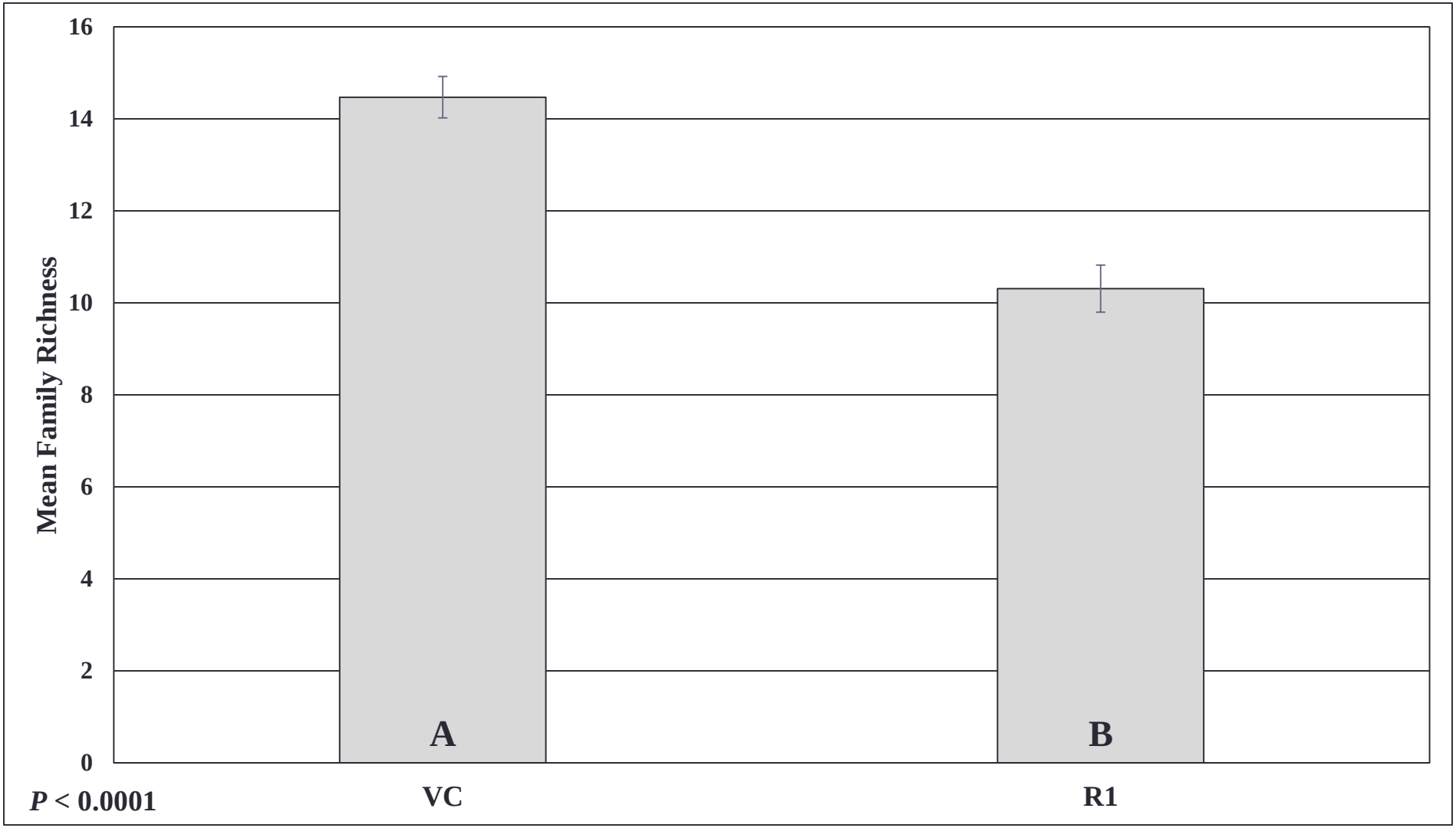
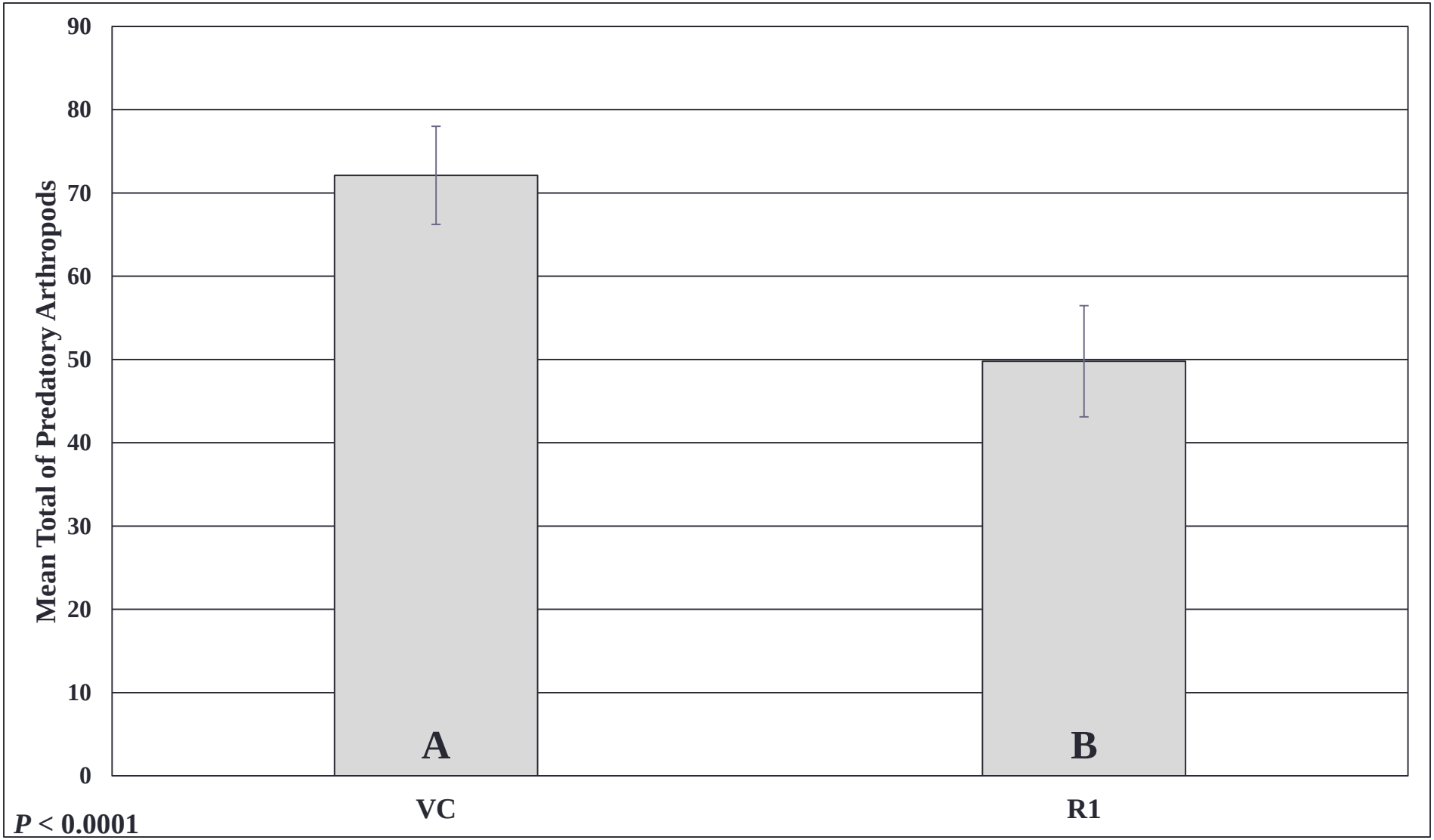
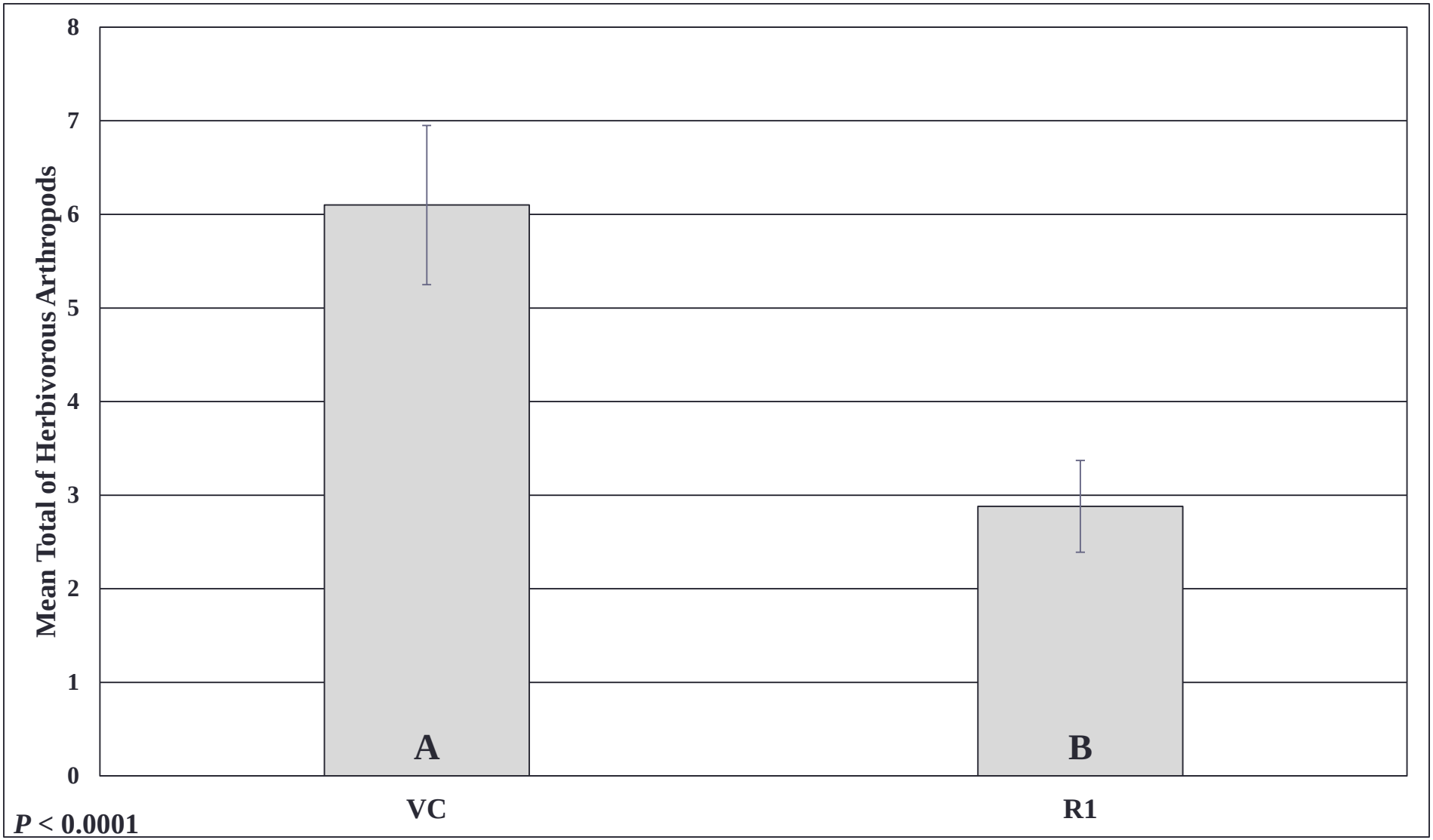
Mean Family Richness for the Epigeal Community at each Soybean Growth Stage



Mean Total of Predatory Arthropods for the Epigeal Community of each Soybean Growth Stage



Mean Total Herbivorous Arthropods of the Epigeal Community of each Soybean Growth Stage



Sweep Net Results for Cover Crop Study

- 6 Cover Treatments
- 2 Growth Stages: VC & R1

- Total of 4,621 insects and spiders collected from all plots at all locations over both years.
  - Insecta: 4,513 (97.66%)
  - Araneae: 108 (2.34%)

- 8 orders, 38 families collected.

Major Families Collected over all Cover Types (>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 Familes	Number	% of Total Catch
Oxyopidae	58	1.26%

Minor Families Collected over all Cover Types (<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 Familes	Number	% of Total Catch
Theridiidae	21	0.45%
Tetragnathidae	11	0.24%
Salticidae	7	0.15%
Thomisidae	6	0.13%
Clubionidae	5	0.11%

Mean ENS of the Foliar Community for each Previous Cover Type at each Soybean Growth Stage

Soybean Growth Stage	Previous Cover Type	Mean Total of Herbivorous Arthropods	SEM
Before Cover Crop Termination	Natural Winter Vegetation	2.52de	0.19
	Blended Cover Crop	3.84a	0.34
	Austrian Winter Peas	3.34ab	0.37
	Hairy Vetch	3.81a	0.26
	Winter Wheat	3.84a	0.25
	Triticale	3.31ab	0.22
R1	Natural Winter Vegetation	2.66bcde	0.24
	Blended Cover Crop	2.80bcde	0.13
	Austrian Winter Peas	2.88bcde	0.24
	Hairy Vetch	2.52de	0.18
	Winter Wheat	2.50e	0.19
	Triticale	2.31e	0.15
R2	Natural Winter Vegetation	2.75bcde	0.30
	Blended Cover Crop	2.58dec	0.22
	Austrian Winter Peas	2.74bcde	0.30
	Hairy Vetch	2.69bcde	0.23
	Winter Wheat	2.70bcde	0.20
	Triticale	2.80bcde	0.27
R3	Natural Winter Vegetation	3.20abcd	0.38
	Blended Cover Crop	3.23abc	0.35
	Austrian Winter Peas	2.66bcde	0.26
	Hairy Vetch	2.87bcde	0.30
	Winter Wheat	2.72bcde	0.24
	Triticale	2.69bcde	0.31

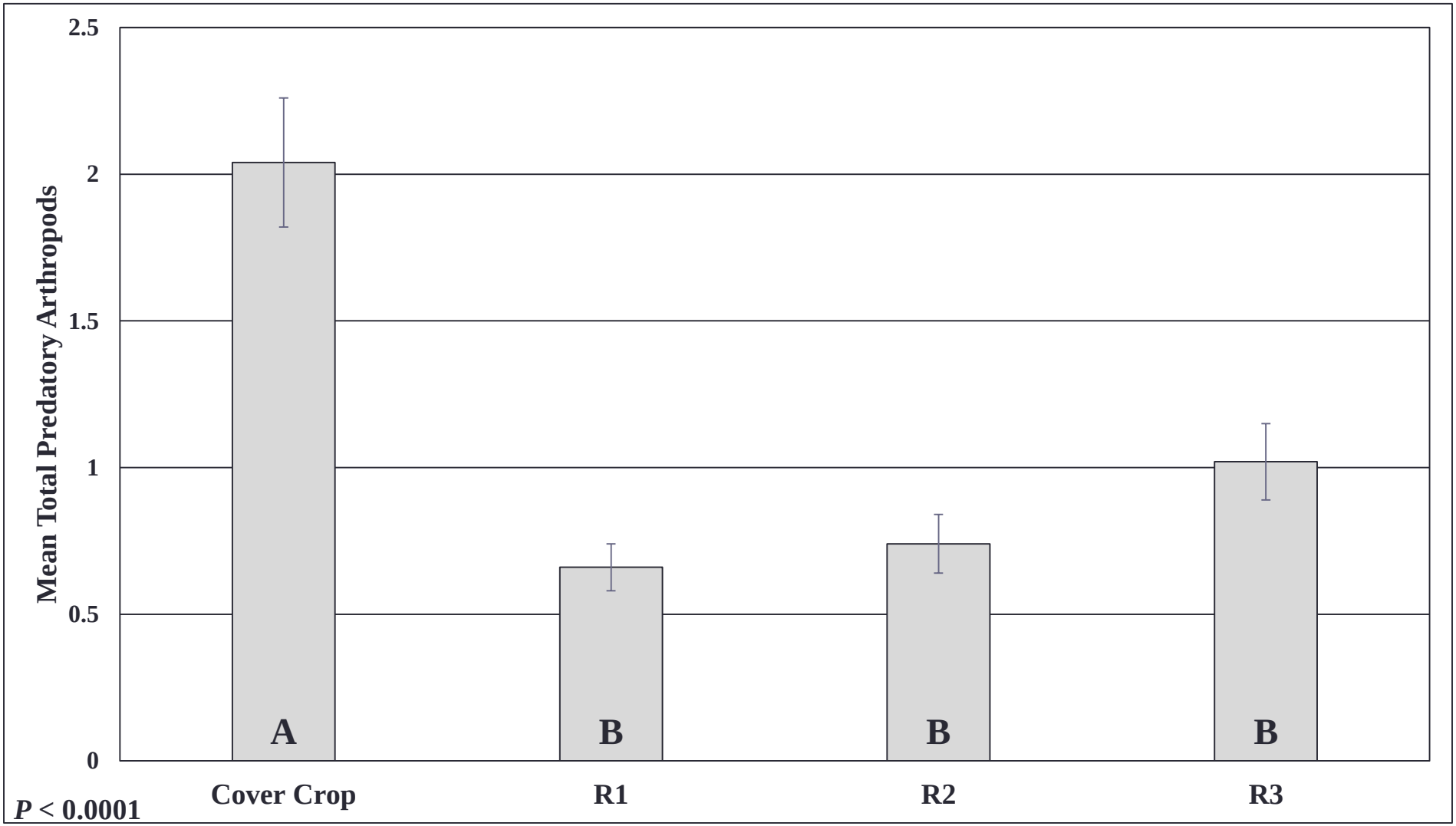
***P* = 0.05**

Mean Family Richness of the Foliar Community for each Previous Cover Type at each Soybean Growth Stage

Soybean Growth Stage	Previous Cover Type	Mean Total of Herbivorous Arthropods	SEM
Before Cover Crop Termination	Natural Winter Vegetation	2.94h	0.19
	Blended Cover Crop	4.81ab	0.39
	Austrian Winter Peas	4.31bcde	0.51
	Hairy Vetch	5.38a	0.41
	Winter Wheat	4.75abc	0.31
	Triticale	3.81defgh	0.23
R1	Natural Winter Vegetation	3.38fgh	0.29
	Blended Cover Crop	3.63defgh	0.15
	Austrian Winter Peas	3.69defgh	0.24
	Hairy Vetch	3.44efgh	0.24
	Winter Wheat	3.19gh	0.21
	Triticale	2.94h	0.23
R2	Natural Winter Vegetation	3.69defgh	0.52
	Blended Cover Crop	3.31fgh	0.34
	Austrian Winter Peas	3.63defgh	0.40
	Hairy Vetch	3.63defgh	0.35
	Winter Wheat	3.69defgh	0.30
	Triticale	3.75defgh	0.42
R3	Natural Winter Vegetation	4.19bcdef	0.61
	Blended Cover Crop	4.44bcd	0.56
	Austrian Winter Peas	4.13bcdef	0.57
	Hairy Vetch	4.00bcdefg	0.49
	Winter Wheat	3.94bcdefg	0.47
	Triticale	3.88cdefg	0.56

***P* = 0.01**

Mean Total of Predatory Arthropods for the Foliar Community of each Growth Stage



Mean Total Herbivorous Arthropods of the Foliar Community in each Previous Cover Type

Soybean Growth Stage	Previous Cover Type	Mean Total of Herbivorous Arthropods	SEM
Before Cover Crop Termination	Natural Winter Vegetation	5.50d	1.20
	Blended Cover Crop	11.50bc	2.06
	Austrian Winter Peas	11.25bc	2.31
	Hairy Vetch	18.50a	2.93
	Winter Wheat	7.94cd	1.54
	Triticale	5.13d	0.99
R1	Natural Winter Vegetation	8.31cd	1.09
	Blended Cover Crop	10.38c	2.18
	Austrian Winter Peas	11.31bc	1.38
	Hairy Vetch	9.25cd	1.27
	Winter Wheat	11.19bc	1.98
	Triticale	7.50cd	1.52
R2	Natural Winter Vegetation	8.38cd	1.75
	Blended Cover Crop	8.44cd	1.49
	Austrian Winter Peas	8.19cd	1.74
	Hairy Vetch	8.00cd	1.09
	Winter Wheat	8.31cd	1.22
	Triticale	8.88cd	1.61
R3	Natural Winter Vegetation	9.44cd	2.15
	Blended Cover Crop	11.50bc	2.32
	Austrian Winter Peas	14.94ab	5.00
	Hairy Vetch	9.06cd	1.85
	Winter Wheat	11.69bc	2.62
	Triticale	10.25c	2.17

***P* < 0.0001**

Conclusions

- The epigeal communities of soybean planted behind legume cover crops were more diverse at the earlier growth stage than soybean behind other cover types at both growth stages.
- Time after termination was important for mean family richness and for predatory and herbivorous arthropods within the epigeal community.
- The foliar communities of hairy vetch and winter wheat cover crops were significantly more diverse than the soybean planted behind them.
- When soybeans become reproductively mature, previous cover type did not effect diversity of the foliar community.

Materials and Methods

- Plots from Objective 1 study were used to measure diversity of arthropods in neonicotinoid treated and untreated soybeans following a blended cover crop or winter weeds.
- Asgrow 4835 soybean seed was planted into 8 row plots measuring 7.72 m wide by 15.24 m long.
- 4 treatment combinations replicated 4 times in two Mississippi locations.
- Soybean plots were treated at threshold for insect pests once soybean plants reached reproductive growth stages.

Major Families Collected over all Cover Types and Treatments (>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%

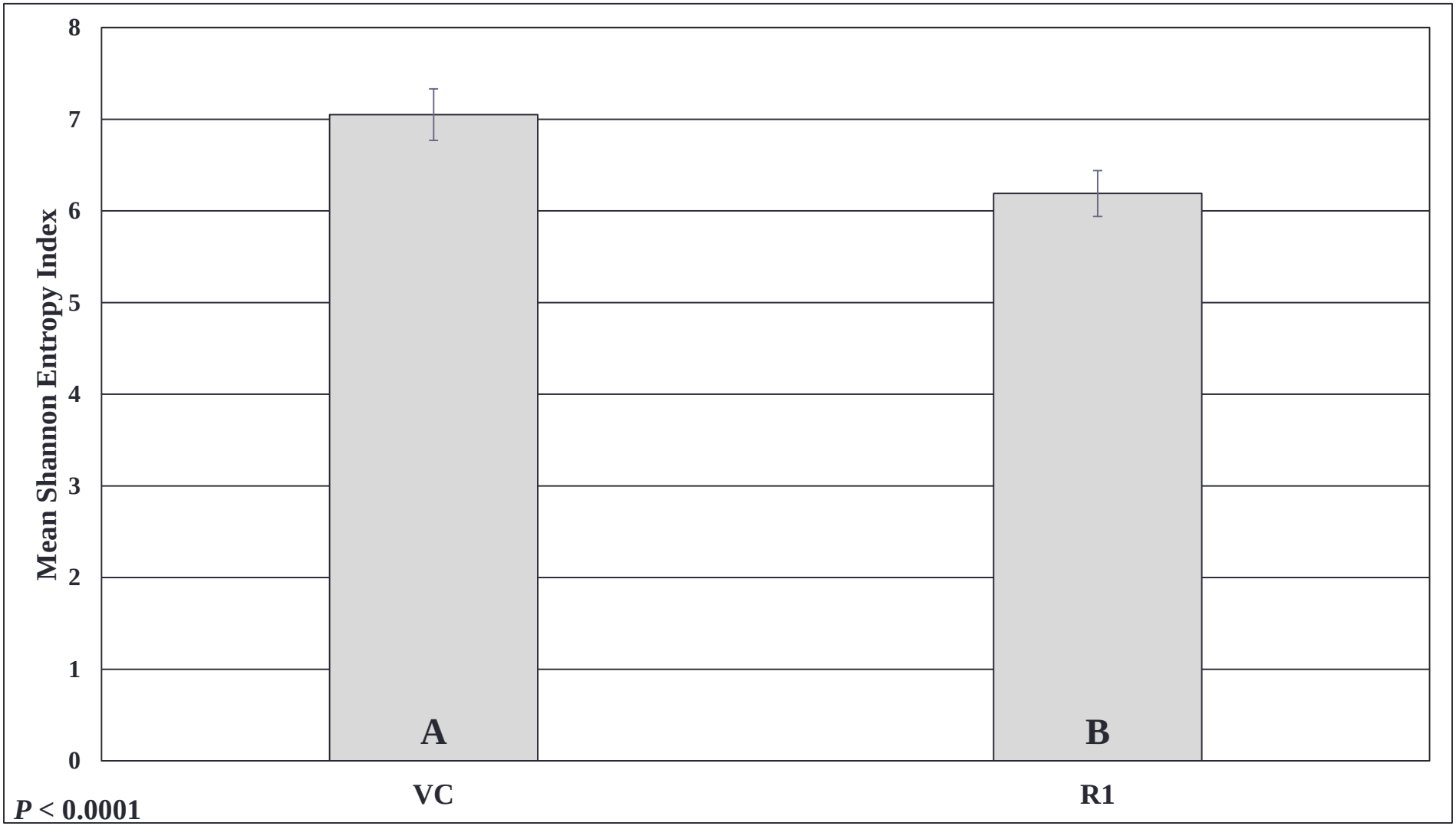
Minor Families Collected over all Cover Types and Treatments (<1% of the Overall Total Catch)

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%

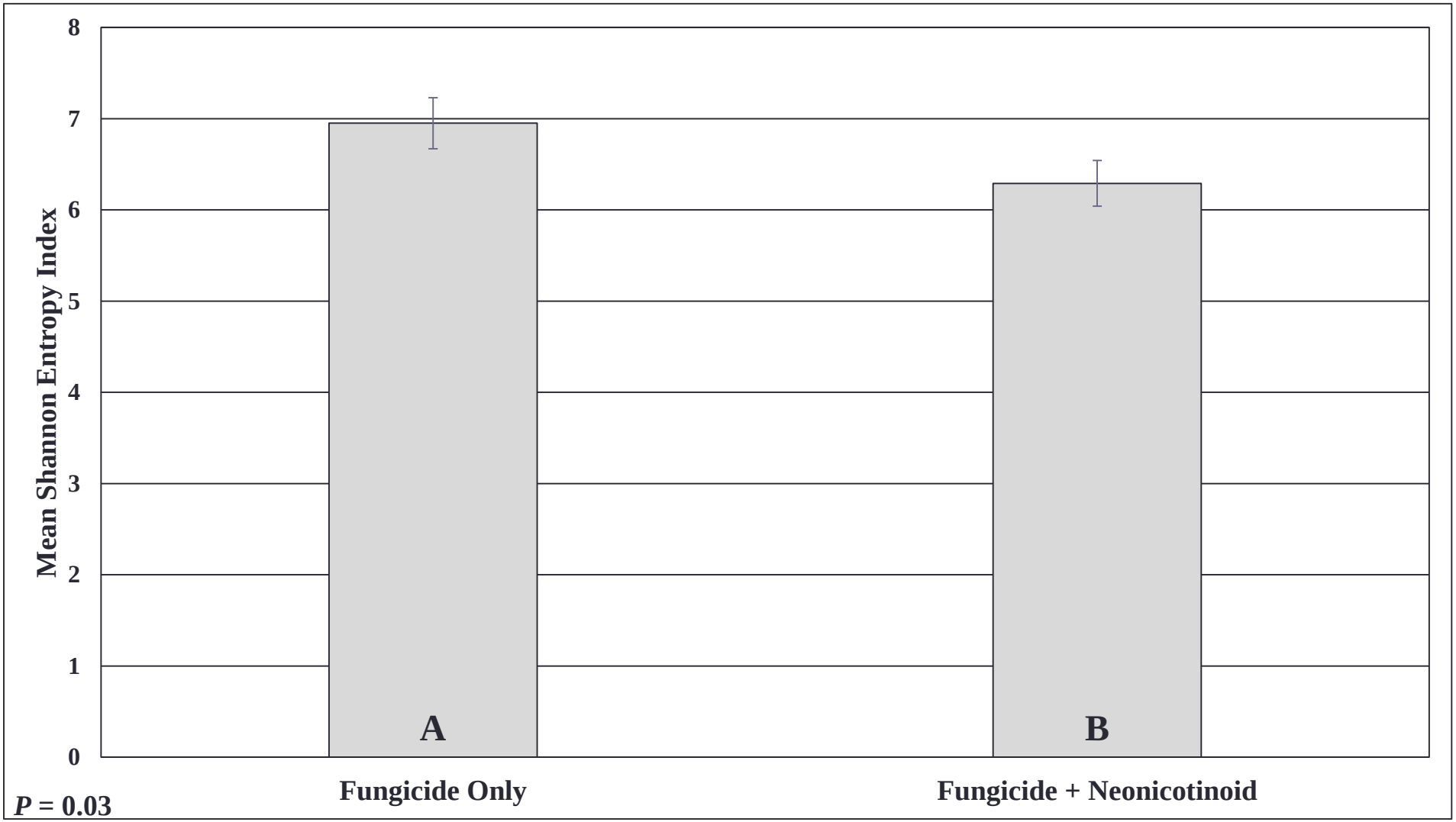
Insect Families	Number	% of Total Catch
Chrysopidae	3	0.04%
Pentatomidae	2	0.02%
Coreidae	2	0.02%
Coccinelidae	1	0.01%
Byrrhidae	1	0.01%
Miridae	1	0.01%
Anthocoridae	1	0.01%
Tridactylidae	1	0.01%
Dolichopodidae	1	0.01%
Tipulidae	1	0.01%
Ichneumonidae	1	0.01%

Araneae Families	Number	% of Total Catch
Theridiidae	5	0.06%

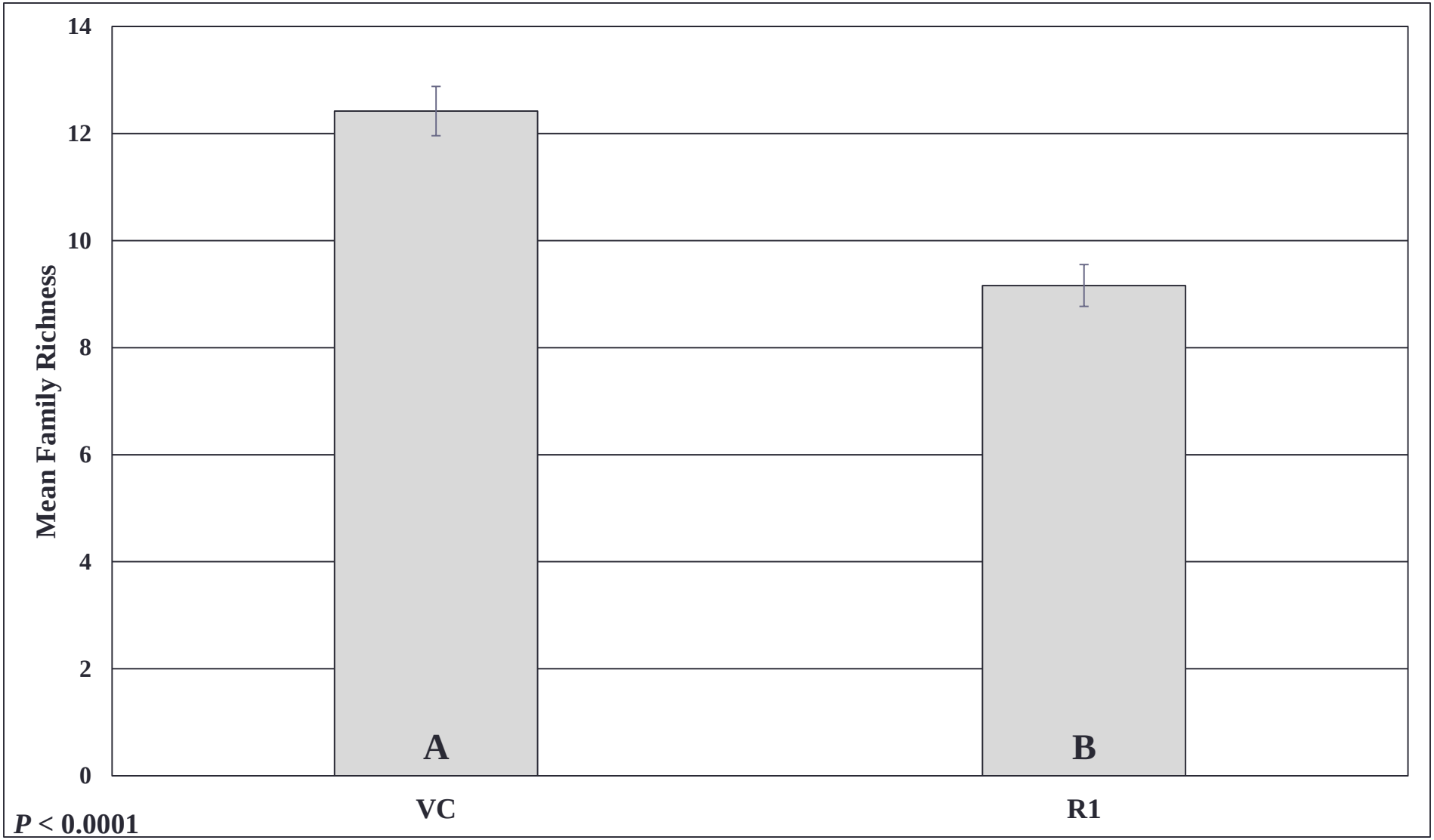
Mean ENS for the Epigeal Community of each Soybean Growth Stage in the Second Field Trial



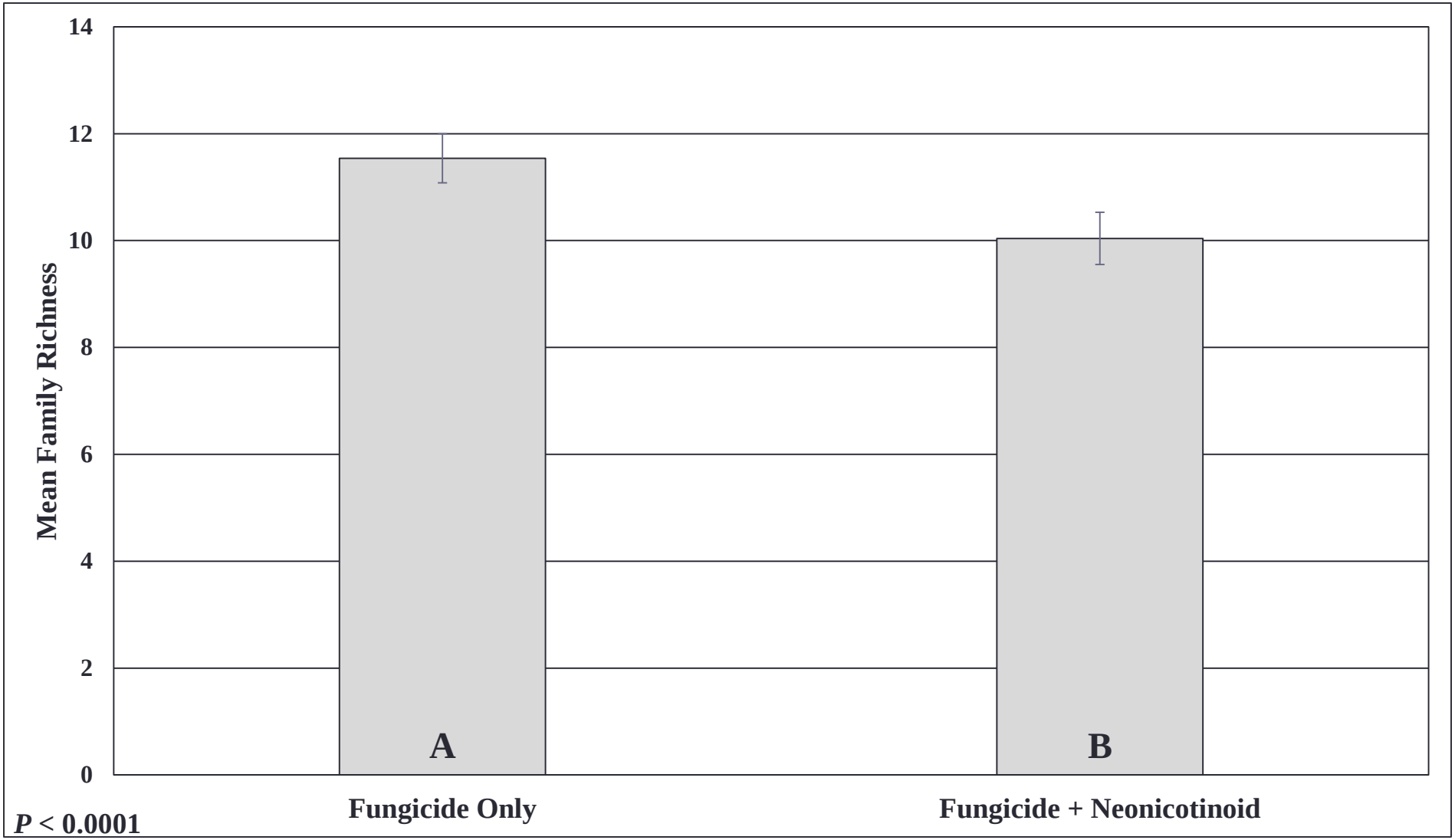
Mean ENS for the Epigeal Community of Soybean Treated with each Seed Treatment in the Second Field Trial



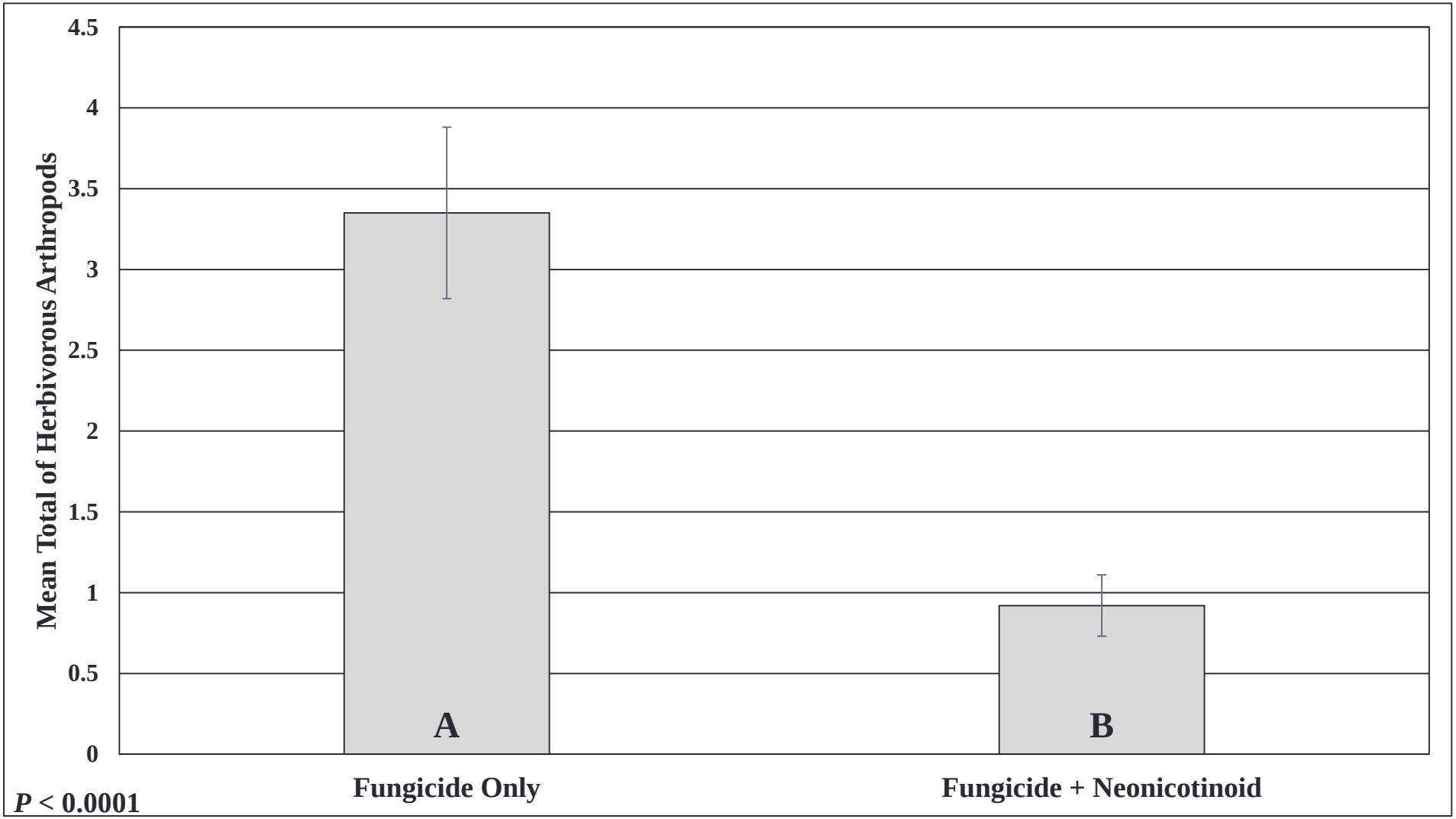
Mean Family Richness for the Epigeal Community of each Soybean Growth Stage in the Second Field Trial



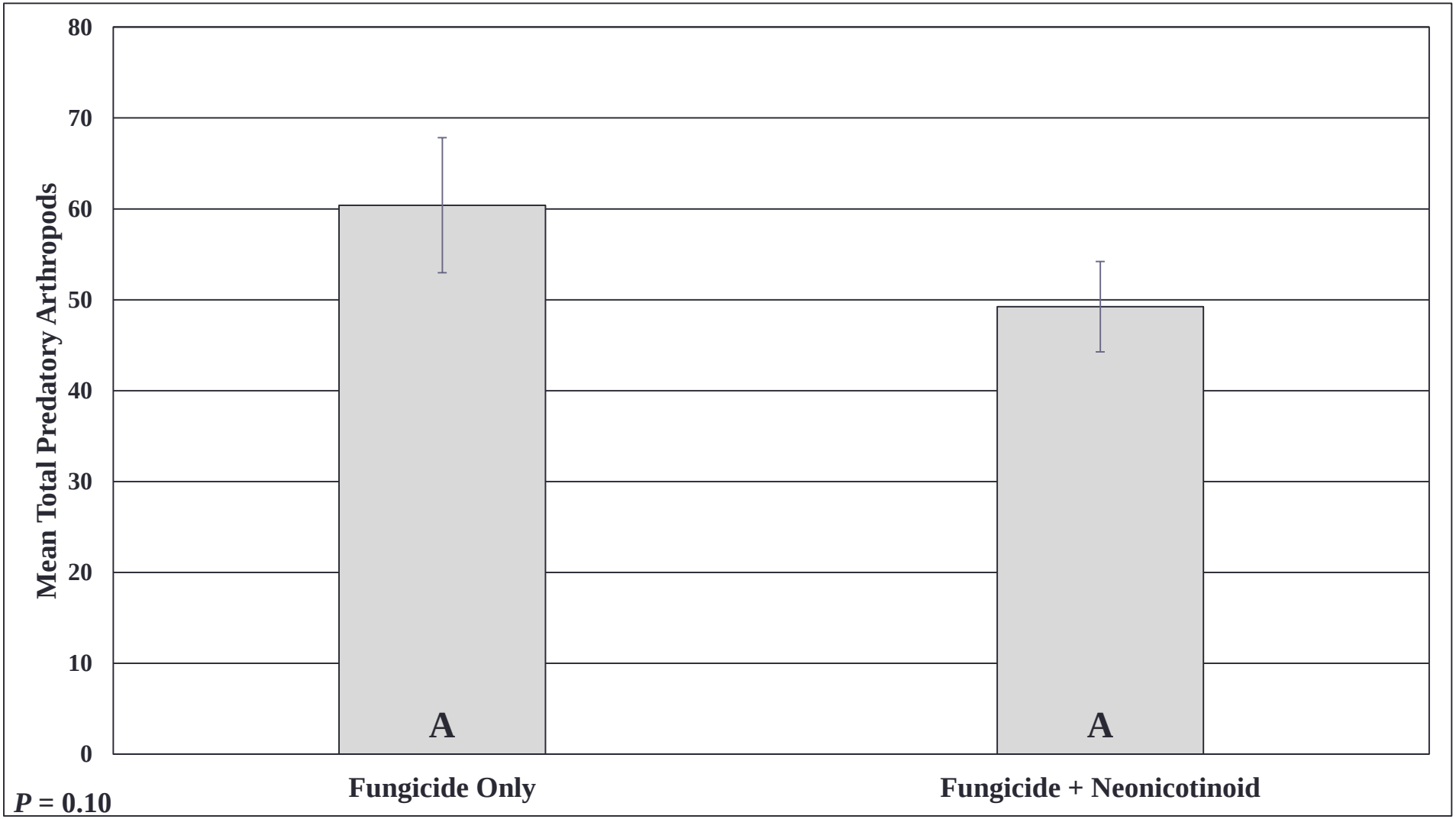
Mean Family Richness for the Epigeal Community of Soybean Treated with each Seed Treatment in the Second Field Trial



Mean Total of Herbivorous Arthropods within the Epigeal Community of Soybean Treated with each Seed Treatment in the Second Field Trial



Mean Total of Predatory Arthropods within the Epigeal Community of Soybean Treated with each Seed Treatment in the Second Field Trial



Conclusions

- **The epigeal communities of soybean treated with neonicotinoid seed treatments were less diverse at than soybean treated with only a fungicide seed treatment.**

- **While herbivorous arthropods were significantly less abundant in neonicotinoid treated soybean, predatory arthropod abundance was not affected by the seed treatment.**

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