Summary

The native highbush blueberry crop is worth over $90 million to New Jersey. With the ongoing changes in insecticide regulations, growers are faced with restrictions on the application of broad-spectrum insecticides. In commercial highbush blueberry management, this mandates the search for alternative and sustainable practices with which growers can tackle pest challenges. One such sustainable solution is the use of row-middle cover crops in blueberry production for insect and weed control and reducing run-off. This strategy can work for both conventional and organic blueberry management strategies; therefore it can be adopted on a large scale throughout the region.

Six cover crop species were tested during the 2009 growing season at a commercial higbush blueberry farm in New Jersey. The goal of the proposed research was to measure and evaluate the tested cover crops in their ability to manipulate arthropod populations and their contribution to plant quality and yield.

Our measurements of insect populations indicated that cover crops slightly increased overall diversity of the arthropod assemblages. Interestingly treatments with some type of grasses were more abundant in ladybeetles than other treatments. Ladybeetles are good predators of aphids, and these pest were more abundant in perennial rye but less abundant in winter rye, compared to tilled treatment. Damage to blueberries by plum curculio was highest in alfalfa and fescue and lowest in winter rye and tilled treatments. However the size of berries were slightly better on the cover cropped treatments than the tilled treatment, especially when comparing the largest berry in a cluster. This indicates that although arthropod populations may not be manipulated within a single growing season, there may be benefits in terms of nutrition, or soil moisture, which could improve yield.

This study will be continued in the next growing season, since the collaborating farmer is interested in a longer-term study to understand the benefits that cover crops may present in blueberry production. He found clover especially interesting, because of its easy maintenance and biomass produced in the first year of growth. He also liked some of the perennial grass treatments, because easy establishment and as a soil cover for tractors to drive on in the wet parts of the season.

Introduction

The native highbush blueberry (Ericaceae: *Vaccinium corymbosum* L.) is an economically important crop for New Jersey and the Northeast, worth over $90 million in New Jersey alone (NASS 2008). With a greater-than-ever demand for healthy foods, consumer interest in blueberries is at an all time high, and this is corroborated by increased prices. In New Jersey, the average price per pound of blueberries in 2007 was $1.67, up from $1.61 in 2006 and $1.23 in 2005 according to the National Agricultural Statistics Service. This increase in market value is despite more fruit present on the market: yield per acre has been increasing from 6,840 pounds in 2006 to 7,110 pounds in 2007.

With the currently ongoing changes in insecticide regulations, growers are increasingly faced with restrictions on the application of broad-spectrum insecticides. These have traditionally provided a cost-effective, easy and reliable solution to pest managers and the newer pesticides are either not yet registered for use in this crop or are not providing the same level of control as the older chemicals. In commercial highbush blueberry management, this translates into an increased need for alternative and sustainable management practices with which growers can tackle this complex problem. One such sustainable solution is the use of row-middle cover crops in blueberry production.

Most of New Jersey's blueberry production is in the ecologically unique and pristine Pine Barrens which the local governments are eager to maintain in the current condition for future generations. The Pine Barrens are famous for their unique flora, fauna and high ground water level. Retaining the purity of the ground water in New Jersey is a vital concern for the local communities, and the leaching of pesticides into the ground water is expected to be reduced in the presence of cover crops rather than bare ground. At the present time, 100% of New Jersey's blueberry fields are clean cultivated. This research will be the first to investigate the use of cover crops for blueberry in this

Objectives/Performance targets

- establish and maintain cover crops in a highbush blueberry field
- measure how different insect groups are affected by the use of cover crops
- identify some of the causes for observed patterns, changes
- measure some vegetational characteristics that may contribute to observed changes
- disseminate results to highbush blueberry growers

Materials and Methods

The field was comprised of 26 year-old blueberry bushes (Duke variety). The seven treatments were replicated three times in a completely randomized blocked design, including a tilled (no cover crop) treatment as the control. The six cover crop treatments contained plants from two plant families: Poaceae and Fabaceae. These plant species were chosen because they tolerate acidic soil conditions and because seeds are readily available from commercial sources. Experimental units (N=21)

were two row middles on either side of a row of blueberry bushes receiving the same cover treatment. The field was 3.5 hectares (~8 acres), a row middle was ca. 200 m^2, and rows contained 130-180 blueberry bushes. Sampling was be conducted weekly from bud-break through harvest unless otherwise indicated. The six cover crop treatments are:

1. **Clover** – 50% *Trifolium repens* L. & 50% *Trifolium hybridum* L.
2. **Grass mix** – 39.05% *Lolium perenne* L. & 29.54% *Festuca rubra* L. & 29.54% *Festuca rubra* L. spp. commutata
3. **Alfalfa** - *Medicago sativa* L. 'Vernal'
4. **Perennial rye** - *Lolium perenne* L.
5. **Winter rye** - *Secale cereale* L.
6. **Fescue** - *Festuca arundinacea* Schreb.

1. *Pests and natural enemies*

Cover crop: We conducted sweep net sampling (10 sweeps x 3 / experimental unit). A golf-cup cutter was used to take standardized soil cores, and 5 cores will be taken per row middle.

Blueberry bush: We set yellow sticky traps onto metal stakes placed into the rows of bushes at canopy height. Four traps were placed per experimental unit; traps will were changed biweekly. This method provided information on presence and abundance of pest species belonging to the Coleoptera, Lepidoptera, Homoptera and Hemiptera, Diptera and natural enemies i.e.: Hymenoptera. We used beat trays (5 beats per bush, 4 bushes/experimental unit) to survey populations of leaf and bud damagers i.e.: gypsy moth and cranberry weevil. We assessed the level of cluster damage to survey the presence of fruit pests (focus on species of Diptera, Coleoptera, Lepidoptera). Aphids were surveyed visually by counting on 5 randomly chosen branches in the lower canopy of 4 randomly selected bushes per experimental unit.

Soil: Pit-fall traps were set up to assess species belonging to Carabidae, Arachnidae, and Formicidaea (these will be the main focus groups). Four traps will be placed into each experimental unit (two traps in the row middles and two traps into the row). Traps will be opened for 24 hrs weekly. Traps were set up twice over the season. All samples were returned to the laboratory for taxonomic identification.

2. *Pollinators*

Samples were taken once during bloom and at monthly intervals thereafter. Two pan traps were placed into each row middle at 9 am and retrieved at 3pm. Sweep-net samples were taken from the cover crops. Ten sweeps x 4 / experimental unit, two sets from near bushes and two from cover crops. Bees were identified using the Discoverlife online key.

3. *Plant quality and yield*

Blueberry bush: Leaf samples were sent to Midwest Laboratories Inc. for nutrient analysis. Data on the current condition in the field was taken and analyzed in Fall 2008. Seventy blueberry leaves were collected at mid-height from 10 randomly chosen bushes in each experimental unit. Yield was measured after harvest and fruit quality was assessed by measuring weight and size. Three clusters from five randomly chosen bushes per experimental unit were used for these measurements.

Cover crop: The size/weight of flowers (where available), floral density in peak bloom (where available), the average plant height, biomass and stem density was measured. These measures were taken from three subsamples per experimental unit twice, once in June and once in July. Level of weed infestation and stem-density was assessed visually using 0.5 m^2 quadrates.

Soil quality

Samples were taken with a 0.75 inch soil corer, by combining 5 sub-samples per experimental unit. Soil samples were sent to A&L Eastern Analytical Services Lab for analysis. Sample was taken per experimental unit in July 2009.

Statistical analyses: The diversity of arthropod groups (i.e.: pest, natural enemies, pollinators) was calculated and compared among treatments using the Shannon-Weiner Diversity Index. Using correlations we searched for plant attributes of the cover crops (i.e.: size of flower, avrg. height, biomass, stem density) that could explain arthropod richness and abundance. *R* statistical package was used for the analysis of the completely randomized design for subsamples with block as a fixed factor and time as a repeated measure.

Results and Discussion

Overall, the Shannon diversity index and evenness parameters did not reveal a consistent and marked difference among arthropod populations among the different cover treatments. According to the yellow sticky trap data Asian ladybeetle (*Harmonia axyridis*) and spotted ladybeetle (*Coleomegilla maculata*) abundance in grass mix and perennial rye was higher compared to tilled treatment (Table 1). Counts of insects on the lower branches of bushes showed higher aphid numbers (24% of total) in perennial rye treatment than in any of the other treatments (12% of total on average) (Table 2). The numbers of leafminers on lower branches were approximately half of that found in other treatments. The largest differences among insects on bushes among the cover treatments according to the beat sheet data were in the numbers of gypsymoth larvae, ants, and ladybeetles. Grass mix harbored the highest numbers of all of these groups relative to the other treatments, for example 31% of all the gyspymoth larvae were counted in this treatment, whereas only 20% or less were found in the other treatments (Table 3). About 25% more plum curculio damage was recorded in alfalfa and fescue that in tilled and winter rye treatments (Figure 1). Cranberry frutiworm damage was found in all of the treatments, but tilled, alfalfa, and clover had the highest levels of damaged berries relative to the other treatments. Percent weediness was highest in alfalfa and fescue treatments throughout the growing season, the least weedy treatments consistently were clover and grass mix (Figure 2). The amount of plum curculio damage increased with increasing weediness ($R^2 = 0.47$), but there was no correlation between plant density and plum curculio damage, indicating that specific plant species or plant management schemes play a role in regulation of damage by this insect (Figures 3 and 4).

The average weight of blueberry clusters, the number of berries per cluster and the number of blue colored (i.e. ripe) blueberries per cluster was similar among the seven treatments, however tilled treatment had slightly lower values in all of these categories, indicating that there is some benefit for berry quality of cover

cropping, regardless of the species of cover crop (Figure 5). This perhaps indicates that most of the advantages for a single growing season may come from the soil cover that the plants provide. Changes in soil moisture, capillary activity, and soil temperature could be responsible for the short-term benefits of keeping the row middles with cover crops. Results of the soil analysis have not detected any differences among the seven cover treatments. We were not able to find any insects in the soil cores that we examined.

Impacts of results / Outcomes

- Short term benefits of cover crops may not be plan species specific, it may rely more on having any type of soil cover
- Weediness in the row middles can be manipulated with the cover crops
- Weediness was positively correlated with plum curculio damage, but plant density was not
- The size of the top berry in the cluster was higher on bushes that grew in cover cropped row middles

Economic Analysis

Insecticide spray has been applied once during the course of this experiment. This has been done early in the season to control plum curculio and gyspy moth. Thereafter thresholds for any of the pests did not exceed the tolerable levels so no other insecticide treatments were required. This compared to other fields, farms, and years is an extremely low level of insecticide application. Because this experiment was set up at a single farm and single field, we are not able to determine, if this effect was due to the cover crops or some other biotic or abiotic parameters. Nevertheless, this desirable outcome is promising and has initiated interest in cover crop adoption by blueberry growers in New Jersey.

Publications/Outreach

The experiment has been completed in the fall of 2009 and we are anticipating on continuing this research. An undergraduate student who has been trained by the PI in 2009 will continue this investigation for medium and long term benfits of cover crops. Growers have been visiting the cover crop field and the current grower cooperator has decided to plant clover in other part of his farm.

Farmer adoption

To date, only our cooperator is using cover crops in commercial blueberries, but he is increasing the acerage of cover cropped blueberries for 2010.

Areas needing additional study

A collaboration with a soil scientist would be desirable to uncover and distinguish between the short and long term benefits of cover crops.

Table 1. Arthropod species found in a commercial highbush blueberry field in New Jersey in 2009 growing season. Row middles were maintained with one of six cover crop treatments and a tilled or no cover crop treatment as control. Numbers represent total number of species or groups counted on yellow sticky traps.

	alfalfa	clover	fescue	grassmix	perrenialrye	tilled	winterrye	total
cranberry weevil	6	5	9	6	7	9	10	52
plum curculio	0	0	1	0	0	0	1	2
gypsymoth larva	5	2	3	4	5	6	5	30
Japanese beetle	0	0	0	0	0	0	0	0
Oriental beetle	1	1	0	0	0	0	1	3
Asian Garden Beetle	1	3	4	2	2	3	2	17
cerambycidea	0	0	0	0	2	0	0	2
clickbeetle	**20**	**20**	**22**	**16**	**27**	**18**	**25**	148
Tumbling Flower	3	7	5	4	3	5	6	33
chrysomelidae	3	4	2	0	0	3	3	15
spotted cucumber	1	2	0	2	0	1	0	6
Scolytid	7	6	4	7	8	6	4	42
Cleridae	2	1	1	3	6	1	0	14
Rose chafer	0	0	0	0	0	0	0	0
Carabidae	**17**	**20**	**23**	**25**	**28**	**27**	**27**	167
Colliuris	0	0	0	0	0	1	0	1
flea beetle	0	2	1	2	1	0	0	6
Earwig	0	1	3	1	0	0	0	5
net-winged bug	1	0	0	0	0	1	0	2
minute pirate bug	11	10	13	10	14	10	8	76
aphid	**64**	**60**	**64**	**69**	**63**	**67**	**62**	449
leaf hopper	59	58	61	61	55	58	57	409
lygus	**19**	**19**	**12**	**22**	**18**	**27**	**21**	138
winged ants	30	28	31	30	28	31	28	206
cantharid	**44**	**39**	**29**	**41**	**44**	**35**	**36**	268
seven-spotted	**13**	**7**	**10**	**10**	**9**	**12**	**10**	71
spotted ladybeetle	**1**	**3**	**1**	**6**	**4**	**3**	**2**	20
Cocconellidae	**11**	**7**	**7**	**6**	**6**	**8**	**4**	49
Harmonia axyridis	**7**	**10**	**9**	**19**	**16**	**10**	**18**	89
Scarabaeidae	2	1	0	0	1	2	0	6
cranberry fruitworm	0	0	0	0	0	0	0	0
Lepidoptera	0	2	1	0	0	1	2	6
Noctuidae	6	4	8	6	8	3	8	43
gypsymoth larva	**5**	**2**	**3**	**4**	**5**	**6**	**5**	30
sawflies	0	0	0	0	1	0	0	1
spiders	**60**	**62**	**68**	**67**	**66**	**70**	**63**	456
Hymenoptera	3	5	4	4	4	6	4	30
cuckoo wasp	0	1	1	0	1	3	0	6
Hymenoptera spp A	53	48	45	49	57	42	45	339
Blueberry maggot	0	1	0	0	0	0	1	2
picture winged fly	13	22	20	10	16	17	20	118
Dipetra spp.	61	65	62	62	66	65	61	442
termite	20	16	14	15	17	14	18	114
moth flies	12	12	11	11	12	11	12	81
white fly	0	0	0	1	0	0	0	1
Syrphid	**9**	**14**	**12**	**14**	**16**	**22**	**12**	99

mayflies	0	1	0	0	0	2	0	3
other pollinator fly	0	0	1	0	1	1	0	3
Diptera spp A	13	12	13	16	14	13	8	89
Fishfly	1	0	1	1	0	0	0	3
stone/caddis fly	**26**	**30**	**20**	**23**	**25**	**14**	**18**	156
Miridae	1	4	1	4	4	3	4	21
brown lacewing	5	1	4	3	5	2	3	23
green lacewing	0	1	3	0	1	1	1	7
plant hopper	**33**	**35**	**37**	**26**	**35**	**36**	**35**	237
tree hopper	0	1	0	0	0	0	0	1
Cicadellidae	3	4	1	3	5	3	4	23
ant	9	9	5	7	8	5	9	52
nabid	2	2	1	4	1	1	2	13
negro bug	**10**	**11**	**11**	**14**	**10**	**7**	**9**	72
lacebug	1	0	3	0	1	0	0	5
Lampyridae	0	0	0	0	1	0	0	1
cereal leaf bettle	0	1	1	0	0	0	0	2
diving beetle	0	1	0	0	0	0	0	1
grasshopper	0	1	0	0	0	0	0	1
burrower bug	2	1	0	0	1	0	0	4
Buprestidae	0	0	2	1	1	3	2	9
meadow plant bug	0	0	0	0	0	1	0	1
seed bug	0	1	1	1	0	0	0	3
Myodocha serripes	0	1	0	0	0	0	0	1
assasin bug	1	1	0	0	0	0	0	2
Tenebrionidae	0	0	0	2	0	0	0	2
shannon evenness	**0.837002**	**0.814845**	**0.82429**	**0.846417**	**0.841112**	**0.833396**	**0.855887**	
shannon diversity	**3.204581**	**3.280038**	**3.224641**	**3.222023**	**3.256112**	**3.243427**	**3.219164**	
number of species	**46**	**56**	**50**	**45**	**48**	**49**	**43**	

Table 2. Number of insects counted on the lower branch of blueberry bushes in a commercial blueberry field in New Jerseywith seven row middle treatments. Numbers of arthropods were counted on a single, randomly chosen branch weekly throughout the season.

	alfalfa	clover	fescue	grassmix	perennialrye	tilled	winter rye	total
gypsymoth	1	1	0	3	0	1	0	6
plum curculio	0	1	0	0	0	0	0	1
cranberry weevil	1	0	0	0	0	0	0	1
syrphid fly	2	1	1	2	0	0	0	6
fruitworm	0	0	0	0	0	0	0	0
maggot	0	0	0	0	0	0	0	0
spider	**11**	**10**	**15**	**5**	**10**	**12**	**9**	72
spider eggcase	1	0	2	3	5	3	3	17
tipworm	**66**	**38**	**33**	**59**	**78**	**50**	**45**	369
ants	**1**	**2**	**6**	**16**	**4**	**3**	**3**	35
whitefly	10	7	10	16	13	9	16	81
aphid nymph	**44**	**32**	**49**	**50**	**88**	**59**	**43**	365
winged aphids	**135**	**120**	**115**	**130**	**115**	**125**	**125**	865
aphid mummy	**5**	**3**	**5**	**8**	**1**	**6**	**0**	28
planthopper	0	1	0	0	1	1	0	3
leafhopper	4	3	0	2	4	1	0	14
leafminer	**22**	**11**	**23**	**20**	**21**	**17**	**13**	127
leafroller	1	1	0	0	0	2	3	7
lygus nymph	1	1	0	0	0	0	0	2
lygus adult	0	0	1	0	0	0	0	1
lacewing	**0**	**1**	**1**	**4**	**0**	**2**	**6**	14
redovid egg	0	0	1	0	0	0	0	1
cantharid	0	0	0	0	0	0	0	0
membracid	0	0	0	2	0	0	0	2
minute pirate bug	0	1	0	1	0	0	0	2
mirid bug	1	0	0	0	0	0	0	1
Podisus	0	0	1	0	0	0	0	1
stinkbug eggmass	1	0	0	0	0	0	1	2
other ladybeetles	**6**	**9**	**6**	**9**	**5**	**10**	**4**	49
C7	**0**	**0**	**0**	**0**	**0**	**1**	**0**	1
Cmac	**1**	**3**	**2**	**2**	**1**	**0**	**0**	9
Harmonia	0	0	0	0	0	0	0	0
lacebug	0	0	0	0	0	0	0	0
lacewing eggs	0	1	0	0	0	0	1	2
leaffootedbug	0	0	0	0	0	0	0	0
grasshopper	0	1	0	0	0	0	0	1
parasitic wasp	**0**	**7**	**2**	**4**	**6**	**1**	**0**	20
Caterpillars	0	0	0	3	2	1	0	6
thrips	0	2	0	1	0	0	0	3
Lepidoptera spp.	0	0	0	0	0	1	1	2
Geometridae	0	0	1	0	1	0	0	2
shannon evenness	***0.60***	***0.61***	***0.65***	***0.68***	***0.65***	***0.62***	***0.65***	
shannon diversity	***1.77***	***1.91***	***1.88***	***2.03***	***1.81***	***1.84***	***1.72***	
number of species	***19***	***23***	***18***	***20***	***16***	***19***	***14***	***35***

Table 3. List of species and species groups from a commercial blueberry field in New Jersey. Samples were collected weekly with a beatsheet from half of a bush. Numbers represent totals from from the 2009 growing season. Row middles were maintained with one of six cover crop treatments, and tilled as a control.

	alfalfa	clover	fescue	grass mix	perrennialrye	tilled	winter rye	total
gypsymoth larva	**3**	**7**	**7**	**11**	**2**	**4**	**1**	**35**
plum curculio	5	3	1	1	2	0	0	12
cranberry weevil	4	1	2	3	0	1	1	12
cranberry weevil	0	1	0	0	0	0	0	1
Aranae	32	35	20	36	26	29	33	211
Aphididae spp.	0	1	1	0	2	0	1	5
Formicae	10	11	14	22	15	13	13	98
lacewing	0	1	2	0	1	0	0	4
leafminer	0	1	0	0	0	0	0	1
leafroller	0	1	0	0	0	0	0	1
leafhopper	0	0	0	0	1	0	0	1
Cantharidae	1	0	0	0	0	0	1	2
lygus	6	3	2	1	1	2	1	16
boxelder beetle	0	0	2	0	0	0	0	2
planthopper	3	0	0	2	2	2	0	9
Lepidoptera larvae spp.	3	0	0	1	1	0	0	5
Geometridae spp.	5	0	0	0	0	0	2	7
termite	0	0	0	1	0	0	0	1
minute pirate bug	3	0	0	0	2	1	0	6
thrips	0	0	0	1	0	0	0	1
parasitic wasp	0	2	0	4	0	0	1	7
mirid family	0	0	0	1	0	1	0	2
Podisus	0	0	0	0	1	1	0	2
Coccinellid spp.	3	1	1	5	1	2	3	16
convergent ladybeetle	0	1	0	0	0	0	0	1
Seven spotted ladybeetle	0	0	0	0	0	0	0	0
Coleomegilla mac.	2	0	0	1	3	0	0	6
Harmonia	0	0	0	0	0	0	0	0
Assasin bug	0	0	0	0	0	1	0	1
pentatomid nymph	0	1	0	0	0	0	0	1
copper underwing larva	0	0	0	1	1	0	0	2
fleabeetle	1	0	0	0	3	1	0	5
lacebug	0	0	0	1	0	0	0	1
leaffootedbug	0	0	0	1	0	0	0	1
cereal leaf beetle	2	0	0	0	0	0	0	2
stink bug eggs	0	0	0	0	0	1	0	1
Apinae	0	0	0	0	0	0	2	2
tomato horn worm	0	0	0	0	1	0	0	1
syrphid fly	1	0	0	0	0	0	0	1
stonefly	0	0	0	1	0	0	1	2
shannon evenness	***0.8012***	***0.659311***	***0.746959***	***0.682415***	***0.719383***	***0.659971***	***0.609434***	
shannon diversity	***2.2216***	***1.785447***	***1.719936***	***1.972433***	***2.038166***	***1.692792***	***1.514386***	
number of species	***17***	***16***	***11***	***19***	***18***	***14***	***13***	

Table 4. List of species found in white bowl traps set out in the row middles of a commercial highbush blueberry field with seven different types of cover crop treatments.

	alfalfa	clover	fescue	grassmix	perrenialrye	tilled	winterrye	total
syrphid fly	1	2	3	1	2	0	0	9
Diptera spp.	12	12	12	8	15	14	12	85
Coleoptera spp.	7	7	3	5	1	4	3	30
mirid bugs	3	1	2	0	0	2	2	10
Lepidoptera spp.	1	0	0	0	0	1	1	3
Honey Bees	**1**	**3**	**0**	**0**	**0**	**1**	**1**	**6**
Sweat Bees	**0**	**3**	**2**	**1**	**1**	**1**	**2**	**10**
Lampyridae	0	1	0	0	0	0	0	1
Carabid	2	1	1	0	2	0	0	6
negro bugs	3	1	1	0	0	0	0	5
Curculionidae spp.	1	0	0	0	0	0	0	1
seven spotted	0	0	0	1	0	0	1	2
rove beetles	0	0	0	0	0	1	0	1
jewel beetles	0	0	0	0	0	0	1	1
seed bugs	0	0	1	0	0	0	0	1
bean weevil	0	0	1	0	0	0	0	1
Spiders	1	1	1	1	0	0	0	4
bumble bees	**1**	**0**	**0**	**0**	**1**	**1**	**0**	**3**
winged aphids	1	1	0	1	0	0	1	4
Scarabaeidae spp.	9	11	11	9	9	7	10	66
Parasitic Wasp	2	1	0	1	0	0	0	4
Minute Pirate Bug	1	1	1	0	0	1	0	4
Hymenoptera spp.	0	0	0	1	0	0	0	1
Thrips	0	0	1	0	0	0	1	2
Winged Ants	0	0	0	0	1	0	0	1
Mites	0	1	0	0	0	0	0	1
shannon evenness	***0.8311***	***0.81052***	***0.7991***	***0.796613***	***0.717368***	***0.761793***	***0.780733***	***0.674547***
shannon diversity	***2.2508***	***2.19493***	***2.0498***	***1.83427***	***1.491725***	***1.754094***	***1.872115***	***2.19774***
total nummber of	***15***	***15***	***13***	***10***	***8***	***10***	***11***	***26***

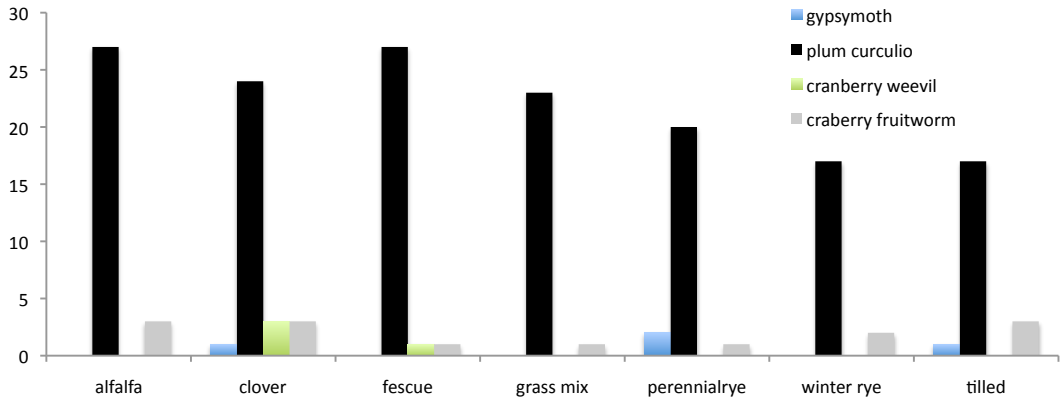


Figure 1. The total number of damaged clusters (shown on 'y' axis) by four of the main blueberry pests in a commercial NJ blueberry field with seven types of cover crop treatments in the row middles (treatments shown on 'x' axis)

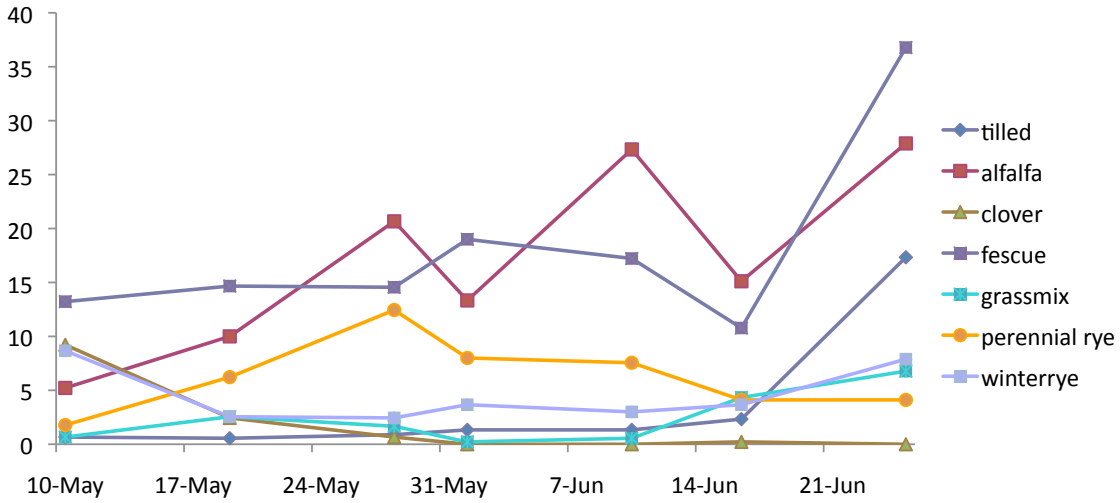


Figure 2. Percent weediness in the row middles in a commercial blueberry field in New Jersey over the 2009 growing season, with seven different types of cover crop treatment.

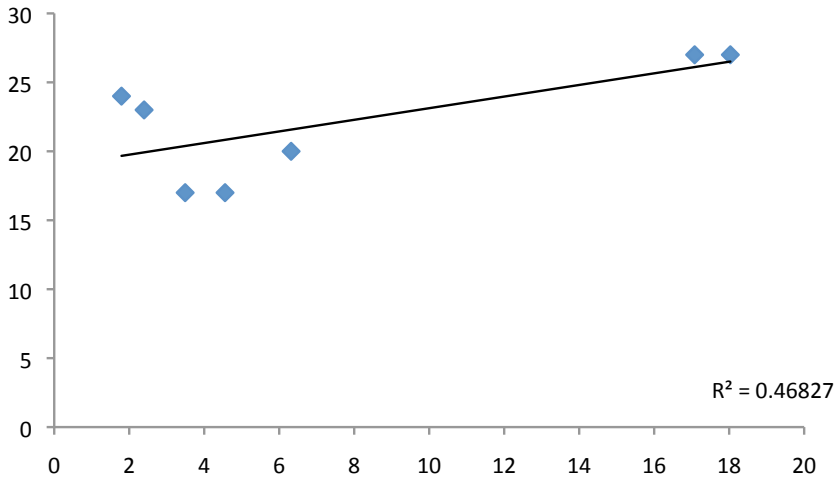
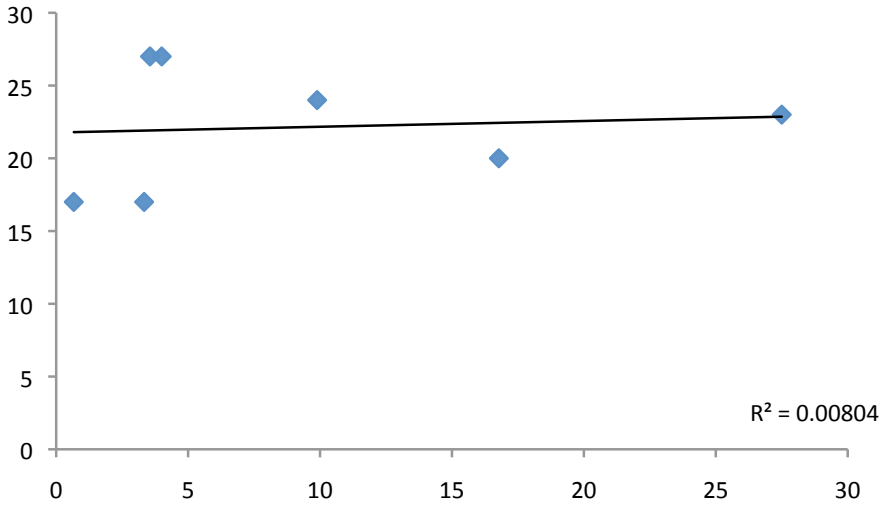


Figure 3 (top). Relationship between weediness of row middles and plum curculio damage on blueberries in a commercial blueberry (NJ) field with seven types of cover crop species (alfalfa, clover, fescue, grass mix, perennial rye, no cover crop = tilled).

Figure 4 (bottom). Relationship between plant density (number of stems in a 5 cm^2 grid) of row middles and plum curculio damage in commercial blueberry field with seven types of cover crop species (alfalfa, clover, fescue, grass mix, perennial rye, no cover crop = tilled).



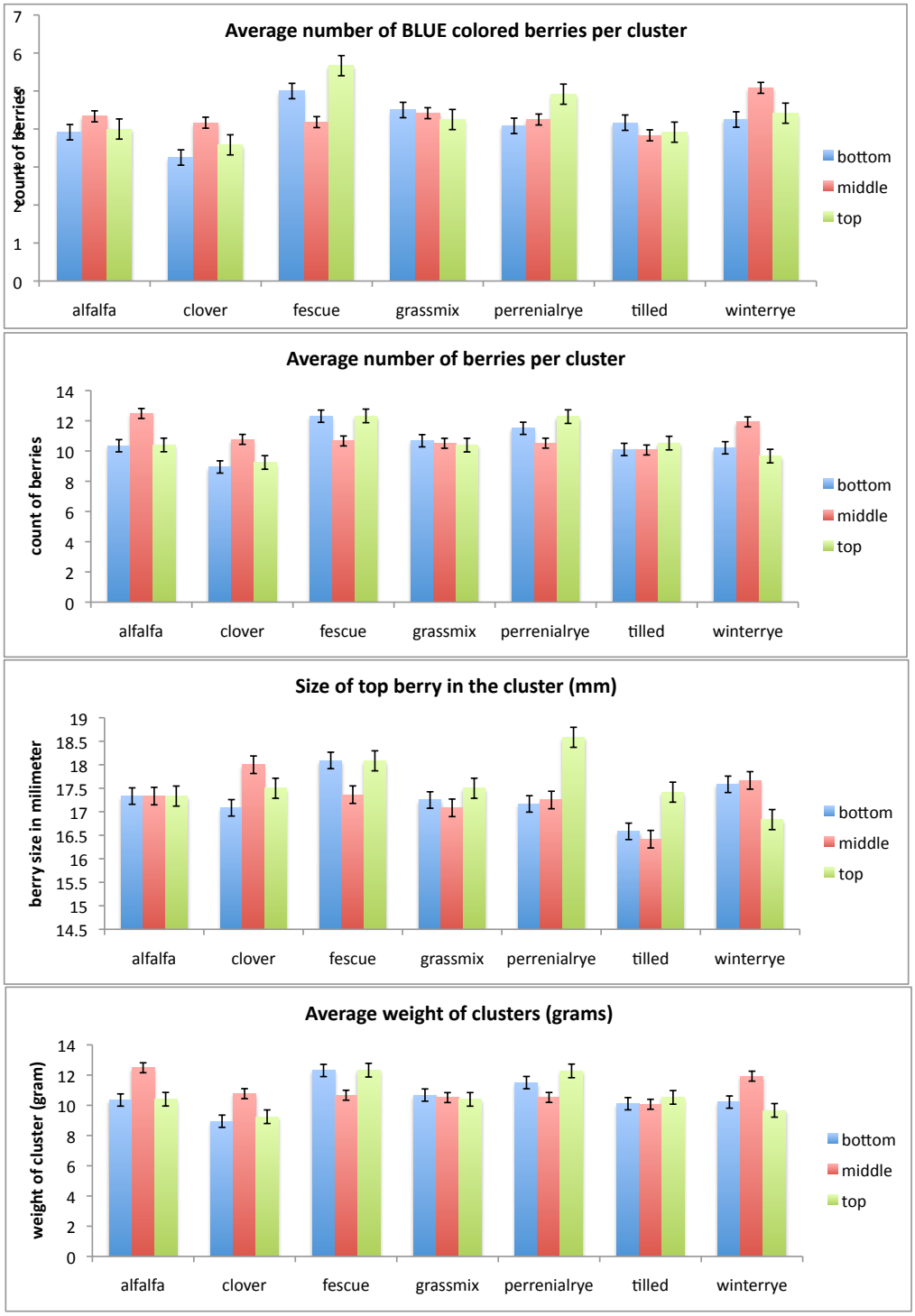


Figure 5. The data in these four graphs show data collected on June 25, 2009 from a commercial blueberry field in New Jersey with seven different cover crop treatments. Three clusters were collected from each sampled bush, the three bar colors indicate the part (top, middle, bottom) of the bush the blueberry cluster was collected from for the sample. One cluster was collected from each bush-part, i.e. one cluster from the top, one cluster from the middle, etc.

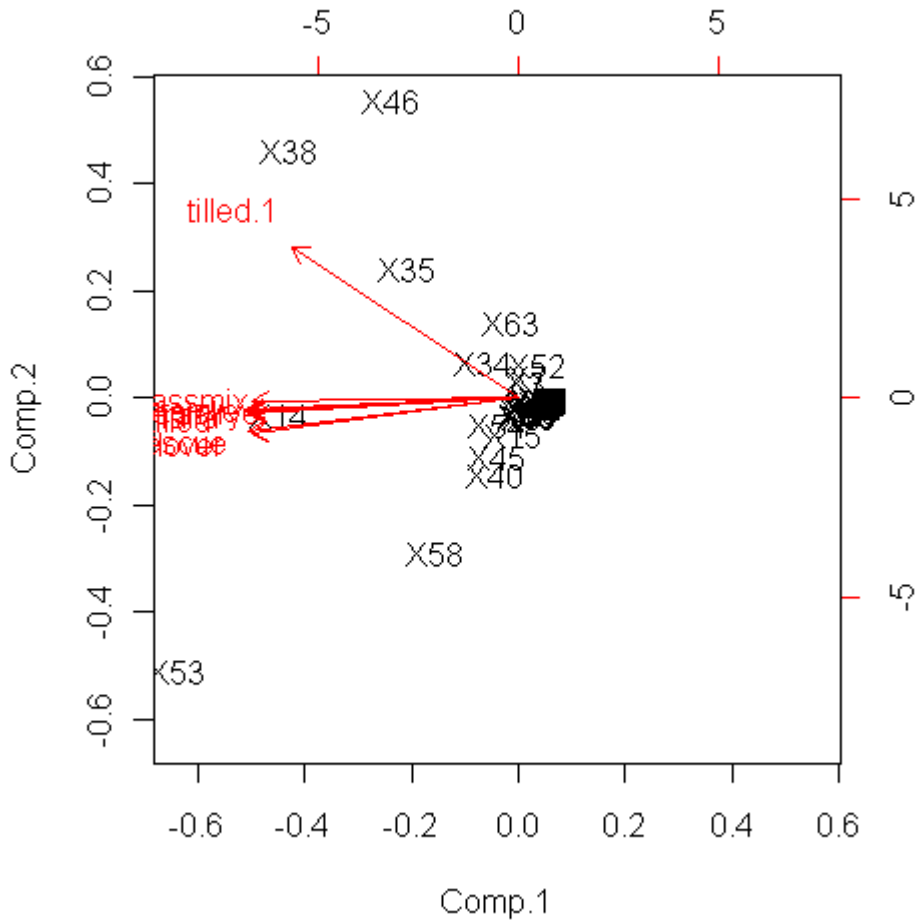


Figure. 6 Row middles in a New Jersey commercial blueberry field were seeded and maintained with one of seven types of cover crop species (alfalfa, clover, fescue, grass mix, perennial rye, no cover crop = tilled). The graph shows the results of a principal component analysis indicating that tilled treatment is different from all other cover treatments when comparing the arthropod species composition caught in yellow sticky traps throughout the 2009-growing season. The insect species that is mainly responsible for this effect are aphids (X46).