Final Performance Report

Project Title: Developing Integrated Pest Management Strategies for Controlling Key Pests in Florida Blueberries

Contract Number: 15635

Specialty Crop Block Grant Funding Year: 2009

Project Summary

Southern highbush blueberries (*Vaccinium corymbosum* L. x *V. darrowi* camp) are an important crop in Florida. In 2008, 9.8 million lbs were harvested from 3000 acres at an average of $5.30 per lb. Rabbiteye blueberries (*Vaccinium ashei*) are better suited for u-pick operations and local sales. The purpose of this project was to develop integrated pest management strategies for four major blueberry pests in Florida: flower thrips (*Frankliniella* spp.), Chilli thrips (*Scirtothrips dorsalis* Hood), blueberry gall midge (aka cranberry tipworm *Dasineura oxycoccana* Johnson), and flea beetles.

Flower thrips, *Frankliniella* spp. is the key insect pest in southern highbush and Rabbiteye blueberries. They feed on floral parts reducing blueberry yields. In addition, when larvae emerge from the flower they cause fruit scarring on ripening berries reducing its marketability. The purpose of this project component was to improve the integrated pest management of flower thrips in southern highbush blueberries to increase grower's profit.

Chilli thrips, *Scirtothrips dorsalis* Hood is generally smaller than flower thrips. They feed mainly on young blueberry foliage. Chilli thrips was first recorded in blueberries in the summer of 2008. Due to its potential to cause significant damage in blueberry plantings its population needs to be monitored throughout the season. The purpose of this project component is to assess the impact of Chilli thrips in some of the major blueberry growing counties in Florida.

Blueberry gall midge, *Dasineura oxycoccana* (Johnson) is a key pest of southern blueberries which produces dramatic yield losses. Adult females deposit eggs in blueberry flower and leaf buds and when hatch the larvae feed on the bud tissues significantly reducing plant vigor. The purpose of this project component is to determine the population density of blueberry gall midge and its parasitoids over a two year period in Florida.

Flea beetles are an emerging post harvest pest for southern blueberry growers. Adults feed on the leaves boring shot holes and reduce the leaf capabilities to carry out photosynthesis, which result in a significant reduction in yield the following year. The purpose of this project component is to investigate the relationship between each species in the flea beetle species complex and their blueberry host plants.

Project Approach

Componant 1: Flower thrips

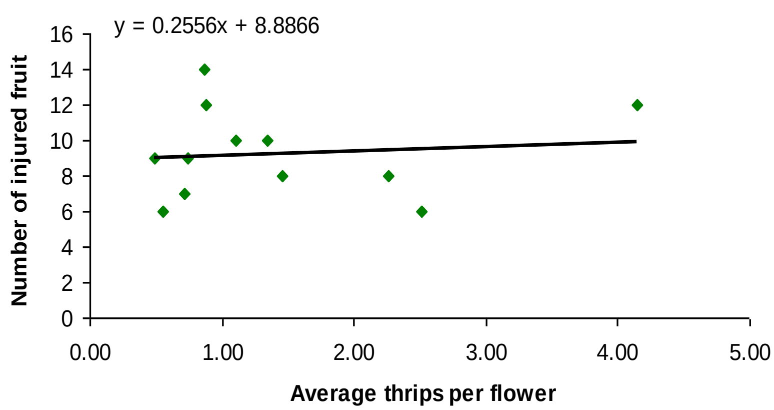
The 2010 replicates of the two experiments, one to determine an EIL for flower thrips in southern highbush blueberries and the other to examine the effects of weed control on flower thrips populations, of this project component have been completed. The first year of the EIL study was conducted on the farm in Inverness. The two varieties sampled from were Emerald and Premadonna. The first set of traps was placed in the field on Feb. 4, 2010. The last samples were taken on March 24.

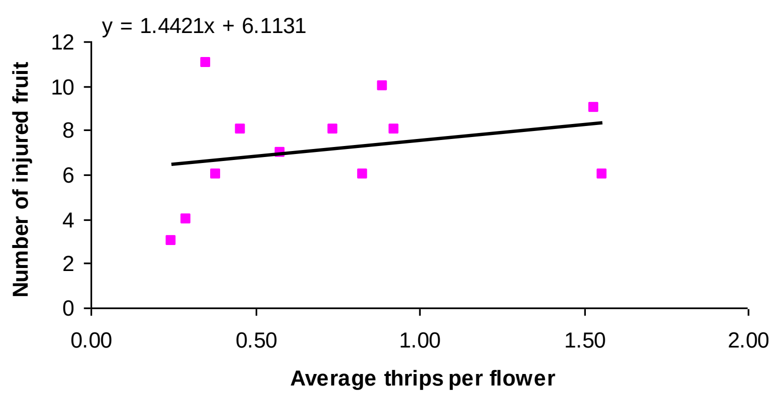
Processing of flower samples was completed by mid-May. Both thrips adults and larvae per flower remained low until the last two weeks of the flowering season. Ninety-eight and 99% respectively of the adult thrips collected from the Emerald and Premadonna flowers were *Franklineilla bispinosa* (Morgan). The remaining 2 % of the Emerald adults were two *Franklinothrips* sp. and a single *Neohydatothrips variabilis* (Beach). The remaining 1 % of the Premadonna adults included a single *Thrips hawaiiensis* (Morgan) and a single *N. variabilis*.

Fruit injury evaluation was done on April 7. In the Emerald variety, an average of 31% of the fruit was injured, but only 4% was unmarketable. In the Premadonna variety, 24% was injured and only 3% was unmarketable.

There was no relationship between thrips per flower and fruit injury in either the Emerald (adj R^2 = -0.09, P_{slope} = 0.74) or Premadonna (adj R^2 = -0.01, P_{slope} = 0.38) varieties (Fig. 1). Because of this, we were unable to calculate an EIL.

a





b

Fig. 1. Average thrips per flower vs. total injured fruit in the a) Emerald and b) Premadonna varieties.

The first year of the weed control study was conducted at the Citra PSREU. The two weeded plots were weeded on Feb. 3. The first set of traps was placed in the field on Feb. 10. The last set of samples was collected on March 16. Processing of sticky traps was completed on April 1. The sticky trap data is shown in figure 2. There were significantly more thrips per trap in the unweeded plots compared to the weeded plots on Feb. 23 (t = 2.00, df = 38, P = 0.05) and March 16 (t = 3.27, df = 38, P = 0.0023).

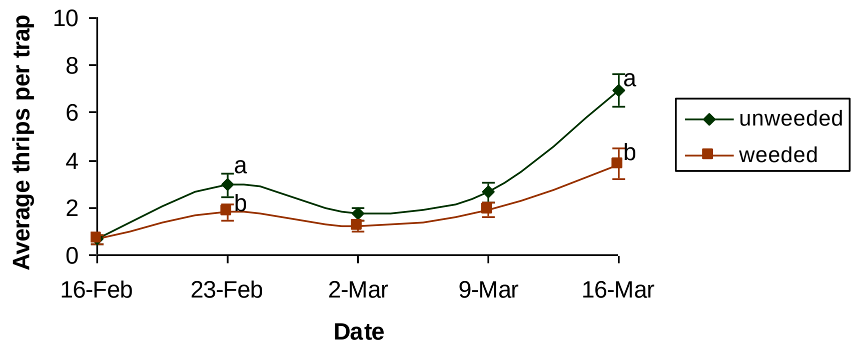
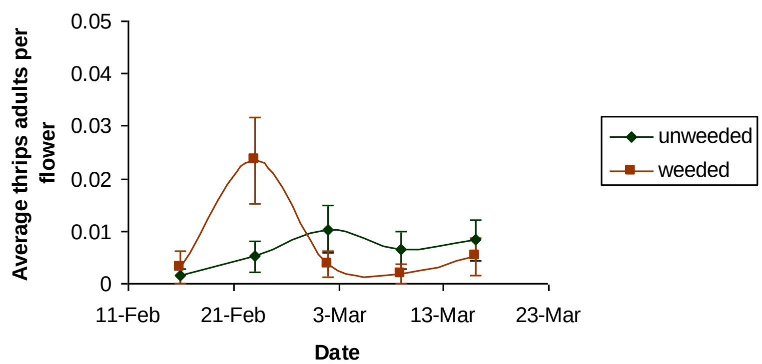


Fig. 2. Average thrips per trap sampled from the weeded and unweeded plots during each sampling week. Error bars represent standard error of the mean.

Processing of flower samples was completed by mid June. There were no significant differences in thrips adults per flower (all P > 0.09) between the treatments on any date (Fig. 3a). The thrips per flower data could not be analyzed because only a single thrips larva was found during the season on Feb. 23 in the weeded plots (Fig. 3b). Out of the 18 adults collected from the unweeded plots, 11 were *F. bispinosa*, three were *Pseudothrips inaequalis* (Beach), and the remaining four included a single specimen each of *Franklinothrips* sp., *Heterothrips azaleae* Hood, *T. hawaiiensis*, and *T. pini* (Uzel). The weeded plots were less diverse, with 10 out of 16 adults identified as *F. bispinosa*, five as *T. hawaiiensis*, and one as *Franklinothrips* sp.



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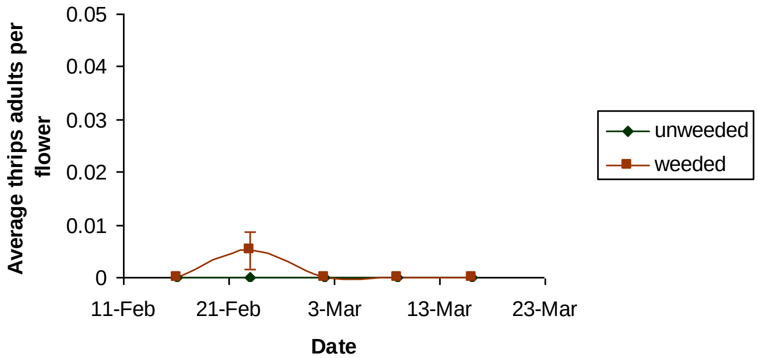


b

Fig. 3. Average thrips a) adults and b) larvae per flower from the weeded and unweeded plots during each sampling week.

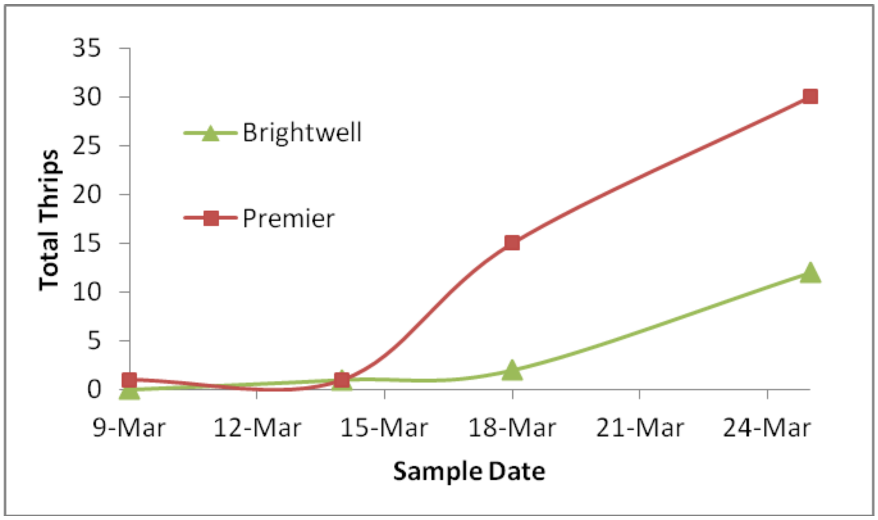
Data on marketable yield was collected twice a week from May 3 to May 27. There was no significant difference in average total yield between the two treatments (t = -1.68, df = 38, P = 0.10, Fig. 6). There were an average of 2.5 ± 0.2 kg and 3.3 ± 0.4 kg in the unweeded and weeded plots, respectively.

During the spring of 2011 flower thrips samples were collected from two 0.3 acre plots of 7 year old rabbiteye blueberry plants at the University of Florida Plant Science Research and Education Unit in Citra, FL. These plots consisted of four Rabbiteye varieties: 'Climax', 'Brightwell', 'Premier', and 'Powderblue'; However, samples were only collected from 'Brightwell' and 'Premier'. All plants were approximately 1.5 to 2.0 m (5 to 6.6 ft) tall. We did not collect any samples from southern highbush varieties because they flower much earlier (February) in Gainesville and thrips population at that time of the year in 2011 was extremely low.

Flower samples consisted of three flower clusters taken from plants that had not been treated with insecticides. Sampling commenced at full bloom. Only flowers with fully expanded and open corollas were collected. Flower clusters were placed in vials containing a dilute alcohol solution and taken to the Small Fruit and Vegetable IPM Laboratory at the University of Florida, Gainesville, FL for processing. Nymphs and adults were removed from the flower clusters using the shake-and-rinse method. Both nymphs and adults stages were pooled for the analysis.

White sticky traps were also used to catch thrips moving through the blueberry canopy. Traps were hung from blueberry branches in the middle part of the canopy at a height of approximately 1.2 m (4 ft). Four traps were used for each sample period (beginning March 11 and 22) and were left in the field for seven days. The total number of adult thrips on each trap was counted. Traps were not saturated so sub-sampling was not required.

More than 90% of the thrips collected were, *Frankliniella bispinosa* (Morgan), the key species attacking southern highbush and Rabbiteye blueberries in Florida. Thrips population at the sampling sites started low in early March but increased rapidly later in the season (Fig. 4. A & B). There was a 15-fold increase in the number of thrips collected in flower clusters between 14 and 25 March, 2011. The Rabbiteye blueberry variety 'Premier' had 5 times as many flower thrips as 'Brightwell' in late March (Fig 4. A & B). The reason for the difference in thrips population between these two varieties is unknown but could be related to a more uniform flowering habit that is expressed by 'Premier', as well as its longer flowering period. More research has to be done before any definite conclusions can be drawn.



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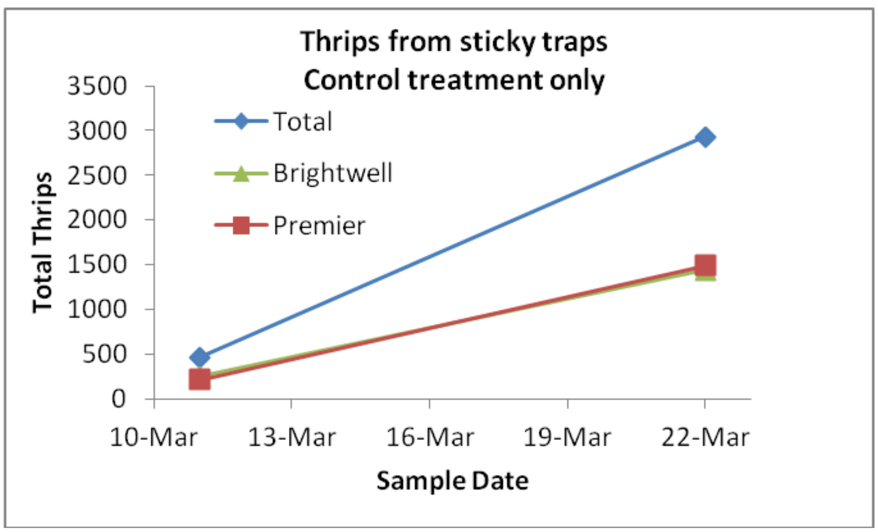

B

Fig. 4. A) Flower thrips from flower samples by variety, B) flower thrips samples from sticky traps

Component 2: Chilli thrips

During 2010 and 2011, blueberry plantings were monitored in 6 counties, including Alachua, Bradford, Gilchrist, Marion, Sumter, and Lake for Chilli thrips. Monitoring was done bi-weekly using white sticky traps. A minimum of two traps were deployed per acre. These traps were replaced every two weeks. Some traps were sent to the Small Fruit and Vegetable IPM laboratory at the University of Florida for thrips identification and confirmation. Diminutive populations of Chilli thrips were recorded in

Lake, Marion, Sumter counties in 2010 and 2011. However, none of these populations were large enough to cause significant damage.

Component 3: Blueberry gall midge

In 2010, yellow sticky traps were used to capture natural enemies flying in the blueberry canopy. These were placed on plants at an organic blueberry farm with a large blueberry gall midge population. Blueberry flower buds and leaf buds were collected and taken to the Small Fruit and Vegetable IPM Laboratory at the University of Florida, Gainesville, FL for dissection. Midge larvae were removed from the buds, counted, and the examined to determine if they had been parasitized.

Many parasitic Hymenoptera were collected, but no potential predators. Of the parasitoids collected, the Platygastridae were most abundant. Some species of Platygastridae have been documented as primary parasitoids of blueberry gall midge. These wasps tended to be most abundant early in the blueberry flowering period (Fig. 5).

All parasitized larvae removed from flower buds were parasitized by a species of *Platygaster* (Platygastridae). Percent parasitism in flower buds was approximately 10%. In leaf buds, however, a species of *Aprostocetus* (Eulophidae) was dominant. Percent parasitism in leaf buds was much higher at 40%.

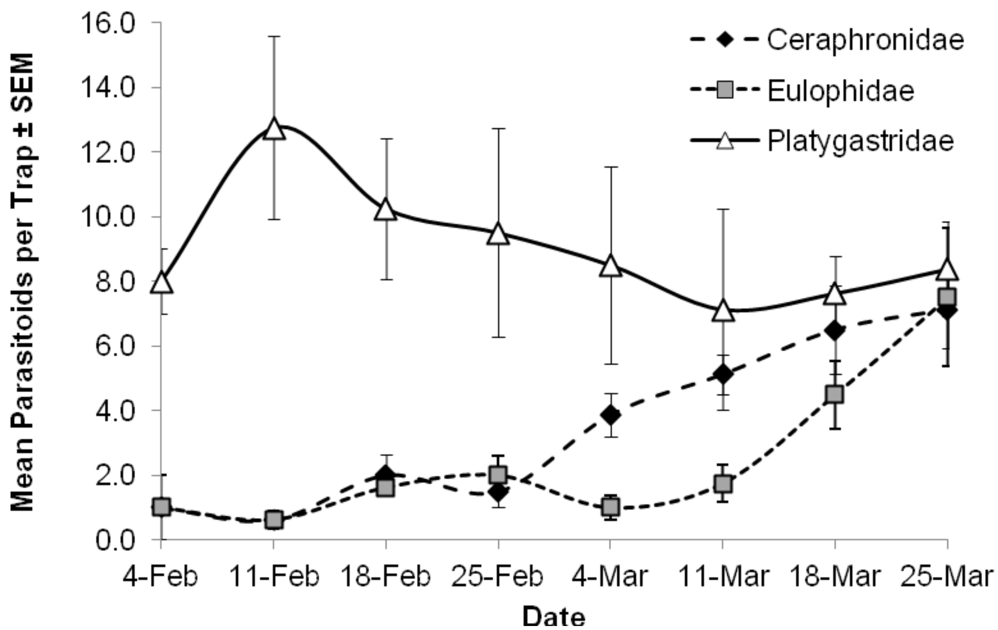

Fig. 5. Seasonal abundance of three parasitoid families (Hymenoptera) known to parasitized blueberry gall midge.

Two blueberry gall midge projects were pursued during the 2011 field-season running from February through April. In the first project we investigated the response of males, *D. oxycoccana* to chemical cues released by females in a Y-tube olfactometer. Our objective was to provide behavioral evidence that blueberry gall midge mating is mediated by a female-produced sex pheromone. Each replication consisted of releasing a single male downwind and giving him time to move upwind and choose either the treatment arm (containing one unmated adult female) or control arm (filtered air only). Gall midge adults used in this experiment were reared from larvae collected in the field.

The second project dealt with the incidence of parasitism of blueberry gall midge infesting blueberries. This was a continuation of a previous year's research. Our objectives were to identify the primary parasitoids attacking blueberry gall midge and determine the stage(s) at which the midge is most vulnerable to parasitoids. Midge larvae were collected from infested blueberry plants and examined in the laboratory to determine their stage of development and whether or not they contained parasitoid eggs. A census of adult parasitoids was also conducted by using yellow sticky traps hung in blueberry plants. From this we will determine the seasonal patterns of the major parasitoid groups that occur in north-central Florida blueberry farms.

Our preliminary results indicated that more than 70% of *D. oxycoccana* males flew up-wind in a Y-tube olfactometer in response to females displaying pheromone plumes. This provided preliminary evidence that males responds female pheromone plumes.

We recorded 11 families of hymenoptera parasitoids (Table 1). The highest number of parasitoids was recorded from the family Platygastridae in Rabbiteye and southern highbush blueberry bushes. Platygastrids were abundant from February when sampling started to April 7th when the population crashed (Fig. 6). Other common parasitoids include those in the families; Scelionidae, Ceraphronidae and Eulophidae. These parasitoids began to increase in early march and peaked around the first week of April.

Table 1. Show the percentages of various hymenoptera parasitoid families found on two farms in Florida

Family	Farm 1 (RE)	Farm 2 (SHB)
Aphelinidae	4.6	10.2
Braconidae	3.0	5.8
Ceraphronidae	8.8	9.0
Encyrtidae	7.0	10.7
Eulophidae	10.4	8.1
Eupelmidae	6.8	7.8
Ichneumonidae	2.9	3.6
Mymaridae	5.5	6.6
Platygastridae	29.6	18.4
Pteromalidae	5.9	1.0
Scelionidae	10.2	13.9
	n = 1380	n = 620

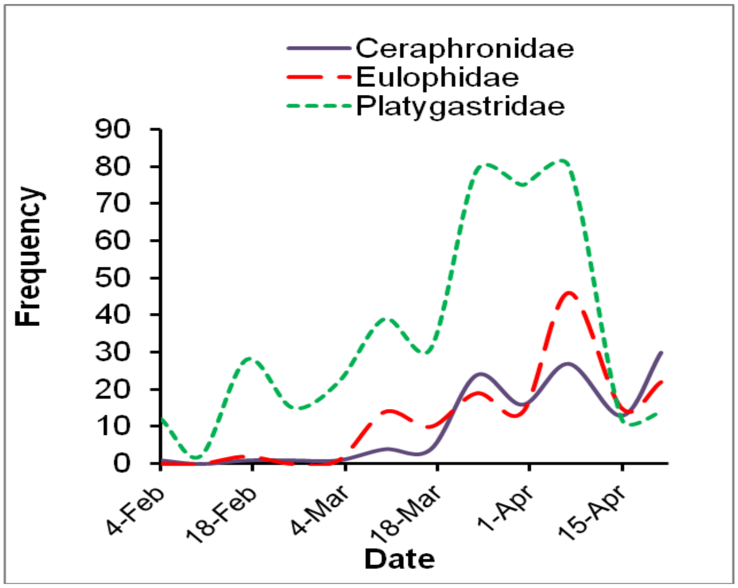

Fig. 6. Population of hymenoptera parasitoids in a Rabbiteye planting in Alachua county Florida

Component 4: Flea beetles

During the summer of 2010, adult flea beetles were sampled in two 5-acre blocks of southern highbush blueberries at a commercial blueberry farm. Sampling was conducted by visually observing every third bush per row. Twenty specimens of each species were collected and brought to the Small Fruit and Vegetable IPM Laboratory at the University of Florida, Gainesville, FL for identification.

The two species found were *Colaspsis pseudofavosa* and *Systena frontalis*. *C. pseudofavosa* was more abundant (68% of total) than *S. frontalis* (32%). *Altica sylvia* was not encountered in this sampling.

Our 2011 flea beetle summer experiments were designed to evaluate cultivar preferences and feeding behaviors between southern highbush and Rabbiteye blueberry varieties. Two experiments were conducted between June and July 2011. For experiment 1, choice tests were conducted with 5 blueberry cultivars consisting of 3 southern highbush varieties, Jewel, Millenia and Star, and two Rabbiteye varieties, Brightwell and Climax. The experimental arena consisted of 3 cm (~1 inch) diam. leaf discs taken from the 5 cultivars being evaluated. Leaf discs (5) were placed into each Petri dish containing two adult beetles, *Colaspis pseudofavosa* (n = 50). Beetles were allowed to feed for 48 h then leaf discs were scanned and area consumed were measured from digital images (Scion Image Corp, Fredick, MD). There were no differences in leaf area consumed among the southern highbush varieties Millennia, Star and Jewel. However, significantly more southern highbush leaf disc area was consumed compared with Rabbiteye. The average leaf area consumed for southern highbush was approximately 25% versus 12% for Rabbiteye cultivars.

Experiment 2 was similar to experiment 1; however, no-choice tests were used to evaluate two blueberry cultivars, one southern highbush (Jewel) and one Rabbiteye variety (Climax). Only 1 beetle was used per Petri dish and each leaf disc was replaced every 24 h for 4 days. The experimental arena and measurements of leaf area consumed were evaluated using the same methodology as in experiment 1. Significantly more southern highbush (Jewel) was consumed compared with Rabbiteye (Climax) (fig. 7).

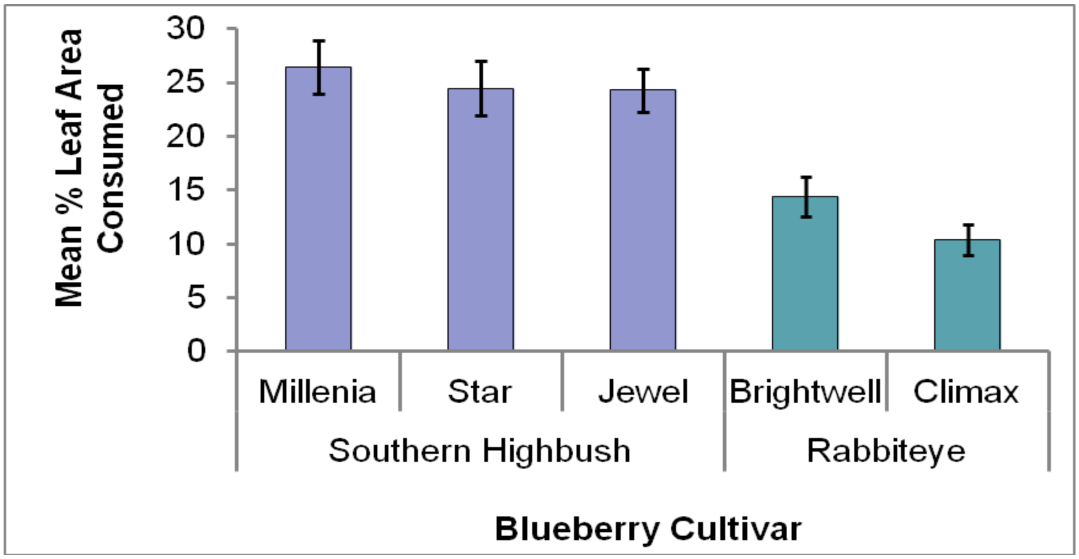

Fig. 7. Cultivar preferences of *Colaspis pseudofavosa* in highbush blueberries, Alachua, Co.

<u>Goals and Outcomes achieved</u>

Component 1: Flower thrips

We made significant progress towards the goal of determining the feasibility of mowing fields of flowering plants adjacent to blueberry plantings to reduce thrips populations. Our results from the spring of 2010 indicate that weed control may be a feasible tactic.

Unfortunately, we were unable to calculate an EIL for flower thrips in southern highbush blueberries due to the low population of thrips that was present in 2010.

Component 2: Chili thrips

The goal of this project component was completed. As expected, we determined the extent of Chilli thrips infestation in six counties in north Florida. Chilli thrips were recorded at low levels in Lake, Marion, and Sumter Counties in both years.

Component 3: Blueberry gall midge

We successfully completed the goals of this project component, also. We identified several blueberry gall midge parasitoids and were able to determine when the most common parasitoids were abundant. Platygastrids were abundant from February to early April, which coincides with the presence of flower buds. Parasitoids in the families Scelionidae, Ceraphronidae and Eulophidae began to increase in early march and peaked around the first week of April, which is when leaf buds are abundant.

Component 4: Flea beetles

We accomplished both goals of this project component. There are two flea beetle species in southern blueberries, *Colaspsis pseudofavosa* and *Systena frontalis*. *Colaspsis* *pseudofavosa* is the more abundant of the two species. Because it was twice as abundant as *S. frontalis,* we focused our varietal preference tests on *C. pseudofavosa*. This species prefers southern highbush blueberries compared with rabbiteye blueberries.

Meetings. We participated in the spring and fall blueberry meetings that were held in Plant City, Florida on March 3rd and November 1st, 2011. Over 150 blueberry growers, crop consultants, and marketing representatives attended the meetings. A research update on thrips, gall midge and flea beetles was presented to growers to allow them to track our progress.

Workshops. On February 1st 2011 we had an in-service training workshop in Bartow Florida where we trained extension agents working with blueberry growers on pest identification (thrips, gall midge and flea beetles), and management practices. This workshop was a success and approximately 25 extension agents from around the state attended.

Beneficiaries

Southern blueberry growers, crop consultants and extension agents will benefit from the information we have gathered. The flower thrips data are preliminary, but interested growers could implement the mowing of open fields on their farms based on our data if it is of low cost to them. Southern blueberry growers are aware of the potential of chilli thrips to cause problems and which counties they are present in so far. Knowledge of the peaks in blueberry gall midge parasitoid activity will allow growers to time sprays minimize impacts on these natural enemy populations. The information we gathered about flea beetle ecology will lead to better management tactics for growers in the future.

Extension agents have also benefitted from our research. They can aid growers in the identification of pest species and provide guidance on management tactics.

Future researchers can build on our findings to further improve the management of pests in southern blueberries.

Lessons Learned

We were able to make significant advances in blueberry pest management in terms of understanding thrips population dynamics, identifying key parasitoids that were common in blueberry plantings with potential to regulate blueberry gall midge populations. In addition, we were able to understand the feeding preferences of a key flea beetle that is common in southern blueberries. Overall, the research outlined here will help us to develop better management practices for key pests in southern blueberries.

The one goal we did not achieve was to develop an EIL for flower thrips in southern highbush blueberries. The flower thrips population in 2010 was too low. A colony of flower thrips *F. bispinosa* (Morgan) would have to be established to avoid relying on unpredictable wild populations.

Goals and Outcomes Achieved

The information gained from each component will be disseminated to estimated 250 members of the Florida Blueberry Growers Association

- The information obtained has been disseminated to more than 250 blueberry growers. In fact at my last presentation at the blueberry growers' fall meeting, there were more than 300 people registered at the meeting. In addition, more than 100 blueberry growers attended several other meetings and on-farm demonstrations that took place throughout the duration of the project.

Information will be disseminated to extension agents representing Florida's 67 counties

- As discussed in the report we had a training session (in-service training) on February 1st, 2011 and we had extension agents from all 67 counties in Florida

Information will be made available through extension media outlets including the Electronic Data Information systems (EDIS) in the University of Florida system, the quarterly FBGA Blueberry Newsletter, the FBGA Website and through workshops, field days and on-farm demonstrations.

- Our research is periodically published in the Florida Blueberry Growers Association newsletter. In addition the research and final report is published on the University of Florida, Fruit and Vegetable IPM website at http://entnemdept.ufl.edu/liburd/fruitnvegipm/ . We have already published (as discussed in the final report) several research papers and we will also be publishing several EDIS publications over the next two years. Finally, presentations given at the Florida Blueberry Growers Association meetings are listed on their website.

The Florida Blueberry Association expects to reach 90% of the Florida Blueberry producers and 100% of the Florida Extension Agents

- The Florida Blueberry Growers Association extends information to over 90% of the blueberry growers and all of the extension agents in Florida. Therefore, our information is well disseminated to all of the blueberry growers and potential blueberry growers in Florida as well as neighboring states.

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Additional Information

Publications

Rhodes E. M. and O. E. Liburd. 2011. Flower thrips (Thysanoptera: Thripidae) dispersal from alternate hosts into southern highbush blueberry (Ericales: Ericaceae) plantings. Florida Entomologist. 94: 311-320.

Rhodes E. M., O. E. Liburd and S. Grunwald. 2011. Examining the spatial distribution of flower thrips in southern highbush blueberries by utilizing geostatistical methods. Environ. Entomol. 40: 893-903.

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Liburd, O.E., and C.R. Roubos. 2010. Blueberry gall midge: A key pest of southern highbush and rabbiteye blueberries. Refereed section. Proceedings of the Florida State Horticulture Society. 123: 23-25.