2009 Research Proposal to the Southern Region
Small Fruit Consortium – Progress/Final Report
SRSFC Research Project 2009-03

TITLE: Thrips prevalence and management in southeastern blackberries

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OBJECTIVES

1. Identify thrips species feeding on blackberries in North Carolina.
2. Determine the seasonal abundance of thrips on blackberries.
3. Correlate thrips incidence and densities to fruit development/pollination, yield, and disease occurrence.
4. Test available insecticides for thrips management.

JUSTIFICATION

Thrips (several species) are common insects present on brambles in the southeast, but very little is known about their biology and management on blackberries. So little is known that, prior to the initiation of this project, it was unclear which thrips species were present and if they are economically damaging to blackberries. However, growers have indicated that thrips are their number one insect concern (G. Fernandez pers. comm.) Before we began this project, we considered the flower thrips, *F. tritici,* and the western flower thrips, *F. occidentalis* the two most likely thrips species to be found on blackberries. We thought that these thrips may be found individually on blackberries, in combination, or with additional species. The goals of this project has been to determine which thrips species are present on blackberries in the southeast; track the seasonal abundance of these species; to correlate these population fluctuations with reductions in yield, fruit damage, and possible disease incidence; and to test available control methods.

Blackberry acreage is rapidly expanding throughout the southeast, in particular in western North Carolina and South Carolina. Significant plantings are also present in Georgia and Arkansas. Thrips occur in all these locations and are of concern to growers elsewhere in the United States, including Oregon and California. The utility of the results generated by this project, therefore, are certainly regional and potentially national.

Several thrips species are known virus vectors. *F. occidentalis* is a key vector of Tomato Spotted Wilt Virus in vegetable and tobacco systems and is capable of vectoring Impatiens Necrotic Spot Virus (INSV), which has been detected in southeastern blackberries. The impact of thrips vectored viruses in blackberries is unknown, but is the subject of a recently funded USDA SCRI project (described below). Limited chemical control options are available for thrips on brambles, particularly during the bloom period when thrips are most prevalent. The overlap between bloom and harvest in brambles also limits which insecticides which can be used, and our assays included organic and reduced risk materials with short preharvest intervals.

This report summarizes the findings of the second of a 3 year project. In the second year, we have compared thrips monitoring methods, identified thrips species present in flowers and on foliage, and conducted efficacy trials on both registered an unregistered materials. We have also established a research planting of blackberries (var. Ouachita) at the Sandhills Research Station in Jackson Springs, NC.
This research facilitated the investigator's participation in a USDA SCRI proposal lead by Ioannis Tzanetakis, University of Arkansas. This project was funded, and therefore, additional SRSFC support is not being sought for the third proposed year of this project. This report serves are our final project report to the SRSFC on this work.

PROCEDURES

Procedures for 2008 and 2009 were the same except where noted.

Objective 1: Thrips diversity

A subsample of 30 thrips per trap or plant sample were (when available) slide mounted and identified to species. This allowed for both determination of species composition and tracking of these species throughout to season to determine their relative abundances over time.

Objective 2: Thrips abundance and seasonal biology

Five thrips monitoring locations were established; one in eastern NC (Lenior County), and 4 in western NC. Sites 1, 2, 3, and 4 (western NC) were maintained by industry cooperators, while the eastern NC site was maintained by the Burrack Laboratory. This report focuses on data from Sites 1, 2, 3, and 4, in North Carolina's main blackberry production area. At each location, 5 trap types were compared: AM (yellow sticky traps), blue sticky cards, and 3 different colored PVC traps, yellow, blue, and dark blue (Figure 1). PVC traps were coated with stable fly paper. Yellow traps are attractive to a broad range of insects, while blue traps are more attractive to western flower thrips.

Two colors of blue were used because commercial western flower thrips traps vary in hue, but ecause no difference between light and dark blue traps was observed during 2009, dark blue traps were not included in 2009. Traps were hung on trellis wire, level to flowers and developing fruit. Traps were changed weekly, and bud, blossom, or fruit samples (depending upon the season) were collected from the canes adjacent to the traps to relate trap captures to insect presence on plant reproductive tissue. These samples were stored in 70% EtOH.

Objective 3: Relating thrips abundance to fruit injury

Harvest samples were collected for 4 of the treatment trials conducted (*Objective 4*): registered materials at trapping Site 1 in Cleveland County, NC and unregistered materials at the Cunningham Research Station, Kinston, NC. Insufficient fruit for harvest samples was available from the unregistered materials trial at the Sandhills Research Station, Jackson Springs, NC. Forty fruit samples were collected from each plot. These samples were weighed, rated as percent marketable, and subsamples of 20 fruit from each plot were measured (length, width, and height) and number of druplets per fruit counted. Size measurements and druplet counts were collected to determine if thrips feeding on developing fruit had any impact on resulting size and shape.

Objective 4: Testing available materials for thrips management

Two treatment trials were established in 2008 and 2009, the first designed to gather efficacy data on unregistered materials on thrips in southeastern blackberries. This trial was supported by the Southern Region IR Program, and a separate report submitted to them details the results to date. A second trial comparing currently registered materials with potential activity against thrips was established with a grower cooperator in Cleveland County, NC. This site was also used for trap comparisons as Site 1 (*Objective 2*). The treatments were compared in a RCB design, replicated 4 times.

All treatments were applied with a Solo Mistblower at 200 gpa to simulate grower standard airblast application. 2008 treatments were applied on 19 May 2008 (prebloom), 26 May 2008, and 2 June 2008. Plots consisted of 5 plants (var. Chester), and samples were collected from the center 3 plants in each plot.

In 2009, plot size was increased to 10 plants each (var. Triple Crown), and a row was skipped between treated rows to minimize drift. 2009 treatments were applied on 11 May 2009 and 19 May 2009. Bloom was shorter during 2009, and a third treatment was not required.

One yellow and 1 blue PVC trap was placed in each plot to determine if trap captures were reduced by treatments. Blossom and foliage samples were also collected from plots as follows: 10 blossom clusters (5 flowers each) and 10 trifoliate leaves (from a fruiting cane) were collected and washed in 70% EtOH to remove thrips.

Thrips were then counted and a subsample indentified to species (*Objective 1*). Traps were changed and samples collected 3 and 7 days post treatment.

Data for all objectives were analyzed in SAS v.9.1 via Proc Mixed as repeated measures.

RESULTS

Objective 1: Thrips diversity

Thrips collected from blackberry blossoms and indentified to species to date are almost exclusively *Frankliniella tritici* (eastern flower thrips), but only 2 early season dates (5/26/2008 and 5/29/2008, from Site 1) have been completely identified thus far. High trap captures in blue sticky traps from later in the season indicate that a flight of western flower thrips (*F. occidentalis*) may occur as well. Thrips were also found on blackberry foliage, but at roughly 1/10 the density as in blossoms. Foliage samples were more diverse, however, and included tobacco thrips (*F. fusca*), onion thrips (*Thrips tabaci*), cereal thrips (*Limothrips cerealium*), tomato thrips (*F. schultzei*), soybean thrips (*Seicothrips variabilis*), and *F. tenuicornis*. Many of these species are likely nonresident visitors to blackberries and are not of economic concern. Tobacco thrips, onion thrips, tomato thrips, and *F. tenuicornis* are potential vectors of INSV, so their presence, although transient, may have implications for disease movement.

Preliminary counts indicate that a similar number and diversity of species was found in 2009, and these samples continue to be identified. To date, no western flower thrips have been found in sticky traps or plant samples.

Objective 2: Thrips abundance and seasonal biology

Thrips populations can reach very high numbers in blackberry blossoms (Figure 2), and mirrors blackberry phenology. Thrips can be present on plants from before bloom through harvest. Low numbers of thrips were washed from harvest fruit samples in 2008. Traps do a good job of mirroring thrips fluctuations in blossoms during bloom, but as fruit develop and fewer thrips are present in plant reproductive tissue, trap captures still increase. This is likely due to a post bloom population of western flower thrips, as evidenced by the increase of trap capture in blue traps and decreased capture in yellow traps (Figure 3).

At Site 1, blue traps consistently caught more thrips than yellow PVC traps (Figure 3), but this trend did not hold across all 4 western sites. While blue traps generally caught more thrips (Figure 4), these differences were not significant on most dates. Monitoring at Sites 2, 3, and 4 terminated before the largest number of thrips were captured at Site 1, so these differences may have appeared if trapping continued. Western flower thrips populations are also not uniform across North Carolina, so it is possible that Site 1 has a great proportion of western flower thrips than the other locations. Ongoing thrips identification of samples from these traps will address these questions.

Similar thrips abundance was observed in during the 2 years, but adult thrips captures less closely paralleled thrips presence in blossoms in 2009 than in 2008. A notable exception to this pattern was the much higher trap captures on May 29, 2009. This increase appeared almost entirely due to blue trap captures (Figure 3), and we will be identify the thrips present in the traps from this date to determine if different species are responsible for this increase.

Objective 3: Relating thrips abundance to fruit injury

There were no significant effects of treatment on percent marketable fruit, fruit size, shape, or druplet number. Our treatments, however, were not successful at reducing thrips populations, so we cannot necessarily conclude that thrips feeding did not damage fruit. In 2009, we caged developing fruit to exclude thrips and introduce laboratory reared thrips on separately caged fruit in different densities to determine if thrips feeding injures fruit under these conditions.

Although thrips were suppressed in treatment plots with respect to the control in our 2009 on farm trial, we still were not able observe a negative impact on fruit size, shape, or druplet number in the untreated control plots. In fact, control fruit were generally larger, had an average number of druplets with respect to the treated fruit, and had no more fruit with white druplets than any other treatment (data not shown, available upon request). Caging trials, where known densities (0, 5, 10, and 20 per cluster) of western flower thrips (*F. occidentalis*) thrips were placed on clusters of 5 buds and/or blossoms at the Cunningham Research Station, Kinston, NC, also failed to result in a negative impact on fruit set, size, or shape (data not shown, available upon request).

Objective 4: Testing available materials for thrips management

Larval numbers were lower in blossom samples, but are more interesting than adult numbers, as adults rapidly re colonize blossoms following treatments. Larval populations indicate that adults were resident in blooms long enough to lay eggs and were not just feeding and departing. Treatment trial results were inconsistent (Tables 1 and 2), likely due to in migration of adult thrips between treatments. Larval thrips data were more consistent, with the 2 Delegate treatments resulting in fewer larvae. Assail treatments seems to flair thrips populations toward the end of the trial, possibly due to non target impacts on beneficial predators. Minute pirate bugs (*Orius* spp.) and big eyed bugs (*Geocoris* spp.) were observed in plots, although counts were collected of these insects. Both predators can feed on thrips eggs and larvae. The minimal treatment effects observed were present for less than a week following treatments, and then thrips movement into plots overwhelmed the treatments.

Unlike in 2008, we saw significant differences in thrips numbers between treated and untreated plots in 2009 (Tables 1 & 2). Delegate (spinetoram) and Mustang Max (zeta-cypermethrin) treatments reduced thrips numbers to the greatest degree when compared to the untreated control. All treatments, had a significant, negative effect on larval density in blooms, meaning that either adult movement into flowers or subsequent reproduction was impacted. Of the organically acceptable (OMRI listed) materials compared, Entrust (spinosad) reduced thrips numbers, while Pyganic (pyrethrins) did not. The addition of a surfactant to Delegate and Entrust did not appear to improve thrips reduction by either of these materials.

Conclusions

We have determined that thrips are present, often in very high numbers, and reproduce in southeastern blackberry blossoms, as indicated by the presence of larvae on both foliage and flowers. We have identified some of the key thrips species present and will continue to categorize species composition through time. We have tested chemical efficacy for managing thrips in blackberries. A link between thrips presence and yield loss through fruit malformation has yet to be established, and unless this is, we are mot convinced that excessive thrips treatments are beneficial.

Impact Statement

This project has developed monitoring tools to track thrips populations in southeastern blackberries, identified key thrips species present, and begun work to identify damage thresholds and management tools for thrips in this crop. Thus far, it appears that even at high densities, thrips do not impact fruit set or quality.

The research conducted in support of this project has lead to the project investigators participation in a USDA Specialty Crop Research Initiative (SCRI) proposal entitled "Management of virus complexes in *Rubus*" and led by Ioannis Tzanetakis, University of Arkansas. This proposal was the highest ranked submission in the 2009 funding cycle and was funded in full ($1,400,000).

Citations

No publications relating to this project were produced in 2008 and 2009. A publication by PI Burrack is in preparation for submission in 2010.

Table 1. Mean adult thrips (± SEM) per blossom sample, 2009 registered insecticide treatment trial. Means followed by the same letter are not significantly different (α = 0.05) via Fisher's Protected LSD.

		Prebloom Treatment	**3 DAT**	**Bloom Treatment (8 DAT)**	**3 DAT**	**7 DAT**
Treatment	**Rate/ acre**	**5/11/2009[2]**	**5/14/2009[3]**	**5/19/2009[4]**	**5/22/2009[5]**	**5/29/2009[6]**
Untreated Control	NA	32.25 ± 3.97	132.50 ± 21.83 **bc**	62.50 ± 8.91 **b**	149.50 ± 24.68 **a**	30.50 ± 15.92 **bc**
Pyganic 1.4 EC	32 fl oz	25.00 ± 1.78	203.50 ± 33.06 **ab**	116.75 ± 35.29 **a**	113.50 ± 16.62 **ab**	13.75 ± 5.23 **c**
Delegate WG + NIS[1]	4 oz + 0.25 %	21.25 ± 5.31	125.75 ± 22.00 **c**	58.50 ± 8.72 **b**	59.25 ± 7.42 **c**	66.25 ± 25.89 **b**
Delegate WG	4 oz	20.25 ± 5.57	119.25 ± 16.06 **c**	44.25 ± 2.21 **bc**	55.75 ± 14.99 **c**	36.75 ± 9.47 **bc**
Entrust + NIS	2 oz + 0.25 %	26.50 ± 4.43	219.25 ± 12.86 **a**	80.00 ± 13.79 **ab**	86.75 ± 17.81 **bc**	34.00 ± 19.00 **bc**
Entrust	2 oz	29.00 ± 4.30	201.25 ± 41.64 **ab**	75.00 ± 11.56 **b**	79.75 ± 7.98 **bc**	44.75 ± 12.98 **bc**
Assail 30 SG	5.3 oz	23.25 ± 5.14	168.50 ± 15.82 **abc**	67.25 ± 3.90 **b**	112.25 ± 21.70 **ab**	188.50 ± 19.59 **a**
Mustang Max	4 fl oz	26.75 ± 7.08	115.50 ± 14.63 **c**	14.00 ± 5.20 **c**	55.25 ± 7.86 **c**	28.25 ± 9.10 **bc**

[1]NIS = non ionic surfactant

[2] $F = 0.67_{7,21}$; $p = 0.6952$

[3] $F = 2.86_{7,21}$; $p = 0.0292$

[4] $F = 4.68_{7,21}$; $p = 0.0027$

[5] $F = 5.90_{7,21}$; $p = 0.0007$

[6] $F = 17.41_{7,21}$; $p < 0.0001$

Table 2. Mean larval thrips (± SEM) per blossom sample, 2009 registered insecticide treatment trial. Means followed by the same letter are not significantly different (α = 0.05) via Fisher's Protected LSD.

		Prebloom Treatment		**Bloom Treatment**		
Treatment	**Rate/ acre**	**5/11/2009[2]**	**5/14/2009[3]**	**5/19/2009[4]**	**5/22/2009[5]**	**5/29/2009[6]**
Untreated Control	NA	4.00 ± 0.70	2.25 ± 0.25	46.75 ± 6.32 **ab**	139.00 ± 36.99 **a**	19.00 ± 15.92
Pyganic 1.4 EC	32 fl oz	2.25 ± 1.11	2.25 ± 1.93	54.00 ± 17.08 **a**	142.50 ± 28.27 **a**	5.25 ± 2.69
Delegate WG + NIS[1]	4 oz + 0.25 %	3.25 ± 1.25	0.75 ± 0.25	13.50 ± 4.72 **d**	12.75 ± 3.15 **b**	10.75 ± 7.89
Delegate WG	4 oz	1.00 ± 1.00	1.50 ± 1.19	27.25 ± 2.50 **bcd**	9.25 ± 7.39 **b**	2.50 ± 1.26
Entrust + NIS	2 oz + 0.25 %	2.50 ± 1.89	1.50 ± 1.19	30.25 ± 5.42 **bcd**	27.25 ± 5.76 **b**	5.50 ± 4.19
Entrust	2 oz	1.75 ± 1.18	1.75 ± 1.18	28.50 ± 11.81 **abc**	53.50 ± 11.98 **b**	12.75 ± 7.52
Assail 30 SG	5.3 oz	3.75 ± 2.39	1.00 ± 0.41	28.00 ± 10.21 **bcd**	16.00 ± 5.58 **b**	8.25 ± 2.10
Mustang Max	4 fl oz	4.50 ± 2.90	0.25 ± 0.25	17.50 ± 5.19 **cd**	12.50 ± 3.12 **b**	3.25 ± 1.60

[1]NIS = non ionic surfactant

[2] $F = 0.55_{7,21}$; $p = 0.7858$

[3] $F = 0.77_{7,21}$; $p = 0.6184$

[4] $F = 3.06_{7,21}$; $p = 0.0221$

[5] $F = 12.30_{7,21}$; $p < 0.0001$

[6] $F = 1.22_{7,21}$; $p = 0.3374$

Figure 1. Trap types compared in 2008. Clockwise from top, AM trap, blue sticky card (both from Great Lakes IPM, Vestaberg, MI), dark blue PVC, blue PVC, and yellow PVC. Note all PVC trap are the same size (approximately 3.5 inches long) but are shown different sizes for scale and detail. Dark blue PVC traps were not included in 2009 comparisons.

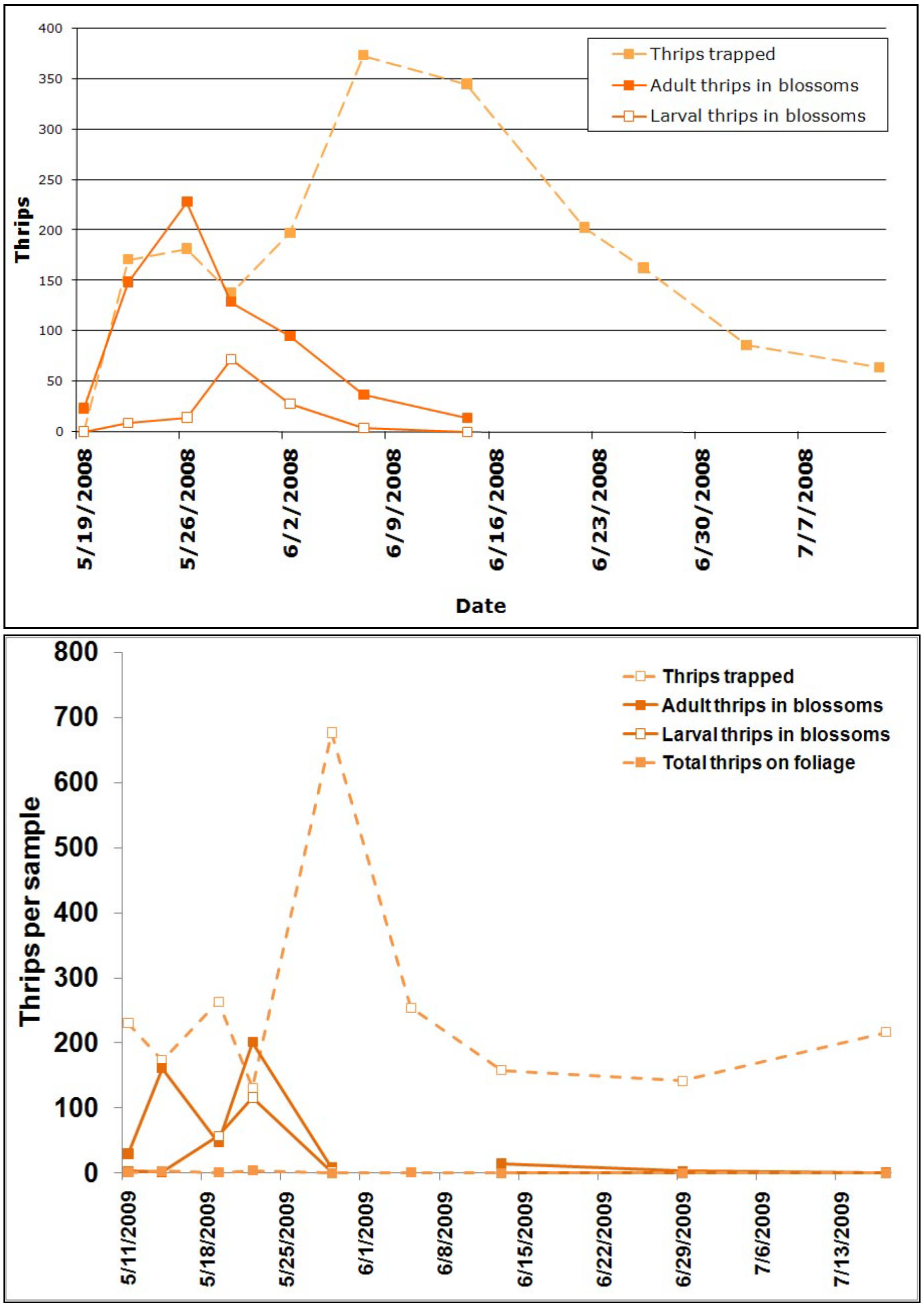

Figure 2. Thrips phenology, Site 1 (Cleveland County, NC). Blossom counts for adult and larval thrips are from untreated control plots from on farm insecticide trial, and trapping data are totals from one blue sticky trap per plot. Adult and larval thrips samples are total for 10 cluster bud, blossom, or fruit samples (depending upon the season) per plot.

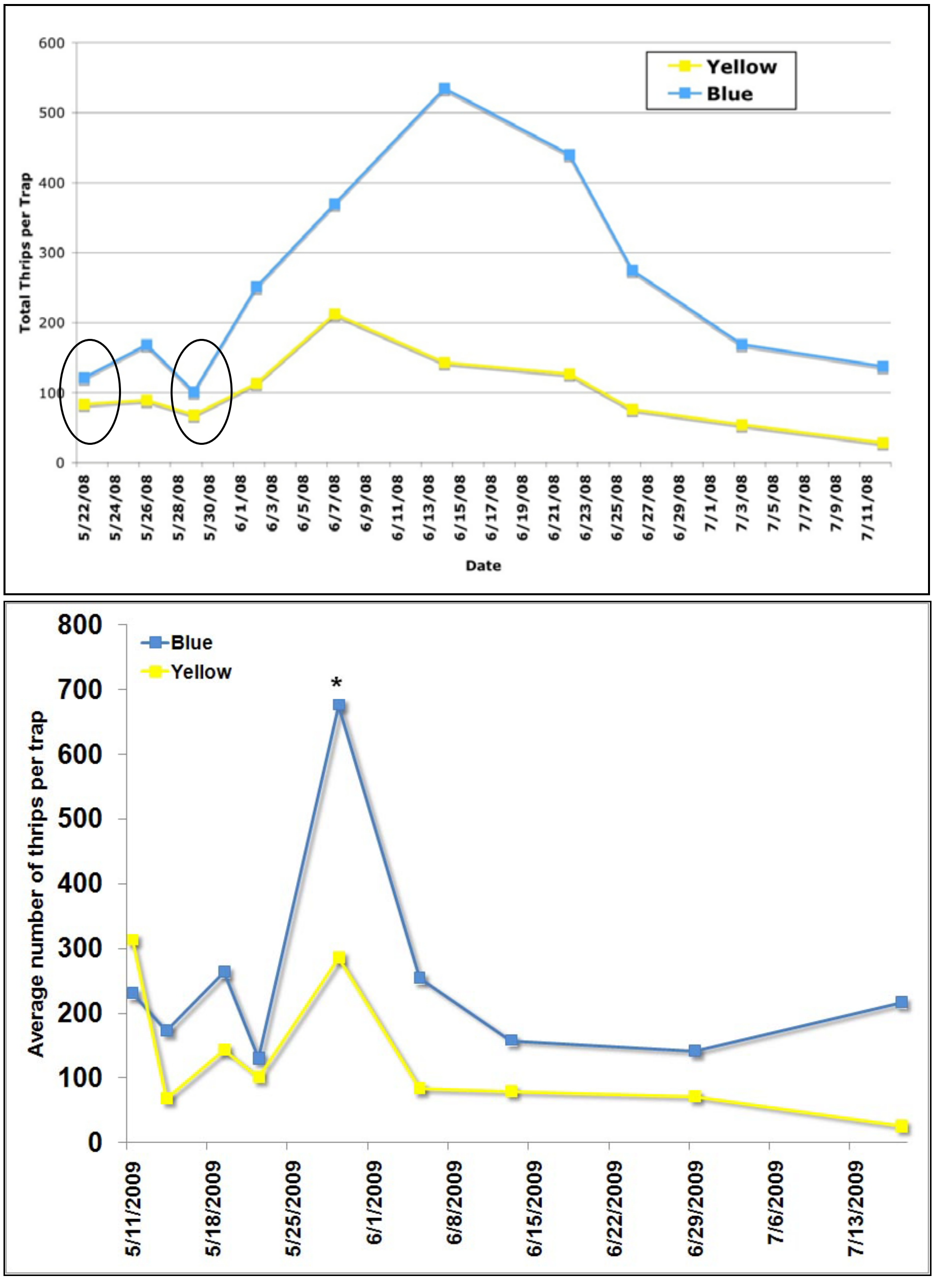

Figure 3. Thrips trap captures in insecticide treatment trial, Site 1 (Cleveland County, NC) in yellow and blue PVC cylinder traps. Values from a single date within the same circle are not significantly different (α = 0.05) via Fisher's Protected LSD. In 2009, only the 5/29 trapping data differed significantly between trap colors (indicated by *).

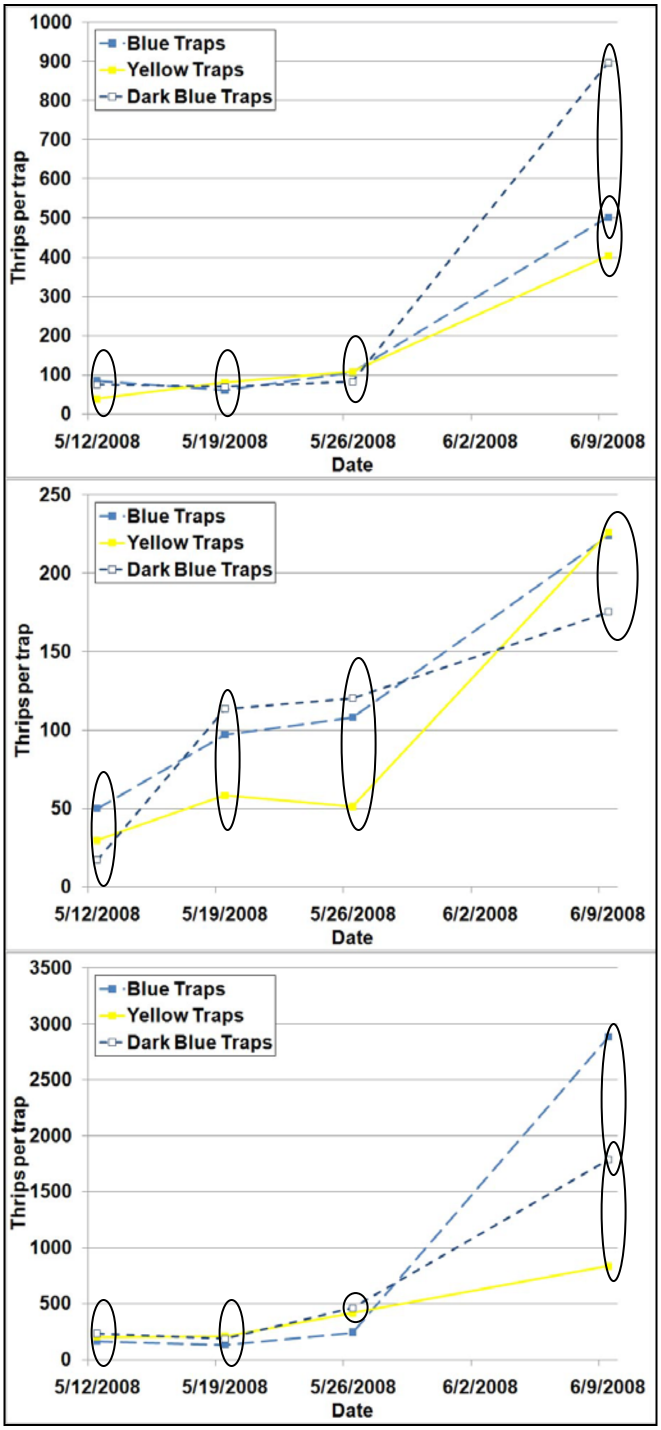

Figure 4. Trap color comparison. Yellow, blue, and dark blue PVC cylinder trap capture data from Sites 2, 3, and 4 (from top), all in southwestern NC. Data points for a date within the same circle are not significantly different (α = 0.05) via Fisher's Protected LSD.