Assessing the impact of strawberry clipper in annual strawberry production

Interim report

2014-02

Research proposal

Name, Mailing and Email Address of Principal Investigator(s):
Hannah J. Burrack
Department of Entomology
North Carolina State University
Raleigh, NC 27695-7634

Jayesh Samtani
Small Fruit Production Specialist
Hampton Roads AREC
Department of Horticulture
Virginia Polytechnic Institute and State University
1444 Diamond Springs Rd.
Virginia Beach, VA 23455
jsamtani@vt.edu

OBJECTIVES

1. Determine the frequency and distribution of strawberry clipper weevil damage in annual plasticulture strawberries.
2. Assess the impact of simulated strawberry clipper damage on strawberry yield and harvest period.
3. Screen reduced risk insecticides for efficacy against adult strawberry clipper weevils.

JUSTIFICATION

Strawberry clipper weevil (*Anthanomus signatus*) is a widespread pest of strawberries in the eastern United States (listed as an important pest in AR, CT, ME, MA, NC, NH, NY, OH, PA, RI, TN, VA, and WV strawberry), and feeds on a narrow range of spring flowering crop profiles plants, including strawberries, caneberries, and red bud. Female strawberry clippers (2-3mm long beetles) lay their eggs in developing flower buds, and then chew partially through the pedicel, causing the bud to droop or fall from the plant. Beetle larvae develop and pupate within the flower buds. Following pupation, adults emerge and migrate into wooded areas, where they remain inactive (estivate) through the summer. There is only one generation of strawberry clippers per year.

Because strawberry clippers kill developing buds, thus preventing them from developing into fruit, growers are often very conservative in their management practices and routinely apply broad spectrum insecticides both preventatively and in response to damage by strawberry clipper weevils. However, it is unclear as to whether this aggressive response is justified. Research in New York conducting during late 1990s demonstrated that many strawberry plants compensate for flower loss by producing larger fruit and that clippers rarely lay eggs on primary buds, which produce the largest fruit (Pritts et al. 1999, Kovach et al. 1999). Other plant species have also demonstrated the ability to compensate for injury from related weevils (Long and Averill 2003). However, the results from these studies are not generalizable to southeastern strawberry growing conditions for several reasons. Most notably, previous research on strawberry clipper damage and distribution was conducted in matted row strawberry plantings which differ greatly in production practices from the annual plasticulture strawberry systems common in the southeast.

One significant difference between these systems are the varieties grown, and varieties are known to vary widely in their ability to compensate for bud loss (Pritts et al. 1999). An additional concern specific to annual strawberry plantings is that of seasonality. Insect activity periods occur later in the year in northern growing areas, so it is unclear if strawberry clipper damage timing is the same in the southeast as in the northeast. In addition to potential differences in insect activity timing, harvest periods vary between matted row and annual plantings. One means by which strawberry clippers may indirectly damage plants is by shifting harvest intervals, meaning that plants may compensate for lost buds by fruiting heavily either later or earlier than they would have if undamaged. This potential form of damage is of particular concern to southeastern strawberry growers, as they often try to hit specific intervals for direct market customers, e.g. Mother's Day and Easter.

Our project has taken a three phase approach to understanding strawberry clipper significance in southeastern strawberries. First, we have surveyed commercial strawberry fields to determine how common and severe damage from strawberry clipper weevil is. Second, we have simulated different degrees and timing of damage to determine impacts on yield. Finally, we have screened reduced risk insecticides for efficacy against strawberry clipper in our findings from our first and second activities suggest that management is necessary.

METHODOLOGIES

Objective 1: Determine the frequency and distribution of strawberry clipper weevil damage in annual plasticulture strawberries.

To determine how common damage due to strawberry clipper weevil was, we established monitoring sites at ten NC locations and one VA location. Within each location, four transects were established, each moving into a field from adjacent non crop habitat, most often a wooded edge. Transects were spaced 10m apart and observation points within a transect were placed 20m apart. At each observation point, 4 plants were observed and the total of number of buds present and any clipped buds were counted. A yellow sticky trap was also placed at each observation point to determine if trap captures provided either a warning of upcoming damage or were predictive of damage severity. Clipped buds were counted and traps checked weekly. Traps were changed as needed.

Objective 2: Assess the impact of simulated strawberry clipper damage on strawberry yield and harvest period.

We assessed the impact of bud removal at three developmental points on yield in a single variety, Camarosa, in the first year of our project. We compared plants with all their primary buds removed, all their secondary buds removed, and all their tertiary buds removed to plants for which no buds were removed. Plants were grown at the Central Crops Research Station, Clayton, NC, following standard nutrient and pathogen management strategies, but no insecticides were applied. Plots consisted of 20 plants each. All ripe berries were harvested twice per week and weighed. While we did not separate marketable from unmarketable yield, pathogen pressure was very low and uniform across all plots and berry size was very large overall.

Objective 3: Screen reduced risk insecticides for efficacy against adult strawberry clipper weevils.
We compared four potential reduced risk and organic insecticides for efficacy against adult strawberry clipper weevils: Mycotrol (*Beauveria bassiana*), Exirel (cyantraniliprole), Rimon (novaluron), and Pyganic (pyrethrins). A grower standard, Brigade (bifenthrin), and an untreated control were also included. Beetles were reared from clipped buds collected at commercial monitoring sites and held no more than one week with food and water prior to bioassays. A semi-field bioassay was conducted in 32 oz arenas. Briefly, strawberry plants at the Central Crops Research Station were treated with one of the test materials at field rates and dilutions (50 gpa early in the season and 100 gpa when plants were full grown). The experiment was repeated twice, once per fruiting, and once during harvest. A trifoliate leaf and associated buds were removed from four plants treated with each material, placed in the bioassay arena, and returned to the laboratory where five beetles were added. Arenas were observed 24, 48, 72, and 96 hours after adding beetles and the number of dead beetles was counted.

RESULTS TO DATE
Objective 1: Determine the frequency and distribution of strawberry clipper weevil damage in annual plasticulture strawberries.
Strawberry clipper weevil were detected at 8 of the 11 commercial monitoring sites, and at one NC site and the VA site, between 40 to 50% of buds were damaged during peak activity (Figure 1). Activity began in early April (15^{th} week of the year) and typically decreased by the third week of May (22^{nd} week of the year).

Trap captures rarely predated clipper damage. In 2015 we will focus on determining if trap captures are related to the rate of damage observed.

Objective 2: Assess the impact of simulated strawberry clipper damage on strawberry yield and harvest period.
The removal of all the primary, secondary, or tertiary buds on a plant did not significantly impact total yield (Figure 2), but there was a significant interaction between yield and time, with secondary bud removal delaying during weeks 4 and 5 of picking when compared to the untreated control where no buds were removed (Figure 3). The bud removal timing for secondary buds appears to roughly correspond to the period where clipper activity was greatest in commercial fields (Figure 4).

Objective 3: Screen reduced risk insecticides for efficacy against adult strawberry clipper weevils.
Of the insecticides tested, only Brigade caused significant mortality in strawberry clipper weevils at either 24 or 120 hours. None of the reduced risk materials caused significant mortality (Table 1).

CONCULSIONS

We have demonstrated that strawberry clipper is common throughout NC and VA strawberry growing areas. Damage occurring at a similar time to when clipper populations were present in commercial fields did not significantly impact total strawberry yield but may potential shift harvest peaks by one to two weeks.

We are repeating this study in 2015 with two important changes. We have expanded the number of varieties we assess for bud loss and timing impacts to include: Chandler, Sweet Charlie, Benicia, Albion, and Strawberry Festival in addition to Camrosa. In addition to collecting total yield, we will also calculate average berry weight on a subsample of fruit from each plot. We will also screen additional reduced risk insecticides as those currently assessed appear to be ineffective.

IMPACT STATEMENT

Ours is the first project to assess the impact of strawberry clipper weevil in annual strawberry production in the United States. Our results will allow us determine appropriate management strategies for this pest.

Tables and figures

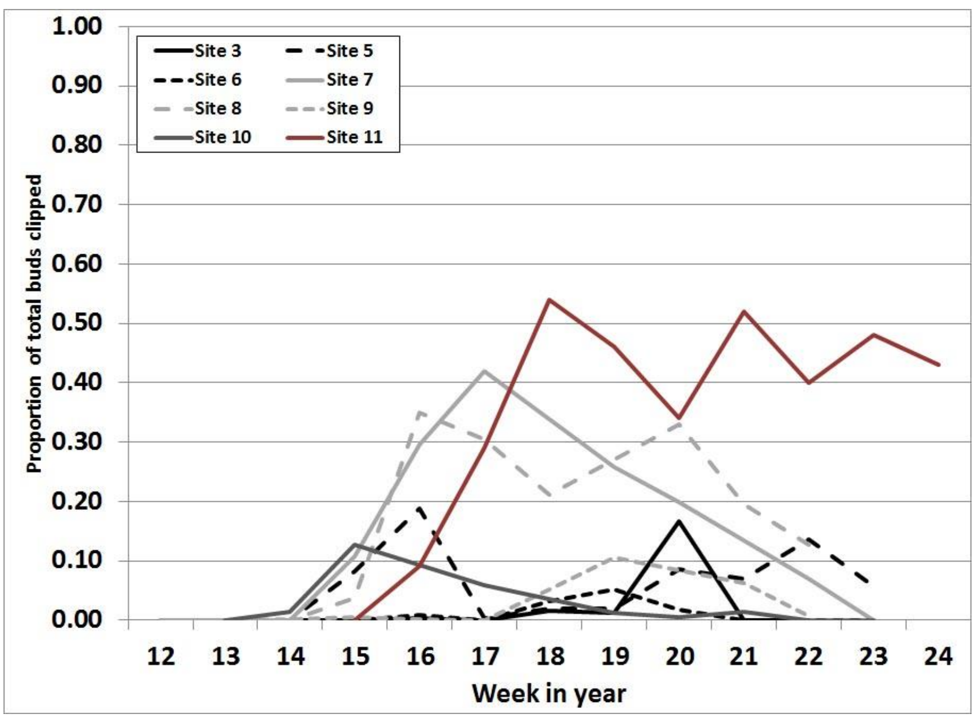

Figure 1. Proportion of total strawberry buds damaged by strawberry clipper weevil at the eight monitoring locations with damage. The three locations where no clippers or damage was observed are not shown.

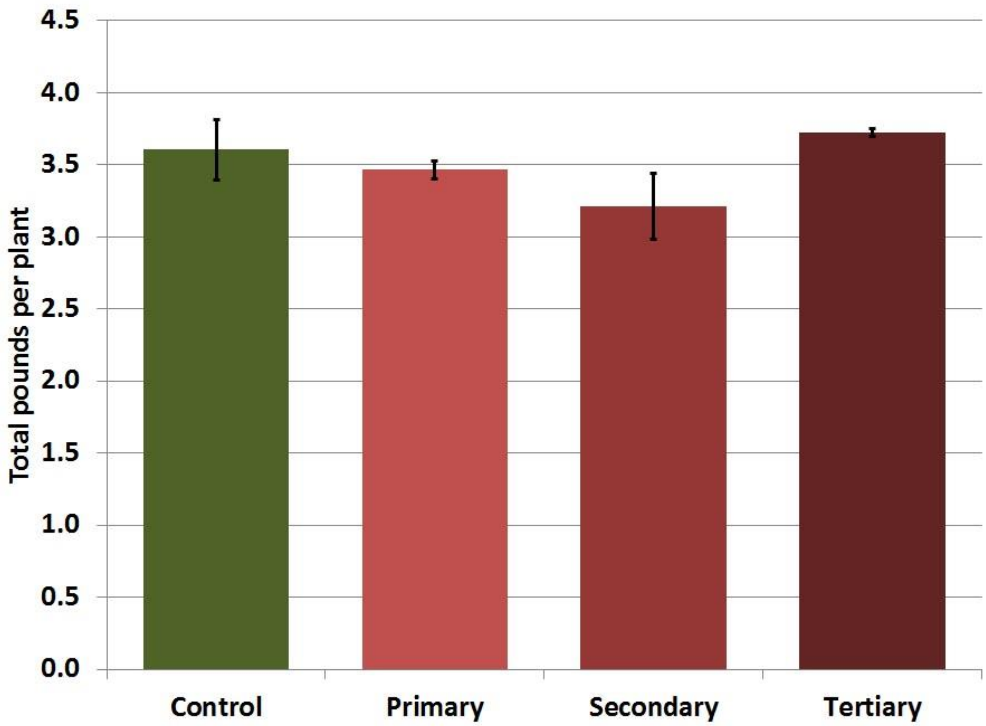

Figure 2. End of season total yield was not impacted by bud removal. (Treatment: $F = 2.18$; df = 3,9; $p = 0.1601$)

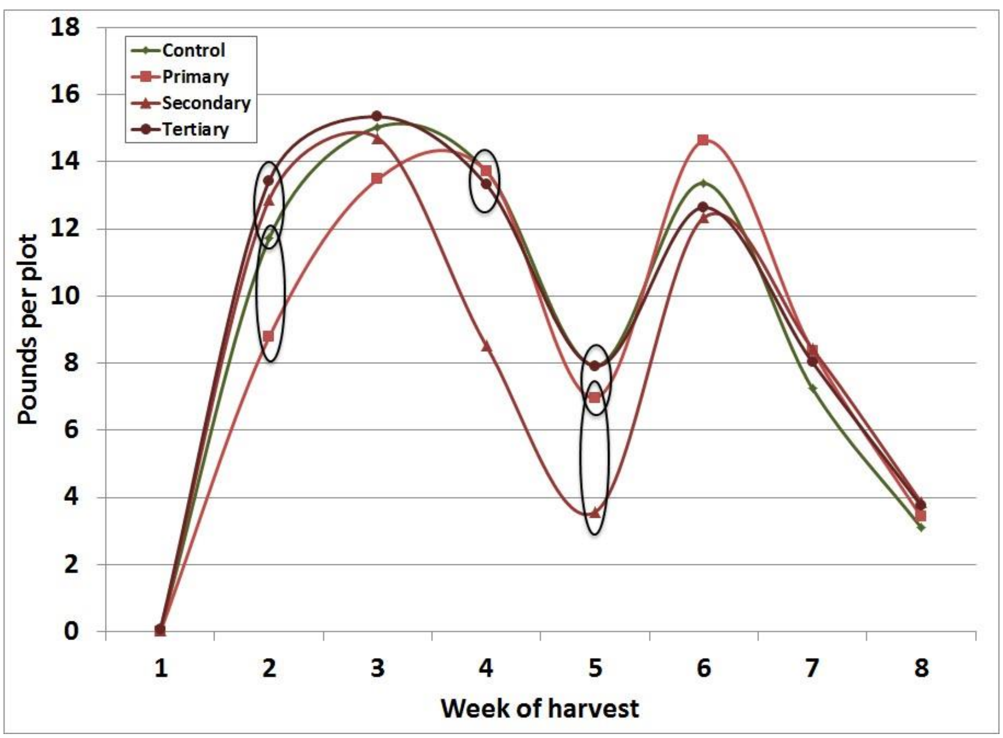

Figure 3. Harvest timing was affected the stage at which buds were removed (Treatment*Week: $F = 4.65$; df = 21, 93; $p < 0.0001$). Values within a week inside the same circle are not significantly different ($\alpha=0.05$).

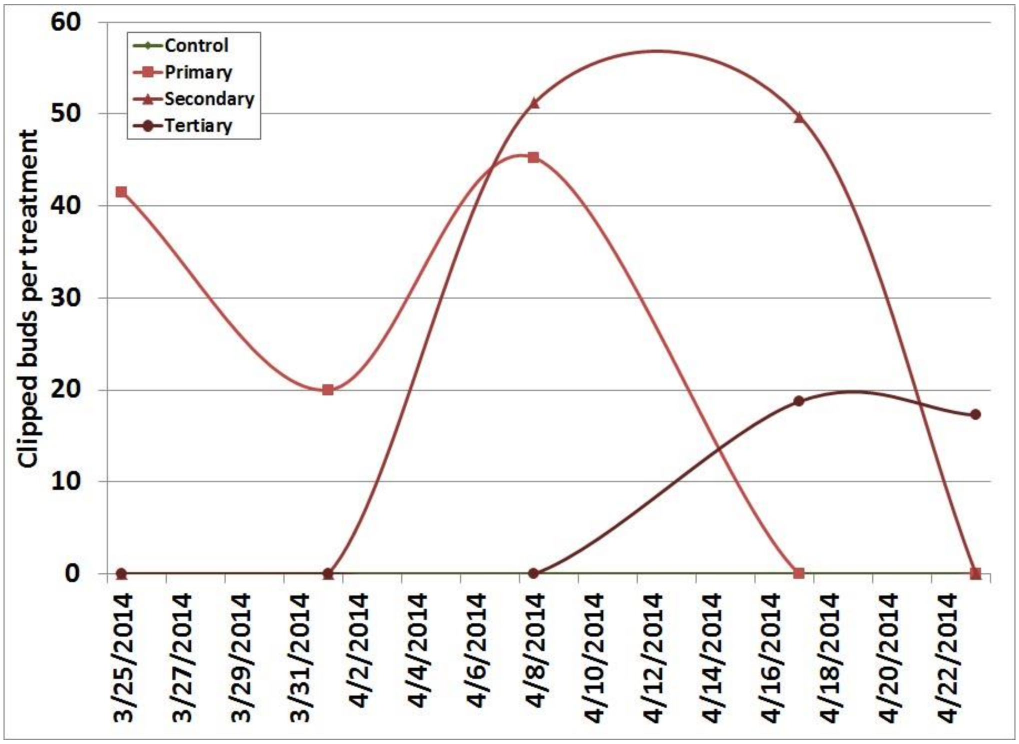

Figure 4. Secondary bud removal timing roughly corresponds to clipper weevil activity period at NC commercial monitoring locations, early April through late April.

Table 1. Proportion dead strawberry clipper weevils in semi field bioassays to assess efficacy of reduced risk insecticides. Means followed by the same letter are not significantly different (α=0.05).

	Early season		**Harvest**	
	24 hr after exposure[1]	**120 hours after exposure[2]**	**24 hr after exposure[3]**	**120 hours after exposure[4]**
Brigade	0.66 a	0.90 a	0.70 a	0.95 a
Exirel	0.00 b	0.16 b	0.05 b	0.34 b
Mycotrol	0.00 b	0.25 b	0.15 b	0.20 b
Pyganic	0.00 b	0.00 b	0.00 b	0.00 b
Rimon	0.00 b	0.00 b	0.00 b	0.00 b
Untreated control	0.00 b	0.10 b	0.00 b	0.06 b

[1]Treatment: $F = 17.16$; $df = 5, 15$; $p < 0.0001$
[2]Treatment: $F = 17.78$; $df = 5, 18$; $p < 0.0001$
[3]Treatment: $F = 16.09$; $df = 5, 18$; $p < 0.0001$
[4]Treatment: $F = 21.52$; $df = 5, 15$; $p < 0.0001$