



A SUCTION TRAP FOR SAMPLING APHIDS AND APHIDOPHAGOUS INSECTS IN PECAN TREES

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ABSTRACT

Aphids and aphidophagous insects were monitored in a pecan orchard by enumerating the insects collected on leaf samples and suction trap samples. Season long monitoring of the pecan foliage revealed that the aphid abundance prior to the late season outbreak on the leaves increased to higher population levels than could not be explained by the reproductive potential of the aphids. Concomitant season long sampling of the air in the canopy indicated that fecund alate aphids were continuously abundant in the air both before and between the outbreaks on the leaves. The results have important implications for improving scouting methods to predict aphid outbreaks and facilitate insecticide applications for aphid control.

Keywords: *Carya illinoensis* (Wangenh.) K. Koch, Seasonal population dynamics, Insect predators, Parasitoids.

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Contribution/ Originality

This study is the first attempt to sample the pecan tree canopy with a suction trap and describe the seasonal long activity of three aphid species and associated beneficial insects in the pecan tree canopy from series of samples.

1. INTRODUCTION

Three pestiferous autecious aphid species, blackmargined aphid (*Monellia caryella* (Fitch)), yellow pecan aphid (*Monelliopsis pecanis* Bissell) and black pecan aphid (*Melanocallis caryeaeifoliae* (Davis)) [Hemiptera: Aphididae], on pecan, *Carya illinoensis* (Wangenh.) K. Koch, foliage [1]. Aphid injury causes significant leaf loss through premature defoliation and aphids are controlled in commercial orchards with resistant cultivars [2] insecticides [3] aphidophagous insects and spiders as natural enemies, an introduced ladybeetle, *Harmonia axyridis* (Pallas) [4] and cool season intercrops to enhance predatory insects. Monitoring the pecan trees to assess the abundance of aphids and aphidophagous insects is important to the application of these control methods. These aphids are currently monitored in commercial orchards by counting the aphids

on leaf samples collected at a height of ~3 m with either a pruning pole or from a custom-built, raised, aerial platform affixed to the bed of a pickup truck that transports the observer directly through the canopy. Nut-bearing pecan trees are typically 10-25 m in height and the distribution of aphids in the tree canopy varies over the season and with aphid abundance [5]. Aphid outbreaks can occur at any time during the season and trees in commercial orchards are typically monitored one time per week for aphid abundance. Weekly leaf samples are effective in identifying aphid outbreak but the estimates of aphid abundance before and after an outbreak often measure a weekly increase in abundance that exceeds the reproductive potential of the aphids [6]. The research reported, herein, estimated and compared the relative abundances of aphids and aphidophagous insects in concomitant samples of the pecan foliage (using leaf samples) and the canopy air (using an aerial suction traps).

2. METHODS AND MATERIALS

Four fan traps were fabricated from common materials for pecan trees following the design of Allison and Pike [7]. A 1/20 hp AC electric fan was used to draw air through the volute (Fig. 1). One trap was deployed under each of 4 pecan trees. Three traps -3 m in height (Fig. 2) - were deployed under 30-year old 'Desirable' (~10m in height) variety pecan trees One trap - 7 m in height (Fig. 1) - was deployed under a large (~25 m in height) pecan trees at an experiment station orchard near TyTy, GA, USA. The orchard was managed following the recommendations for fungicides, herbicides and fertilizer of the University of Georgia Cooperative Extension Service during 2013. However, the four trees with traps were not treated with insecticides during 2013. Traps were run from 8:00 AM – 3:00 PM for seven hours one time per week (22 times over the season) at the two pecan orchards in 2013 from May through September and compared to weekly foliage samples of the lower canopy of four trees for measuring the abundance of aphids and other flying and dispersing insects in the tree canopy. Foliage samples were collected with a 3-m pruning pole and the number of aphids on the leaves on five shoots per tree were counted on each tree on each sample date. The fan traps could not be operated during rain events and traps infrequently failed to operate and had to be repaired before the running the traps. Due to these events the sample periods were not always exactly at 7 days intervals. Insects collected by the fan traps were enumerated after they were classified into 30 categories – Hemiptera: yellow pecan aphid alate adult; yellow pecan aphid nymph; blackmargined aphid alate adult; black pecan aphid alate adult, Hymenoptera: sawfly adults; Ichneumonoidea – Chalcidae, Braconidae, Ichneumonidae; Sphecoidea, Formicidae, Neuroptera: Hemerobiidae adults; Hemerobiidae larvae; Chrysopidae adults, Chrysopidae larvae, Lepidoptera: *Coptodisca lucifluella* cocoons; hickory shuckworm adults; ballooning fall webworm first instar caterpillars, Diptera: Dolichopodidae adults; Syrphidae adults, Syrphidae larvae; Tachinidae, Coleoptera: *Harmonia axyridis* adults, *H. axyridis* larvae, *Olla v-nigrum* adults. Ballooning spiderlings were also found and counted in the traps. Data were analyzed with Poptools [8] to calculate the mean, standard deviation and 90% confidence interval for the total number of insects per trap overall the sampling day.

3. RESULTS

Sampling the air in the canopy with a suction trap collected flying aphids and aphidophagous insects in the pecan tree canopy and provided a different description of the insect activity than that described by sampling the foliage from the ground. Suction traps collected alate aphids of the three pecan aphid species and all three species carried 0 to 13 aphid nymphs and many were ready to start a new colony when landing on the next leaflet (Fig. 3). Suction traps also collected many flying and dispersing insects, including insects associated with the aphids, such as, long-legged flies, hoverflies, ants, parasitoids of aphids, ladybeetle adults and larvae, and, green and brown lacewings larvae and adults (Fig. 4). First instar fall webworm larvae and spiderlings were also collected while ballooning to disperse. Dolichopodid flies and ants were the most abundant insects in the suction traps. Variation between traps on each sampling date for each insect species or group was high (Table 1) indicating that the abundance estimates were not very accurate with four traps and a weekly sample interval. Alate aphids and aphid nymphs were detected in the pecan leaf samples and the majority (93% of all aphids counted) of the aphids were immatures. Suction traps collected 452 alate adult aphids of all three pecan aphid species. Alate aphids were collected by suction traps on every sample date from June 21 to July 5 and from July 18 to Sept. 27 and these were all viviparous female aphids. A few (22 aphids) yellow pecan aphid nymphs were collected in two traps on Sept. 4. Male blackmargined and black pecan aphids appeared in the foliage samples on Sept. 18 and Sept. 27 and were not collected in the suction traps. During the late season aphid outbreak, black pecan aphids were the most abundant species in the fan traps, whereas, yellow pecan aphids were the most abundant species in the leaf samples.

4. DISCUSSION

Aerial suction traps have been used in to collect information on aerial populations of soybean aphid [9]. The results reported herein, indicated that monitoring pecan aphids and aphidophagous insects with aerial traps is also an important activity for collecting information that is useful in management of pecan aphids to determine the need for a biological or chemical control method. Pecan aphid populations need favorable weather and host plant conditions and low abundance of natural enemy populations to develop to outbreak levels and are not a pest problem every season (Fig. 7) [6]. Monitoring information is used to assess aphid abundance and determine when to apply a control method. Cool-season intercrops are planted in pecan to conserve aphidophagous insects and cut the intercrops in the spring to enhance early season aphid control and insecticides are used to control aphid outbreaks in the late summer and fall (Fig. 8) [10]. Suction trap sampling collects similar types insects to leaf sampling but the insects collected by air samples are dispersing from the leaf and are not detected in the leaf samples. Subsequently, the leaf samples may have very few or no aphids yet the alate aphids are present in the canopy air and apparently, are capable of increasing in abundance on the foliage during favorable weather conditions or low predator abundance. The high variation between traps in the number of insects count indicates that more traps or more frequent trapping are needed to

estimate abundance with any reasonable accuracy. Improvements are needed in the trap design to make it more practical to run the traps more frequently by protecting the motor from rain and converting the motor to DC current to eliminate the need for the power cord.

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Competing Interests: The author declares that there are no conflicts of interests regarding the publication of this paper.

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Table-1. The total season long fan trap collection contained insects from six orders and these were classified into 26 groups. Spiderlings were also collected by the traps. Standard deviation between the traps was calculated to derive the 90% confidence interval for $\alpha = 0.1$ and $n = 4$.

Insect Order	Insect species or taxon	mean #/trap	stdev	90% CI
Hemiptera	yellow pecan aphid alate adult	60.50	60.36	49.64
	blackmargined aphid alate adult	17.25	14.93	12.28
	black pecan aphid alate adult	22.75	15.95	13.11
	yellow pecan aphid nymph	7.75	9.03	7.43
	green peach aphid	1.75	2.36	1.94
	Miridae	1.50	3.00	2.47
Hymenoptera	Ichneumonidae	0.75	1.50	1.23
	Braconidae	5.00	9.35	7.69
	Chalcidoidea	0.50	1.00	0.82
	Formicidae	181.75	336.08	276.40
	Sphecoidea	3.75	5.19	4.27
	pecan sawfly adults	1.25	1.50	1.23
Neuroptera	Hemerobiidae adults	2.00	3.37	2.77
	Hemerobiidae larvae	2.75	4.19	3.45
	Chrysopidae adults	22.25	23.23	19.10
	Chrysopidae larvae	11.75	12.15	9.99
Coleoptera	<i>Harmonia axyridis</i> adults	4.25	3.77	3.10
	<i>Olla v-nigrum</i> adult	0.75	0.50	0.41
	Coccinellidae larvae	4.50	5.20	4.27
Diptera	Tachinidae	6.75	8.30	6.83
	Syrphidae adults	1.75	0.96	0.79
	Syrphidae larvae	0.25	0.50	0.41
	Dolichopodidae	308.75	263.31	216.55
Lepidoptera	<i>Coptodisca lucifluella</i> larvae	13.00	16.71	13.75
	hickory shuck worm adult	0.25	0.50	0.41
	fall webworm first instars	1.75	3.50	2.88
Non-insects	spiderlings	1.00	0.82	0.67

Source: Original data from field trial reported herein.

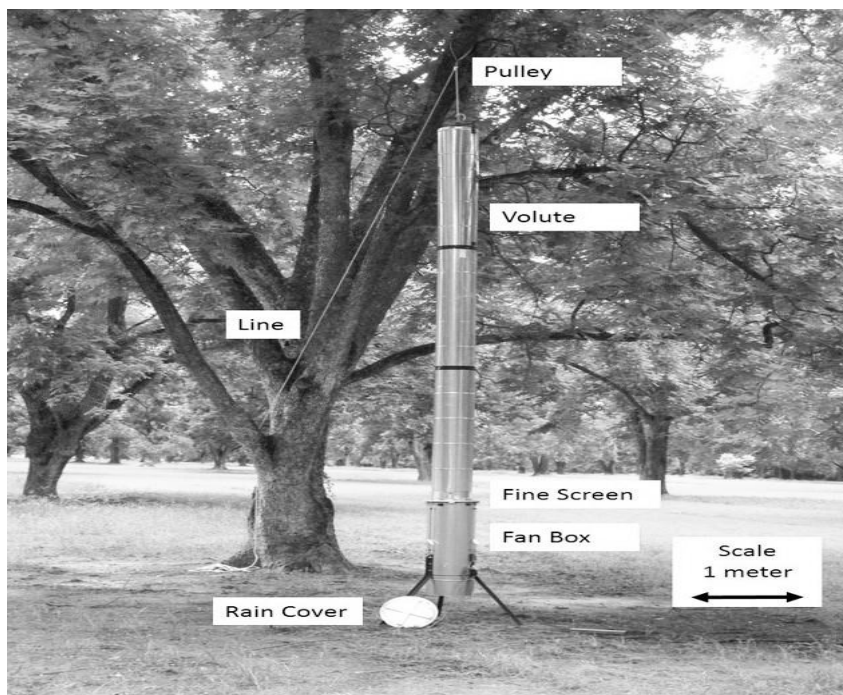


Fig-1. Fan trap were constructed to draw air from the tree canopy at the top of the volute and collect insects on a fine screen in a manifold at the junction of the volute and the fan box. At the end of each sample day the volute was removed by pulling it off the fanbox with a line and replacing it with a rain cover.

Source: Dutcher [10].



Fig-2. Fan traps were deployed with volute extending into the foliage at either 3 m (left) or 7 m (right). Source: Original picture from field trial reported herein.

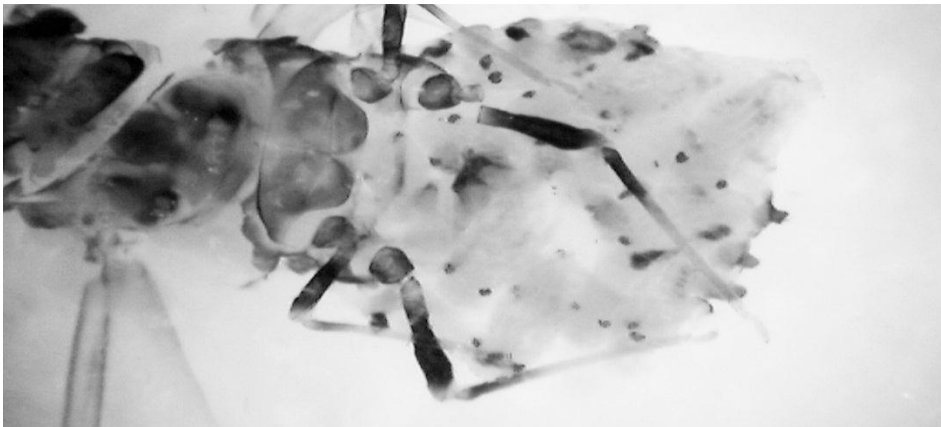
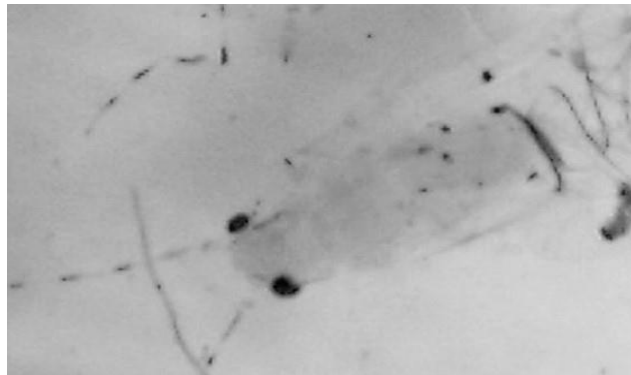


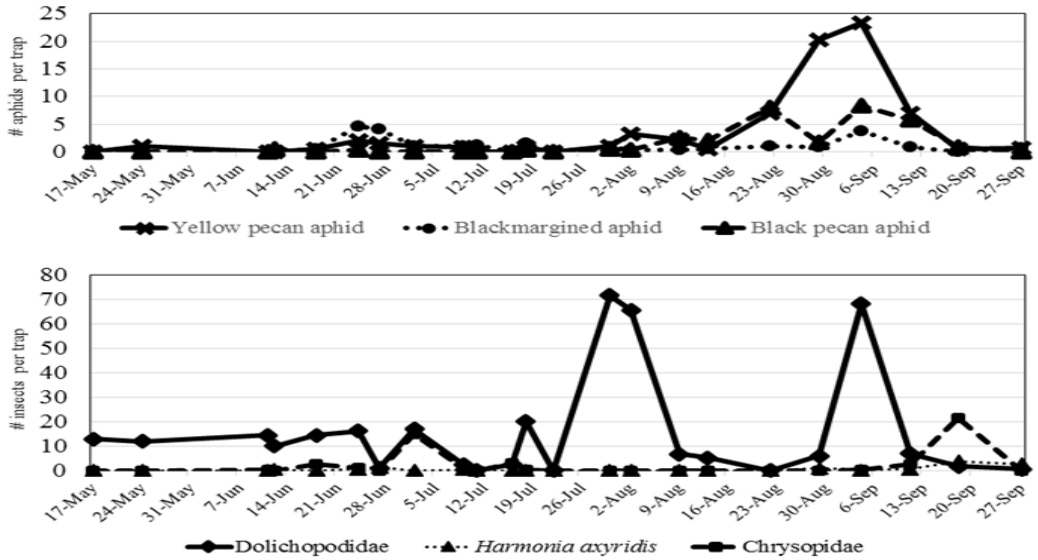
Fig-3. Aphid collected by suction traps carried 0 - 13 nymphs.
Source: Original pictures from field trap collection.



Fig-4. Typical diversity of insects collected on the fine screen of the fan trap.

Source: Original pictures from field trap collection.

Season-long fan trap collections of aphids and aphidophagous insects in the pecan tree canopy



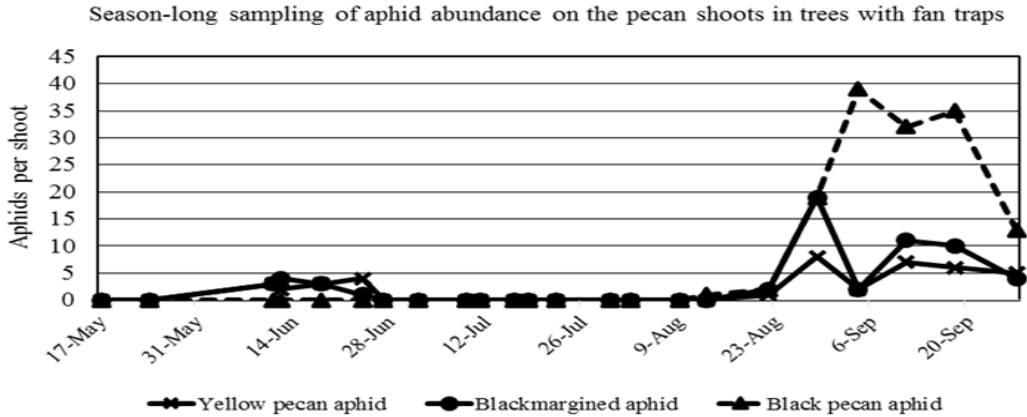


Fig-5. The fan traps collected a sufficient number of insects to estimate seasonal abundance of the three pecan aphids and three aphid predators. Ants were also numerous in the fan trap samples. Comparison to aphid counts in fan trap collections and concomitant shoot samples from the pecan trees indicated that aphids were present
 Source: Original data from field trial reported herein.

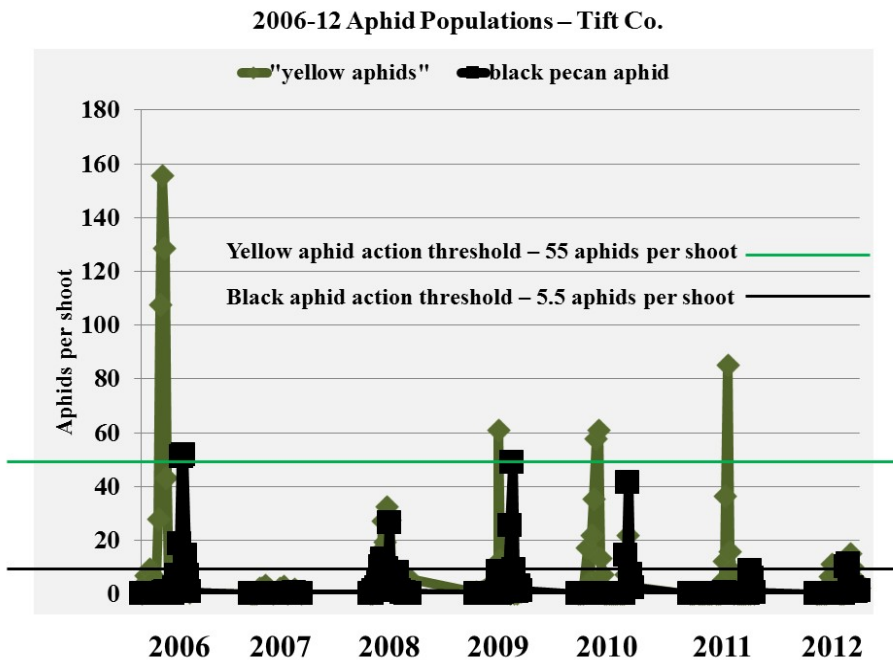


Fig-6. Aphid abundance in pecan trees varies considerable from year to year and often do not exceed treatment thresholds in commercial orchards, thus, effective monitoring methods would prevent the application of insecticide sprays during seasons when natural controls are effective.
 Source: Dutcher, et al. [6]

Seasonal Abundance of Pecan Aphids

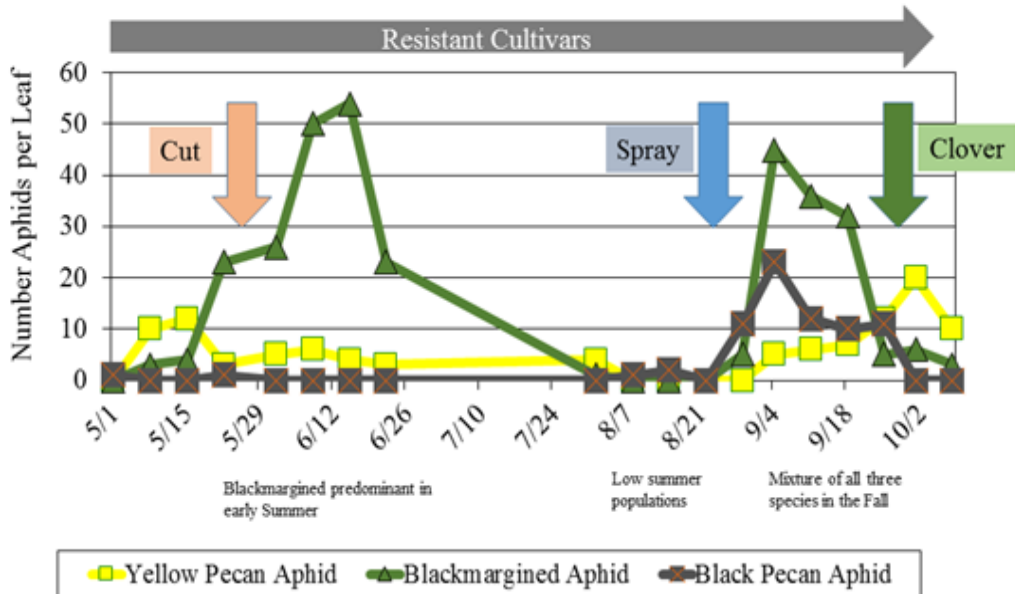
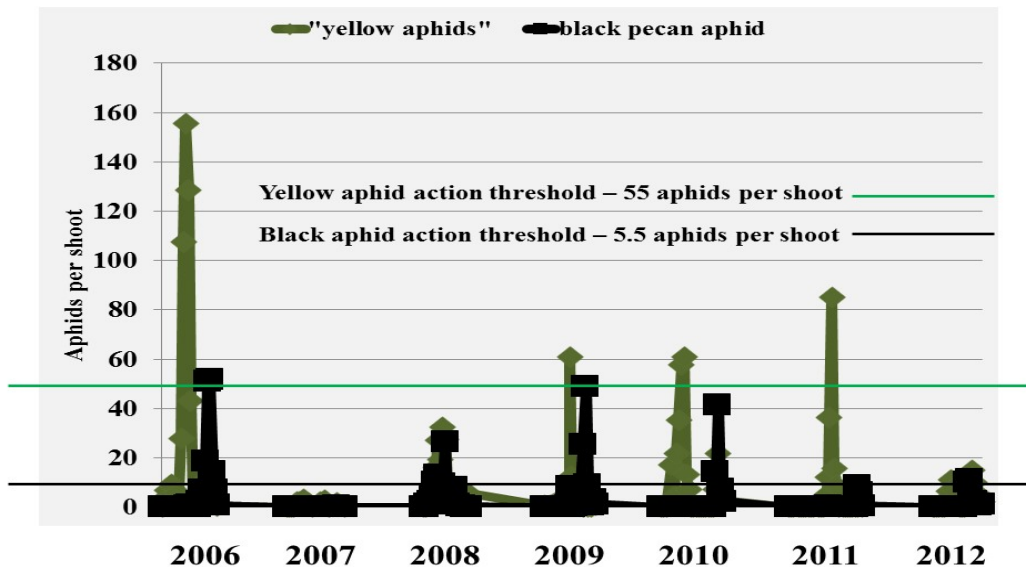


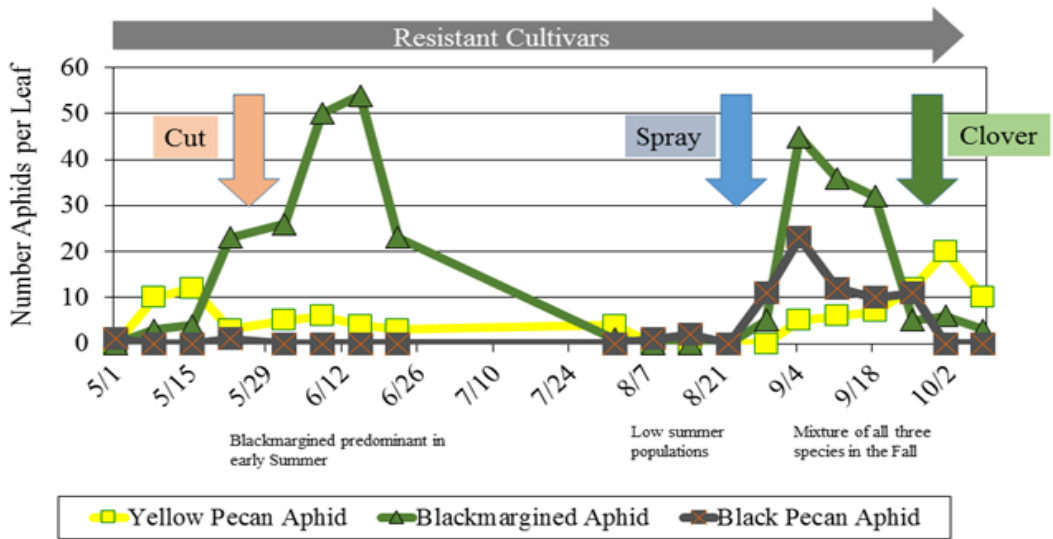
Fig-7. Aphid abundance in the pecan tree canopy varies considerable over the course of the growing season and the timing of biological and chemical controls is more accurate with effective monitoring methods. These controls include cutting intercroops to release aphidophagous insects (“Cut”), spraying insecticides (“Spray”) and planting clover (“Clover”)

Source: Dutcher, et al. [6]

2006-12 Aphid Populations – Tift Co.



Seasonal Abundance of Pecan Aphids



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