IMPACT OF LATE SEASON APHID CONTROL ON PECAN TREE VIGOR PARAMETERS

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(Accepted for publication Nov. 30, 1984)

ABSTRACT

Late season insecticide-based control strategies against the foliar pecan aphid complex which controlled populations of the 3 aphid species, prevented early defoliation of the tree and did not reduce pistillate flower production the following Spring. Pecan trees treated with insecticides which were less efficacious against the pecan aphid complex, defoliated early and had reduced pistillate flower production.

Key Words: Return bloom of pecan, *Monellia caryella* (Fitch), *Monelliopsis pecanis* Bissell, *Melanocallis caryaefoliae* (Davis), *Eotetranychus hicoriae* (McGregor).

J. Entomol. Sci. 20(1): 55-61 (January 1985)

INTRODUCTION

The complex of aphids which infest pecan, *Carya illinoensis* Koch, foliage is composed of three species: *Monellia caryella* (Fitch), *Monelliopsis pecanis* Bissell, and *Melanocallis caryaefoliae* (Davis). Records of the seasonal dynamics of *M. caryella* and *M. pecanis* in Georgia (Dutcher 1983, Tedders 1978) show that two discrete infestation periods occur each season. Early season infestations occur in May and June between the pollination and fruit enlargement phenological stages of the tree. Mid-season population densities during fruit enlargement to shell hardening are typically very low. Vigorous population growth from shell hardening to harvest produces the late season peak in population levels which is usually the most severe infestation. Populations of *M. caryaefoliae* typically infest the pecan foliage at any time from July to harvest and a severe infestation can develop. This general scenerio occurs quite regularly in untreated trees, however, pesticide use can cause resurgence of the aphid complex and alter the seasonal occurence of aphid populations (Dutcher 1983, Dutcher and Payne 1983). Three detailed studies of feeding damage by the three aphid species showed that in addition to removal of carbohydrates (Wood and Tedders 1982, Tedders et al. 1982) the aphids also cause direct damage to the vascular tissue of the leaf (Tedders and Thompson 1981). Pecan aphids can cause premature defoliation of pecan (Tedders 1978). Hand-defoliation of pecan trees early in the season affects return bloom and fruit set (Sparks and Brack 1972), and new shoot growth, kernel quality, pecan size and yield (Worley 1979). Lack of control of aphids and mites accelerated fall defoliation and reduced staminate and pistillate flower production in a three year study of pecan (Dutcher et al. 1984). Trees which retain their foliage late into the fall, especially following a year of high crop yield, tend to have higher yields than trees which defoliate earlier in the fall (Worley 1971).

Two experiments were conducted with selective insecticide treatments to create four late season aphid population regimes and measure the impact of aphid control efficacy on several tree vigor parameters.

METHODS AND MATERIALS

The first experimental plan, at Sumter Co., GA, was a split plot design with three replicates where main plot treatments were the 4 insecticide treatments plus a no insecticide control. Sub-plot treatments were two cultivars. Each main plot contained 4 - 6, 50-year old trees. Main plot treatments were:

1. *Aldicarb + methomyl* — One soil application of aldicarb (Temik® 15G, Union Carbide) at 9.0 kg AI/ha on May 15, 1981 + 4 foliar applications of methomyl (Lannate® 1.8EC, DuPont) at 0.9 kg AI/ha-application, on Aug. 5, 19, 28 and Sept. 8, 1981;
2. *Fenvalerate* — Four applications of fenvalerate (Pydrin® 2.4 EC, Shell) at 0.09 kg AI/ha-application, on Aug. 5, 19, 28 and Sept. 8;
3. *Cypermethrin* — Four foliar applications of cypermethrin (Ammo® 2.5 EC, FMC) at 0.055 kg AI/ha-application, on Aug. 5, 19, 28 and Sept. 8, 1981;
4. *Endosulfan + carbaryl* — Four foliar applications of endosulfan (Thiodan® 50 W, FMC) at 0.45 kg AI/ha-application + carbaryl (Sevin® 80S, Union Carbide) at 1.45 kg AI/ha-application, on Aug. 5, 19, 28 and Sept. 8.
5. *Control* — no insecticide treatment.

All plots were treated with a preventive fungicide spray schedule using benomyl and TPTH following Ga. Coop. Extension Service recommendations (Ellis and Bertrand 1981). The aldicarb granules were applied with a John Deere model 1500 seeder-granule applicator and incorporated about 3 - 6 cm below the soil surface in 4 swaths below the drip line of each tree. Foliar pesticides were applied in 40 - 44 l water per tree with a FMC Model 400 — 1,982 l cap. air-blast orchard sprayer fitted with a pecan volute. The trees were planted to the cultivars "Stuart" and "Schley" in alternate rows on 18 × 18 m spacing. Several response variables were measured in each treatment plot (Table 1). An analysis of variance was calculated for each variable on each sampling date to determine the significance of main- and sub-plot treatment effects.

The second experimental plan, at Turner Co., was randomized complete block design with four insecticide treatments and an untreated control with two replicates and 1 cultivar (Stuart). In each block, two trees were sampled for insects and tree vigor parameters per replicate. Pest population variables were measured weekly from May - Oct. 1982, by sampling two terminals/tree-date. Tree response variables a, c and d (Table 1) were measured during 1982 and 1983 at Turner Co. The following insecticide treatments were applied with a 1,189 l cap. Swanson air-blast orchard sprayer fitted with a pecan volute at 40 - 48 l/tree. Four sprays of each treatment were applied on Aug. 5, 17, 27 and Sept. 3:

1. *Carbaryl* — Sevin® 80S at a rate of 1.45 kg AI/ha;
2. *Fenvalerate* — Pydrin® 2.4 EC at a rate of 0.09 kg AI/ha;
3. *Cabaryl + fenvalerate* — tank mixed at the same rates as in treatments 1 and 2;
4. *Carbaryl + dimethoate* — formulated ad UCSF11 (Union Carbide) at rates of 1.4 kg actual carbaryl + 0.5 kg actual dimethoate per ha;
5. *Control* — no insecticide treatment.

Duter® 50W (Thompson-Heyward) was applied at a rate of 0.36 kg actual TPTH/ha-application as a preventive fungicide to all 5 treatment plots. Statistical analyses were similar to the first experiment.

Table 1. A list of the pest population variables tree response variables measured in 2 experiments from May of the first year to June of the second year.

Variable	Sampling Time-Interval	Sampling Technique(s)
1. Pest population variables		
a. Aphid counts 3 species-adults and nymphs	May 1 - November 1, weekly, 1st yr.	Count/terminal, (a terminal equals the foliage on each year's sheet growth)
b. Leafming Insects - 5 species	May 1 - November 1, weekly, 1st yr.	Count/terminal
c. Pecan Leaf scorch mite counts	May 1 - November 1, weekly, 1st yr.	# Damaged leaflets/terminal
2. Tree response variables		
a. Defoliation rate	Oct. 1 - Nov. 1 weekly, 1st yr.	% leaflet fall from 2 one-year-old branches/tree
b. Yield/tree	Dec., 1st yr.	Weight entire yield/tree of all trees
c. Staminate flower production	April, 2nd yr.	Count/25 one-year old branches-tree (Sparks and Brack 1972)
d. Pistillate flower production	May, 2nd yr.	Count/25 one-year branches-tree (Sparks and Brack 1972)

RESULTS

The insecticide treatments at Sumter Co., produced 3 distinct pecan aphid population levels during the late season after shell hardening (Table 2). The synthetic pyrethroids and aldicarb + methomyl controlled all three aphid species to low population levels. On most sample dates aphid populations could not be detected in the pyrethroid and aldicarb treated trees. All three aphid species were reduced below the control in the endosulfan + carbaryl treated trees. Aphid populations caused honeydew and sooty mold build-up and black pecan aphids damage lesions were numerous on all compound leaves in the samples in the endosulfan + carbaryl treatment. Control trees were infested with large aphid populations which fluctuated between 190 and 609 yellow aphids and 9 and 98 black pecan aphids per terminal during the late season.

Leafminer populations gradually increased during the 1981 season at Sumter Co. to the levels recorded on Sept. 3 (TLM, Table 2). The four common leaf miner species from most to least common in 1981 were *Cameraria caryaefoliella*

Table 2. Relative abundance of certain foliar insect and mite pests of pecan were affected by the insecticide treatments at Sumter Co. 1981.

Treatment	Sample date*	YA	BPA	TLM	PLSM
		No. of indicated pest/terminal†			
1. aldicarb + methomyl	first	10 c	0 c	1.25 C	1.4 a
	second	0 C	0 C		B
2. fenvalerate	first	0 c	0 c	4.8 B	0 b
	second	0 C	0 C		0.23 B
3. cypermethrin	first	0 c	0 c	8.5 A	1.0 a
	second	0 C	0 C		1.8 B
4. endosulfan + carbaryl	first	70 b	8 b	8.2 AB	3.3 a
	second	143 B	21 A		13.8 A
5. control	first	609 a	98 a	8.6 A	3.6 a
	second	298 A	25 A		10.9 A

* The first sample date was Sept. 9 and the second sample date was Sept. 29 for the variables YA, and BPA. The first sample date was Oct. 13 and the second sample date was Oct. 28 for the pest variable PLSM. TLM sample date was Sept. 3.

† YA designates the total number of yellow aphid adults and nymphs; BPA designated the number of black pecan aphid adults and nymphs; TLM designates the total of all 4 spp. of pecan leafminers. PLSM designates the number of leaflets damaged by pecan leaf scorch mites. Means in the same column and sample date which are followed by the same letter are not significantly different at the $P < 0.05$ level (DMRT). Data for YA and BPA were transformed to $\log_{10}(x + 1)$ before analysis. Raw means are listed but analysis refers to the transformed data.

The pecan aphid complex and the serpentine leafminer were the major pests at Turner Co. (Table 3). PLSM populations did not develop to detectable levels at this orchard. The aphid complex developed to a single late season peak in mid-Sept. Yellow aphid resurgence occurred in the carbaryl treated trees and carbaryl did not suppress black pecan aphid populations significantly below levels in the control. The fenvalerate and fenvalerate + carbaryl treatments had very low, season-long aphid and serpentine leafminer *(S. juglandifoliella)* populations. The carbaryl + dimethoate treatment did not suppress the yellow aphid population below the control but did significantly reduce black pecan aphids and serpentine leafminers. Carbaryl reduced serpentine leafminers to an intermediate population level.

Table 3. Relative abundance of certain foliar insect and mite pests of pecan were affected by the insecticide treaments at Turner Co. Sample date* was Sept. 13, 1982.

Treatment	YA	BPA	SLM
	No. of indicated pest/terminal†		
1. fenvalerate	6 c	2 b	1.3 bc
2. carbaryl + fenvalerate	8 c	8 b	0.8 c
3. carbaryl + dimethoate	133 b	3 b	0.9 c
4. carbaryl	382 a	56 a	3.7 b
5. control	167 b	97 a	7.9 a

* The sample date was selected from all weekly scouting reports as the date of peak aphid and leafminer activity.

† YA designates the total for yellow aphid adults and nymphs. BPA designates the total for black pecan aphid adults and nymphs. SLM designates the serpentine leafminer, *Stigmella juglandifoliella* (Clemens), the most common leafminer at Turner Co. Means in the same column followed by the same letter are not significantly different at the $P < 0.05$ level (DMRT). The analysis for YA and BPA were performed on data transformed to $\log_{10}(x + 1)$. Raw means are listed but the analysis refers to the transformed data set.

Sept. Yellow aphid resurgence occurred in the carbaryl treated trees and carbaryl did not suppress black pecan aphid populations significantly below levels in the control. The fenvalerate and fenvalerate + carbaryl treatments had very low, season-long aphid and serpentine leafminer *(S. juglandifoliella)* populations. The carbaryl + dimethoate treatment did not suppress the yellow aphid population below the control but did significantly reduce black pecan aphids and serpentine leafminers. Carbaryl reduced serpentine leafminers to an intermediate population level.

The response of the pecan trees to the insecticide treatments as measured by foliage retention in the fall and staminate and pistillate flower production in the following spring, (Tables 4 and 5) was related to the level of aphid populations in

Table 4. Insecticide treatments affected certain pecan tree response variables at Sumter, Co., GA 1981 - 1982.

	Tree response variable means*			
	1981		1982	
Treatment	Relative degree of aphid control†	Foliage retention (%)‡	No. catkins/ terminal	No. clusters/ terminal
1. aldicarb + methomyl	Excellent	97 a	6.6 a	0.72 a
2. fenvalerate	Excellent	90 a	7.1 a	0.96 a
3. cypermethrin	Excellent	99 a	5.6 a	0.80 a
4. endosulfan + carbaryl	Moderate	80 b	3.8 b	0.36 b
5. control	None	51 c	2.1 c	0.17 c

* Means in the same column followed by the same letter are not significantly different at the $P > 0.01$ level (DMRT). See text for values of other tree response variables.

† See text for detailed description of seasonal dynamics of aphids and other arthropods in treatment plots.

‡ Foliage retention measured as 100×(No. of leaflets retained/No. leaflets orginally) on Nov. 1, 1981.

Table 5. Insecticide treatments affected certain pecan tree response variables in Turner Co. GA 1982 - 1983.

	Tree response variable means*			
	1982		1983	
Treatment	Relative degree of aphid control†	Foliage retention (%)‡	No. catkins/ terminal	No. clusters/ terminal
1. fenvalerate	Excellent	96 a	§	0.99 a
2. carbaryl + fenvalerate	Excellent	96 a		0.88 a
3. carbaryl + dimethoate	Moderate	83 b		0.84 ab
4. carbaryl	Poor	70 c		0.60 b
5. control	None	59 d		0.19 c

* Means in the same column followed by the same letter are not significantly different at the $P > 0.05$ level (DMRT). See text for values of other tree response variables.

† See text for detailed descriptions of seasonal dynamics of aphids and other arthropods in treatment plots.

‡ Foliage retention was measured on Oct. 20, 1982.

§ No significant differences were found between treatments in staminate flower production and the overall mean ± s.d. was 4.83 ± 2.32 catkins/terminal.

the insecticide treatments. The treatments which reduced the aphid complex to the lowest level had the greatest foliage retention and the highest production of staminate and pistillate flowers at Sumter Co. and highest production of pistillate flowers at Turner Co.

The tree responses at Sumter Co. were also related to peak PLSM damage levels but these mite populations developed late in the season on foliage which was already severely damaged by aphid feeding in the control and endosulfan + carbaryl treatments. The three group mean separation of foliage retention, staminate and pistillate flower productions means at Sumter Co. corresponds more closely with the three group mean separation of the yellow aphid population means on the first and second sample dates than with the 2 group mean separation of PLSM damage means.

In the absence of PLSM damage at Turner Co. (Tables 3 and 5) the combination of high yellow pecan aphid and high black pecan aphid populations in the control and carbaryl treatments had the most detrimental effect on tree vigor. The lowest pistillate flower production, in the control trees, may have been due to the additive effect of damage by all three major foliage pests. The vigor of trees treated with carbaryl + dimethoate, which had high yellow and low black pecan aphid population levels, was sufficient to produce a high number of pistillate flowers.

Yield on trees at Sumter Co. was quite variable (mean + s.d. yield/tree was 19 ± kg/tree) and no significant treatment differences were found. Yield at Turner Co. was not measured since the harvest was not controlled at this commercial site. Grower's records indicate a yield of 46 kg/ha.

DISCUSSION

The late season foliar insect and mite pest complex is of considerable concern to pecan producers because of the impact of high pest populations on foliage retention and tree vigor and production. The tree responses to the late season aphid regimes created at Sumter and Turner Co.'s indicated that large trees in commercial plantings respond to premature defoliation caused by a lack of foliar insect control by reducing flower production the following spring. These results also corroborate previous work (Dutcher et al. 1984) and indicate that pecan trees which are not exposed to foliar insect and/or mite feeding damage will consistently produce pistillate flowers the following season if all other stress variables are minimized through appropriate cultural methods.

ACKNOWLEDGMENTS

I thank Drs. R. E. Worley and R. H. Littrell and Messrs. K. Harrison, Hilton Segler and R. H. Heyerdahl for professional and technical assistance in conducting the experiments.

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