TRUNK INJECTION OF DICROTOPHOS AND TRUNK IMPLANTATION OF ACEPHATE TO CONTROL FOLIAR PECAN PESTS

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Abstract. Pecan trees treated with low pressure trunk injection of dicrotophos retained 33-76% of their foliage in late fall and control trees retained only 15%. Two injections increased foliage retention at the 2 gm/15 cm trunk circumference rate over a single injection. Treatments of dicrotophos had the most significant impact on populations of the black-pecan aphid, and yellow aphids. Acephate trunk implantation was not effective in controlling foliar pecan insects.

Pecan, *Carya illinoensis* Koch, is often planted in the Southeastern U.S. as a shade tree in backyards and along city streets. Several foliage inhabiting insects and diseases cause leaf scorch and early defoliation if they are not controlled (Payne et al. 1979). Early defoliation before November 1 can cause yield reduction the following season (Worley 1979). Effective control methods are available for commercial pecan producers which cannot be applied practically or legally to urban plantings. Trunk injection of dicrotophos has been efficacious against foliar pecan insects in Georgia (Polles and Harper 1977, & Littrell et al. 1978). The purpose of our research was to determine the effectiveness of low pressure injection of dicrotophos and trunk implantation of acephate against foliar pecan insects and mites in trees used for shade. We also determined the effect of insect feeding on foliage retention in the fall.

Methods an Materials

Two experiments were conducted during 1979 in mature pecan orchards in Plains and Tifton, GA. At Plains, 5 treatments were applied 2 times (at bud break on 16 April and on 13 July) to 3 single tree ('Stuart' variety) replicates in a completely randomized design. Treatments were: 1) untreated control; 2) liquid benomyl (Lignasan®) at 14 g ai in 2 liter form./tree; 3) liquid benomyl at 14 g ai/tree plus dicrotophos (Bidrin®) at 4 g ai/15 cm trunk circumference; 4) dicrotophos at 4 g ai/15 cm trunk circumference; 5) Acephate at 1 g/10 cm trunk circumference. Liquid benomyl, a systemic fungicide and dicrotophos, a systemic insecticide, were injected into the trunk with a low pressure injection system (Worley et al. 1980). Dicrotophos was carried in 2 liters of water and benomyl was applied as 2 liters of formulation without water. All injections were made between 10 am and 5 pm. The rate of dicrotophos applied was dependent on the total circumference of the trunk and major scaffold limbs of each tree and is, herein, referred to as trunk circumference. Acephate, a systemic insecticide, was applied by placing a gelatin capsule (Orthene Medicap® , 97% active incredient, Creative Sales, Inc., Fremont, Nebraska 68024) into a hole drilled 2.5 cm into the tree trunk. Holes were drilled around the trunk base, 1 m above the ground every 10 cm and a capsule was implanted in each hole. The holes were then covered with grafting compound for protection. The population density or incidence of damage of the arthropods listed in the documentation found below Table 1 was estimated by sampling 5 compound leaves/tree on each sample date (6, 11 June; 9, 15, 29 August) and examining the leaves for insects and/or damage. Defoliation was measured by counting the number of leaves and leaf scars and the number of leaflets and leaflet scars on 10 growth terminals/tree on 11 October, when leaf fall was beginning to occur in the treated trees.

At Tifton, dicrotophos was tested at 2 dosages: 1X rate (2 g ai/15 cm trunk circumference) and 2X rate (4 g ai/15 cm trunk circumference). Each rate was tested at 1 application/year (on 13 April) and at 2 applications/year (on 13 April and on 29 June). Injections were made with the same equipment used at Plains. The 4 insecticide treatments were compared to a control in a randomized complete block design with 4 blocks. Three blocks contained 'Schley' variety trees and 1 block contained 'Frotscher' variety trees. All trees were mature (> 30 years old) and planted in an urban area. All trees were treated twice (on 17 April and 10 May) with benomyl at .4 lbs ai/A as a foliar spray to prevent disease. Insects were sampled in the same manner as at Plains on 20 April, 10 and 15 May, 4 June and 10 and 12 September and defoliation was measured on 22 October and on 12 November by sampling 10 growth terminals/tree as at Plains. All data were analyzed for treatment differences by Duncan's Multiple Range Test.

Results

At Plains on 6 June (Table 1) pecan leaf scorch mite damage (EHD) was lower in trees treated with benomyl and dicrotophos than in the untreated control. *Mn. costalis* adults (MCA) were only found in the control trees. No treatment differences were found in population levels of leafminers, other aphids, or leaf phylloxera. On 11 June (Table 2) leaf phylloxera counts were not continued as damage occurs after bud break during leaf expansion. Dicrotophos reduced damage by and incidence of black pecan aphids (SBA) in trees treated with benomyl. *Mn. costalis* adults (MCA) populations levels were reduced by dicrotophos treatment in trees treated with benomyl and in trees without fungicide treatments. On August 9 (Table 3), after the second injection, black pecan aphid damage (BAD) was higher in the control than in all treated trees. Total yellow aphid counts (SYA) were reduced by dicrotophos treatments, and not by acephate treatments. On 15 August (Table 4) total yellow aphid counts (SYA) in the benomyl treated trees were much higher in the other treatments and the control. Mines of *P. caryaefoliella* (UBLM) were more abundant in control trees than in trees treated with dicrotophos on August 15. On 29 August (Table 5) leafminer counts were discontinued and pecan leaf scorch mite damage was not distinct due to high aphid populations in all treatments. No significant differences were found between treatments in yellow aphid counts, and black aphid damage (BAD) was lower in the control and benomyl + dicrotophos treated trees in the acephate treated trees. The cumulative ef-

Table 1. Mean insect* counts/5 compound leaves on foliage of pecan trees treated with trunk injection or implantation of certain pesticides, Plains, Ga., 6 June 1979.

Treatment	*MCA*	*EHD*
Control	.67 a	20 a
Benomyl	0 b	13 ab
Dicrotophos	0 b	8.0 ab
Benomyl + Dicrotophos	0 b	5.3 b
Acephate	0 b	7.0 ab

* *Documentation for insect abbreviations in tables 1-5:* UBLM — Upper-blotch leafminer; MNA — Yellow aphid, *Monelliopsis nigropunctata* adults; MCA — Yellow aphid *Monellia costalis* adults; YAN — Yellow aphid nymphs, *M. nigropunctata* nymphs + *Mn. costalis* nymphs; SYA — Sum yellow aphids, MNA + MCA + YAN; TCA — Black pecan aphid, *Tinocallis caryaefoliae* adults and nymphs; BAD — Black aphid damage sites, chlorotic lesions or scorch; SBA — Sum black aphids, TCA + BAD; PN — *Phylloxera notabilis* galls; EHD — Pecan leaf scorch mite, *Eotetranychus hicoriae* damage, leaflets curled and mites present.

Table 2. Mean insect* counts/5 compound leaves on foliage of pecan trees treated with trunk injection or implantation of certain pesticides, Plains, Ga., 11 June 1979.

Treatment	*MCA*	*TCA*	*SBA*
Control	5.0 a	1.7 b	4.3 ab
Benomyl	6.3 a	14 a	21 a
Dicrotophos	.67 b	1.3 b	1.3 b
Benomyl + Dicrotophos	.67 b	1.0 b	1.3 b
Acephate	1.7 b	5.7 ab	6.7 ab

*See documentation below Table 1 for insect specifies names which correspond to each column. Means in the same column followed by similar letters are not significantly different at the p = .05 level. No significant differences were found between treatments for population levels of UBLM, MNA, YAN, SYA, BAD and EHD. PN levels were not counted.

Table 3. Mean insect* counts/5 compound leaves on foliage of pecan trees treated with trunk injection or implantation of certain pesticides, Plains, Ga., 9 August 1979.

Treatment	*YAN*	*SYA*	*BAD*	*SBA*
Control	17 a	19 a	6.7 a	7.0 a
Benomyl	18 a	21 a	0 b	.67 b
Dicrotophos	1.3 b	2.7 c	0 b	0 b
Benomyl + Dicrotophos	3.3 b	4.3 bc	0 b	0 b
Acephate	8.0 ab	9.0 abc	0 b	1.0 ab

*See documentation below Table 1 for insect species names which correspond to each column. Means in the same column followed by similar letters are not significantly different at the p = .05 level. No significant differences were found between treatments for population levels of UBLM, MNA, MCA, TCA, EHD. PN levels were not counted.

Table 4. Mean insect* counts/5 compound leaves on foliage of pecan trees treated with trunk injection or implantation of certain pesticides, Plains, Ga., 15 August 1979.

Treatment	*UBLM*	*MNA*	*YAN*	*SYA*
Control	1.0 a	.67 ab	8.0 b	9.0 b
Benomyl	.67 ab	3.3 a	41 a	45 a
Dicrotophos	0 b	0 b	1.7 b	1.7 b
Benomyl + Dicrotophos	0 b	.67 ab	12 b	13 b
Acephate	.33 ab	.33 ab	4.0 b	4.7 b

*See documentation below Table 1 for insect species names which correspond to each column. Means in the same column followed by similar letters are not significantly different at the p = .05 level. No significant differences were found between treatments for population levels of MCA, TCA, BAD, SBA, EHD. PN levels were not counted.

fects of season long aphid and mite activity can be seen in the relative degree of defoliation in the fall in each treatment (Table 6). On October 11, at Plains defoliation was nearly complete in the control, benomyl and acephate treated trees. In trees treated with dicrotophos the greater portion of the foliage was retained.

At Tifton population levels of the yellow aphids were relatively low and no significant differences in population levels were found between treatments throughout the season. The first application of dicrotophos reduced black pecan aphid damage (BAD) early in the season (Table 7). Two applications of dicrotophos were needed to control black pecan aphids season long (Table 8). No significant difference was found between the 1X and 2X rates with 2 applications/year. Defoliation on 22 October (for 'Schley' blocks) and on 12 November (for 'Frotscher' blocks) was reduced below the control by all treatments of dicrotophos (Table 9). No significant differences were found between 1X and 2X rates at 1 application or 2 applications. The 1X rate with 2 applications reduced defoliation below the level in trees treated with the 1X or 2X rates with 1 application.

Discussion

Foliage damage by the black pecan aphid, *T. caryaefoliae*, appears as a chlorotic lesion and scorch and causes serious premature defoliation following a population outbreak. The yellow pecan aphids, *Mn. costalis* and *M. nigropunctata*, cause excessive honeydew build-up on the foliage and black sooty mold grows on the honeydew across the leaf surface which reduces light penetration to the leaf chloroplast. Defoliation does not usually immediately follow a population outbreak of yellow pecan aphids as in black pecan aphid outbreaks. The 4 species of leafminers which commonly occur on pecans often occur at outbreak levels and their damage impact is not known. The pecan leaf scorch mite, *E. hicoriae*, has a significant damage potential which is comparable to the black aphid. Trunk injection of dicrotophos had the most significant impact on aphid and mite populations. Except for a slight decrese in UBLM abundance on August 15 at Plains in the dicrotophos treated trees (Table 4), leafminer populations were not af-

Table 5. Mean Insect* counts/5 compound leaves on foliage of pecan trees treated with trunk injection or implantation of certain pesticides, Plains, Ga., 29 August 1979.

Treatment	*BAD*	*SBA*
Control	57 b	61 ab
Benomyl	151 ab	154 ab
Dicrotophos	56 ab	59 ab
Benomyl + Dicrotophos	27 b	28 b
Acephate	182 a	183 a

*See documentation below Table 1 for insect species names which correspond to each column. Means in the same column followed by similar letters are not significantly different at the p = .05 level. No significant differences were found between treatments for population levels of UBLM, MNA, MCA, YAN, SYA, TCA. PN levels were not counted and EHD was not distinct due to high aphid population levels.

Table 6. % Defoliation = (# of leaflets remaining/# of leaflets originally) X 100 on October 11, for trees treated with trunk injection or implantation of certain pesticides, Plains, Ga., 1979.

Treatment[1]	*Mean % defoliation*[2]
Control	89 a
Benomyl	85 a
Dicrotophos	26 b
Benomyl + Dicrotophos	36 b
Acephate	88 a

[1]See text for treatment formulations and rates.

[2]Means followed by similar letters are not significantly different at the p = .05 level.

Table 7. Number of black pecan aphid damage sites/10 compound leaves (BAD) control and trees treated by low pressure injection of dicrotophos, Tifton, GA. 10 May 1979.

Treatment[2]	*rate (ml/6" trunk circ.)*	*BAD*[1]
Control		8.50 a
Dicrotophos	2	1.50 b
Dicrotophos	4	0.25 b

[1]Means of 8 replicates followed by similar letters are not significantly different at the p = .05 level (LSD test).

[2]Single application on April 13, 1979.

Table 8. Number of live black pecan aphids/5 compound leaves (LBA) in control and dicrotophos treated trees, Tifton, GA. 10 September 1979.

Treatment	*rate (ml/6" (trunk circ.)*	*No. applications*[1]	*LBA*[2]
Dicrotophos	4	1	117 a
Control	—	—	95 ab
Dicrotophos	2	1	63 b
Dicrotophos	4	2	12 c
Dicrotophos	2	2	5 c

[1]1st low pressure trunk injection date was 13 April 1979. 2nd injection date was 29 June 1979.

[2]Mean of 4 replicates followed by similar letters are not significantly different at the p = .05 level (DMRT Test).

Table 9. % Defoliation = (# of leaflets remaining/# of leaflets originally) × 100 evaluated on 22 October 1979 for replicates 1.2 and 3 and on 12 November 1979 for replicate 4., Tifton, GA. 1979.

Treatment	(ml/6" trunk circ.)	No. applications[1]	Mean % defoliation[2]
Control	—	—	85 a
Dicrotophos	4	1	60 b
Dicrotophos	2	1	59 b
Dicrotophos	4	2	49 bc
Dicrotophos	2	2	37 c

[1] 1st low pressure injection date was 13 April 1979. 2nd injection date was 29 June 1979.

[2] Means of 4 replicates followed by similar letters are not significantly different at the p = .05 level (DMRT Test).

fected by trunk injection of dicrotophos. At Plains, some yellow aphid efficacy was observed on 15 August and no efficacy for black or yellow aphids was observed on 29 August indicating that dicrotophos injection is effective for 8-10 weeks after the initial injection (compare Table 4 to Table 6). Benomyl did not enhance foliage retention in the fall when injected with dicrotophos indicating that insects and mites had a greater impact on foliage retention than disease. Pecan scab infections were very low in 1979 at Plains and the differential impact of diseases and insects on foliage retention could shift in a moderate to heavy scab infection or infection from other foliar diseases. The 'Stuart' variety trees used in our study are somewhat tolerant to pecan scab. The ineffectiveness of acephate may be due to the low rate used relative to dicrotophos.

At Tifton, yellow aphid and pecan leaf scorch mite populations never reached economically important population levels in the 'Schley' or 'Frotscher' block. The first injection of dicrotophos greatly reduced damage by the black pecan aphid early in the season (Table 7) and a second application was required to control late season black pecan aphid populations (Table 8). Two applications of the 2X rate of dicrotophos adequately controlled these light foliar insect infestations at Tifton.

The injection process is time consuming and is only useful for foliage insect control in small urban plantings where air-blast equipment is impractical or illegal. Absolutely no control of nut infesting insect pests (pecan weevil and hickory shuckworm) was achieved by trunk injection of dicrotophos at the rates tested in our experiment. Prevention of premature defoliation and increased value of the tree for shade are the only advantages of this control method.

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