Effect of Planting Site Preparation, Hydrated Lime, and DBCP (1, 2-dibromo-3-chloropropane) on Populations of *Macroposthonia xenoplax* and Peach Tree Short Life in Georgia

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Abstract: Annual postplant applications of 40.7 kg/ha DBCP (1,2-dibromo-3-chloropropane) controlled *Macroposthonia xenoplax* (Raski, 1952) deGrisse and Loof, 1965 in peach tree short life sites, reduced bacterial canker incidence from 74% to 6%, and increased the average life of the trees from 3.9 to 6.8 yr for a 7-yr test period. Hydrated lime at 5.5 kg per planting site reduced bacterial canker incidence from 81% to 57% and increased the tree longevity from 2.6 to 6.0 yr. Populations of *M. xenoplax* were inversely correlated with tree longevity. *Key words:* control, interactions.

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Peach tree short life (PTSL) is a serious problem in the southeastern United States (3,14,16,18,27,30) and in California (5,11). Factors influencing the problem include winter injury (3,16,18), pruning date (4,17, 18), rootstock (3,11,18,28,30), soil fungi (18, 22), lime (15,18,20,27), soil preparation (18, 19), bacterial canker (5,11,18,25), and nematodes 2,9,18,27).

A ring nematode, *Macroposthonia xenoplax* (Raski, 1952) deGrisse and Loof, 1965, is widespread in the Southeast and in California peach orchards (2,11,13,22,25,27,30). Population levels of *M. xenoplax* have been correlated negatively with yield and positively with tree death from PTSL (27). Another ring nematode, *M. curvatum* (Raski, 1952) deGrisse and Loof, 1965, has also been reported as a factor of peach tree decline in New Jersey (9).

Preplant (1,3,5,7,8,18,19,22) and postplant (3,13,27,30) soil fumigation to control nematodes reduced PTSL, but the postplant fumigation was more effective (27). Soil fumigations combined with large planting holes prepared with a backhoe increased tree growth and survival in California (19).

Weaver and Wehunt (24) demonstrated that peaches (*Prunus persica* Batsch) were highly resistant to bacterial canker when grown in soil limed to raise the pH from 5.6 to 6.1. A similar reduction in susceptibility of peach to bacterial canker disease was also attributed to high soil pH by Vigouroux and Huguet (23). The results of other studies have shown that application of various types of lime incorporated 15–20 cm in the soil increased (20), decreased (29), or had no effect (6,7,15) on peach tree longevity. Dolomitic limestone incorporated 15–20 cm in combination with nitrogen fertilizer reduced the percentage of dead trees (15). Incorporation of dolomitic limestone to 36–41 cm increased longevity (15).

The purpose of our experiments was to test the effects of combinations of planting hole preparation, hydrated lime, and soil fumigation of peach trees grown on PTSL sites in Georgia.

MATERIALS AND METHODS

A replicated experiment was established in a severe PTSL site in Crawford County, Georgia, in March 1973. Planting sites, 5.5 m apart in rows 6.1 m apart, were prepared with a tractor-mounted earth auger 60 cm in diameter and 90 cm long. Treatments were (a) one auger hole (0.28 m^3) per site, (b) five holes per site clustered to form a planting hole of 1.4 m^3 volume, (c) five clustered holes per site plus lime at 0.45, 2.76, or 5.5 kg/site, and (d) 3.5 ml DBCP in each limed hole (17.5 ml DBCP per planting hole). The hydrated lime (400 mesh with 84% CaO) was sprinkled by hand onto the soil as it was expelled by the auger.

Two weeks after the preplant treatments were imposed, the soil was shoveled back into the hole and peach trees, 'Babygold 5' on "cannery" (unknown parentage) rootstock, were planted. On 20 April 1973, DBCP at 40.7 kg/ha was applied 20 cm deep with a tractor-drawn applicator with chisels

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30 cm apart in a 2.1-m-wide band on each side of two rows in each experiment. Subsequent postplant applications of DBCP at the same rate and method of application were made to the same rows each November.

Plots were single tree sites. The rows contained unequal numbers of trees so there were unequal numbers of replications in the experiment, but treatments were replicated at least five times.

Horticultural and weed, disease, and insect control practices were according to recommendations of the University of Georgia Cooperative Extension Service. Tree pruning and fruit thinning were done by contracted labor, which is customary in middle Georgia commercial peach orchards.

A 5-cm-d soil core to the 60-cm depth was taken from within the planting holes of selected trees twice each year, usually in April and October. The soil core was divided into two parts, and from each half a 50-cm^3 subsample was assayed for pH and a 150-cm^3 subsample was assayed for nematodes. Subsamples were assayed for fungi, bacteria, and actinomycetes, but no trend could be seen and these assays were discontinued after 3 yr.

Soil samples were also taken from the 2.1-m band that was postplant fumigated with DBCP and from the comparable area in nontreated rows. Four 2-cm-d cores to the 30-cm depth were taken from each tree and nematodes were extracted from a 150-cm^3 subsample by the centrifugation method (10) after pretreatment with Electrosol[R] (Economics Laboratory, St. Paul, Minnesota) (26) and pH determined from a 50-cm^3 subsample. Tree growth, mortality, and cause of tree death were recorded annually.

A planting was made in a Peach County PTSL site in October 1973 to demonstrate the effect of planting site preparation, hydrated lime, and postplant application of DBCP on tree growth and death and *M. xenoplax* populations. A motorized road grader was used to make four "V" shaped ditches about 1 m deep, 3 m wide, and 237 m long. Hydrated lime (84% CaO, 400 mesh) at 17.6 MT/ha was incorporated by repeated disking into the expelled soil of two of the ditches. The soil-lime mix was then pushed back into the ditches to form a mounded row. The nonlimed soil from the other two ditches was similarly replaced and mounded. A furrow 30 cm deep made with a subsoil plow simulated a standard planting row and served as the control. The rows were spaced 6.1 m apart. Nursery grown peach trees, Babygold 5 on cannery rootstock, were planted 3.2 m apart in the row in January 1974. The soil pH was near 6.0 in the limed rows in the summer of 1974; we applied an additional 134 kg of lime to the soil surface which raised the soil pH to 7.0. One of the limed and one of the nonlimed ditch-mounded rows received annual applications of DBCP at 40.7 kg/ha in a 2.1-m band on each side of the row.

Tree growth, mortality, and cause of tree death were recorded annually. Nematode populations in the soil around eight trees per treatment were determined twice each year as in the Crawford County experiment.

When data contained zero values, all data was transformed to $\sqrt{x + .5}$ before the analysis of variance was calculated. Significance of differences among treatment means were determined by LSD following methods of Steel and Torrie (21). Tree death date in the Peach County experiment was subjected to chi square analysis (21).

RESULTS

Experiment 1—effect of nematicide: Preplant application of DBCP in the excavated holes suppressed the populations of *M. xenoplax* temporarily. Annual postplanting applications of DBCP suppressed populations of the nematode throughout the experimental period. Average populations of *M. xenoplax* were 483/150 ml soil for the test period in the non-postplant sites, while in the sites receiving the postplant treatment the average populations were 152/150 ml soil (Table 1).

Tree growth was better in the sites receiving postplant DBCP than in sites not receiving the treatment. When sites that received 2.7 or 5.5 kg hydrated lime and preplant DBCP also received postplant DBCP, tree growth was reduced for the first 2 yr after planting.

Preplant DBCP reduced tree death due to bacterial canker only slightly (Table 1).

Table 1. Effect of site preparation, hydrated lime, and DBCP (1,2-dibromo-3-chloropropane) on survival of peach trees on a short life site in Crawford County, Georgia, after seven years.*

	Preplant treatment		Trees killed by bacterial canker (%)		Average tree longevity (yr)		Macroposthonia xenoplax per 150 ml soil	
	Lime† (kg)	DBCP† (ml)	Postplant fumigated†	Not postplant fumigated	Postplant fumigated	Not postplant fumigated	Postplant fumigated	Not postplant fumigated
Small hole† ($0.3\ m^3$)	0	0	10.5	81.3	6.1 a‡	2.6 de	213 cd	582 ab
Large hole† ($1.4\ m^3$)	0	0	10.5	76.7	6.8 a	3.4 d	255 cd	571 ab
	0.5	0	0	88.9	7.0 a	1.8 e	170 cd	458 ab
	0.5	17.5	0	77.8	7.0 a	3.9 cd	187 cd	515 ab
	2.7	0	0	76.5	7.0 a	3.2 d	88 cd	589 a
	2.7	17.5	0	64.3	6.8 a	4.5 bc	80 cd	484 ab
	5.5	0	0	57.1	6.6 a	6.0 ab	120 cd	430 ab
	5.5	17.5	25.0	28.6	7.0 a	6.0 ab	94 d	238 bc

*Trees that died from causes other than bacterial canker were not included in statistical analysis.
†See text for details.
‡Means of tree longevity and *M. xenoplax* populations followed by common letters do not differ significantly as determined by LSD (least significant difference) ($P = 0.05$).

However, postplant DBCP reduced death due to bacterial canker from 73.6% to 6.4%. The average longevity of the trees was 3.9 yr in the sites not receiving postplant DBCP, whereas in the sites receiving annual postplant DBCP, the average age of the trees was 6.8 yr (Table 2).

Experiment 1—effect of hydrated lime: Preplant applications of hydrated lime at 5.5 kg/planting hole raised the soil pH from 4.8 to 7.1 and significantly reduced the population of *M. xenoplax* for 3 yr after application.

Table 2. Effect of planting site preparation, hydrated lime, and DBCP (1,2-dibromo-3-chloropropane) on tree trunk size, percent peach tree death, and *Macroposthonia xenoplax* populations on a short life site in Peach County, Georgia, after seven years.

Treatment	Tree trunk (mm)	Tree death (%)	*M. xenoplax* population (per 150 ml soil)
Furrow	49.8 d*	45	271.9 a
Ditch	78.3 b	26	357.4 a
Ditch + lime†	91.4 a	29	270.5 a
Ditch + DBCP	64.4 c	8	100.1 b
Ditch + lime + DBCP	83.0 ab	29	86.6 b

*Means followed by common letters do not differ significantly as determined by LSD (least significant difference) ($P = .05$).
†400 mesh hydrated lime (84% CaO).

Hydrated lime at 0.5 and 2.7 kg/planting hole did not greatly affect bacterial canker incidence. Lime at 5.5 kg/planting hole reduced bacterial canker from 76.7% to 57.1%. However, in sites receiving both 5.5 kg lime and preplant and postplant DBCP, bacterial canker incidence increased (Table 1). Excluding tree death caused by phony peach, peach tree borers, and clitocybe root rot, trees treated with 5.5 kg lime lived for an average of 6.0 yr, whereas trees receiving 2.7, 0.5, or no lime lived for 1.8–4.5 yr (Table 1).

Experiment 1—effect of planting-hole size: The drilling of five holes with the auger did not reduce nematode populations below those in sites prepared with one auger hole. However, the number of healthy trees in sites prepared by drilling five holes were greater (23.3%) than in sites prepared by drilling a single hole without postplant DBCP (9.3%). When postplant DBCP was applied, 47.4% of the trees in the single hole sites were healthy, while in the five hole sites, 68.4% of the trees were healthy.

Experiment 2: The effect of the ditch-mounded site preparation, lime, and postplant fumigation reduced tree death due to bacterial canker from 81% to 57%.

CONCLUSIONS

We controlled PTSL by annual applications of DBCP on two sides of peach trees. The incidence of bacterial canker, which was directly responsible for most tree death in these experiments, has been reduced by fumigation in California (5,11,19), Georgia (1,22,27), North Carolina (3,18), South Carolina (13,30), and Texas (7). The ring nematode, *M. xenoplax,* was present and usually predominant in the experimental sites. Furthermore, it was usually the only factor associated with tree death. In our test, *M. xenoplax* was the predominant nematode and populations correlated negatively with tree death ($r = -0.88$), strongly indicating association of the nematode with tree death. Winter injury (3,16, 18), pruning date (4,17,18), and rootstock (3,11,18,28,30) influence susceptibility of peach trees to PTSL. These factors were uniform in our tests. The causal agent of bacterial canker, *P. syringae,* was isolated from healthy and diseased trees sampled in a previous test on the site (25); thus, the inoculum was present in all trees.

Liming the soil has been reported to reduce PTSL incidence, but in studies in Georgia, applications of dolomitic limestone failed to influence PTSL incidence except when incorporated 14–16 inches (36–41 cm) deep (15). Applications of 2.3 kg hydrated lime per tree reduced PTSL, but data were not subjected to statistical tests (20). In our tests, 5.5 kg of hydrated lime per tree site reduced PTSL but 2.7 and 0.45 kg per tree site did not. Hydrated lime reduced the population of *M. xenoplax,* further implicating this nematode in the PTSL syndrome.

In the Peach County test, the soil pH of the ditch treatment was 4.3, while in the ditch plus lime treatment, soil pH was 6.1 by October 1977. The combination of lime and postplant DBCP was more effective in controlling ring nematodes, *M. xenoplax,* than was lime alone but was no more effective in reducing tree death. DBCP postplanting alone greatly reduced both nematode populations and peach tree death. The Peach County test was admittedly not a standard experimental design, but we feel that the data are valid estimates of treatment effects. Hydrolysis of DBCP in the presence of high concentrations of lime as reported by McKenry and Naylor (12) might have been manifest in these tests and might have reduced the influence of DBCP in reducing tree death.

Our results show that annual postplant applications of 40.7 kg/ha DBCP controls PTSL on a severe short life site in middle Georgia. They also show that the application of high rates of hydrated lime reduces PTSL. Populations of *M. xenoplax* were correlated negatively with peach tree longevity.

Application of lime to acid soils is a long-standing practice in most agricultural areas. Although all benefits of lime are not well understood, the outstanding merits are enchancement of plant nutrient availability and addition of calcium to the root environment. The nematicidal effect of hydrated lime is of additional value, and further research is needed to assess the value of this form of lime in management of nematode problems.

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