PHYTOTOXICITY OF AZINPHOSMETHYL (GUTHION®) TO LOBLOLLY PINE NEEDLES AND BRANCHES

Azinphosmethyl is unlikely to have a direct role in the dieback troubling Southern pine seed orchards. It could possibly aggravate dieback, but it does not cause it.

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In 1975 an acute dieback of loblolly pines (*Pinus taeda* L.) was detected in two commercial seed orchards at widely separated localities near Washington, N.C., and McNair, Miss. Unprecedented in its dimensions, the dieback affected over half of more than 2,000 trees in the Mississippi orchard and 70 percent of one geographical source in the North Carolina orchard. Among susceptible clones, 90 to 100 percent of the ramets were damaged. While little mortality ensued, cone crops declined sharply.

Symptoms of the dieback were heralded by branch flagging in late fall, and damage appeared predominantly in the upper crowns. Additional symptoms included defoliation, resin-soaked shoots, and sporadic wilting of new growth in spring.

Recent research indicates that the dieback is caused by a disease organism (*4*)[1], but its sudden appearance and severity prompted considerable speculation over potential causes (*6*). In 1974 an Outbreak of needle-feeding midges, *Contarinia* sp., at a seed orchard in Brooklyn, Miss. was believed to be associated with the seasonal use of the insecticide dimethoate.[2] Therefore it appeared that another insecticide, azinphosmethyl,[3] might be implicated at McNair, where midges were also building up despite annual treatment of the orchard with this compound for cone and seed insect control. Apprehensions also developed among orchard managers that this chemical might be involved directly with the dieback. In 1976 we therefore installed a study to determine if repeated applications of azinphosmethyl or the aromatic solvents used as carriers in two of the commercial formulations were phytotoxic to loblolly pines.

Methods and Materials

Azinphosmethyl is marketed as a 50 percent wettable powder and as two emulsifiable concentrate, Guthion 2L® and Guthion 2S®. We tested these materials and samples of the solvents used in the 2L and 2S emulsifiable concentrates:[4] Aromatic petroleum distillates comprise 71.8 percent of the 2L carrier but only 54 percent of the 2S carrier, which contains an unknown polar cosolvent to prevent crystallization during storage.

Initially, 10 trees, 14 to 20 cm d.b.h., were selected in a plantation of 9-year-old loblolly pines at the Whitehall Experimental Forest near Athens, Ga. Chemicals and controls were assigned randomly to individual branches at the same level of the crown. Five trees were treated with chemicals at 1.0 percent concentration (high) and five at 0.2 percent (low) concentration. Sprays were prepared immediately prior to treatment and applied to the same branches on five dates: May 20, June 24, July 27, September 8, and October 13,1976. Materials were applied to the point of runoff with polyethylene hand sprayers. To prevent contamination, all branches except the one being treated were covered with disposable plastic bags.

[1] Italic numbers in parentheses refer to Literature cited at the end of this article.

[2] Overgaard, N. A., H. N. Wallace, C. Stein, and G. D. Hertel. 1976. Needle midge (Diptera: Cecidomyiidae) damage to loblolly pines in the Erambert federal seed orchard, Mississippi. USDA For. Serv., Southeast. Area State and Priv. For., Unpublished For. Insect and Dis. Manage. Group Rep. 76-2-13, 11 p.

[3] 0,0 dimethyl S (4-oxo-1,2,3-benzotriazin-3(4H)-(methyl) phosphorodithioate.

[4] Guthion® and carrier solvents provided by Mr. K. Young, formulation specialist, Chemagro Agric. Div., Mobay Chemical Corp., Kansas City, MO.

Between applications, trees were examined for visible damage. In December the branches were removed for closer inspection in the laboratory. From both sprayed and control branches, 20 fascicles (containing 3 to 5 needles each) were removed from the first growth flush of the primary branch and the longest needle in each fascicle was measured. Between-treatment comparisons were of needle length and the current year's growth of primary and secondary branches. An additional 20 fascicles from each primary branch were examined for insect damage.

Table 1.—*Length of loblolly pine needles treated with three commercial formulations of azinphosmethyl and two solvents at high(1.0 percent) and low (0.2 percent) concentrations*[1]

Treatment	High concentration Mean length[2] (cm)	Low concentration Mean length[2] (cm)
Guthion wettable powder®	18.6 a	18.7 a
2L solvent	17.2 b	19.1 a
Guthion 2L®	16.6 c	[3]19.0 a
2S solvent	16.7 c	19.9 a
Guthion 2S®	16.9 d	19.2 a
Control	18.6 a	19.2 a

[1] Materials applied five times during May 20 to Oct. 13, 1976.
[2] Means followed by the same letter are not significantly different as determined by Duncan's multiple range test ($P>0.05$).
[3] Needles were taken from longest lateral in one case where terminal was missing.

Results

The branches never exhibited any symptoms typically associated with insecticide phytotoxicity or the dieback. At low concentrations, no phytotoxic effects were found. However, small but discrete differences in growth were detected among needles and branches subjected to the treatments at the 1.0 percent concentration. At this concentration, needle length was significantly greater on untreated branches than on branches treated with the two emulsifiable concentrates and their carriers (table 1). In comparison to treatments with the concentrates, needles were longer on branches treated with the respective carriers alone. Needles were also longer on branches sprayed with Guthion 2L® than on those sprayed with Guthion 2S®, as was true of their corresponding solvents. Only the wettable powder did not reduce growth significantly in comparison with the untreated needles.

Branch growth varied considerably more than needle growth (table 2). Control branches were significantly longer than the branches treated with Guthion 2S®. As with the needles, primary and secondary branches treated with carrier alone were significantly longer than those treated with Guthion 2L®; this relationship did not hold between Guthion 2S® and its solvent. Also, like needles, primary and secondary branches treated with wettable powder were significantly longer than their counterparts treated with Guthion 2S®.

There was no indication that insects affected the growth of foliage and branches during the period of treatment. Only feeding lesions produced by a needle midge (*Contarinia* sp.) occurred sporadically on all trees (table 3). Less than one-third of the fascicles from branches treated at either high or low concentrations sustained any damage. Even though as many as 29 percent of the fascicles in one instance were midge-infested, the average number of feeding lesions per needle never exceeded 0.02

percent for any treatment group. Similarly, statistical comparisons failed to reveal any significant differences in the incidence of midge damage whether viewed in terms of numbers of lesions or percentage of infested fascicles.

Discussions and Conclusions

Although no discoloration or chemical burning of loblolly pine foliage was observed with either concentration of azinphosmethyl, some treatments at the 1.0 percent concentration appeared to reduce the current year's growth of needles and shoots. The fact that needles grew less than comparable controls when treated with either emulsifiable concentrate but not with the wettable powder should implicate the aromatic petroleum distillates rather than the azinphosmethyl (active ingredient). If the distillates were the only factor, however, there should be little difference between treatment with either emulsifiable concentrate (with solvent) and its respective solvent alone. Yet better needle growth occurred when only the solvents were used. Similar trends were evident for branch growth as well.

These data strongly indicate that the aromatic solvents in the formulations do not retard growth. Even though aromatic distillates comprise a much larger proportion of Guthion 2L® than 2S®, when the solvents of the 2L formulation were used alone, the needles and branches were longer than those treated with Guthion 2S® (tables 1 and 2).

In the northern United States and Canada, midges (alone or in concert with disease organisms). are strongly implicated in the dieback of pines (*1, 2, 3, 5, 7*). However, the low levels of damage detected during this study failed to show any relationship between midges and the effects noted on treated or untreated foliage.

Table 2. – *Length of primary and secondary branches of loblolly pine treated with three commercial formulations of azinphosmethyl and two solvents at high (1.0 percent) and low (0.2 percent) concentrations*[1]

Treatment	High concentration				Low concentration			
	Primaries		Secondaries		Primaries		Secondaries	
	Number	Mean length[2] (cm)	Number	Mean length[2] (cm)	Number	Mean length[2] (cm)	Number	Mean length[2] (cm)
2L solvent	5	71.0 a	20	38.7 a	5	57.0 a	16	33.9 a
Guthion wettable powder®	5	65.8 ab	17	33.8 ab	5	62.8 a	19	33.8 a
2S solvent	5	49.4 bc	19	32.0 bc	5	73.4 a	17	44.5 a
Guthion 2L®	5	48.6 bc	16	25.7 bc	[3] 4	61.5 a	14	41.2 a
Guthion 2S®	5	39.4 c	15	21.2 c	5	64.6 a	16	39.9 a
Control	5	59.4 abc	16	29.7 ab	5	64.8 a	15	41.3 a

[1] Materials applied five times during period May 20 to Oct. 13, 1976.
[2] Means followed by the same letter are not significantly different as determined by Duncan's multiple range test (P>0.05)
[3] One terminal was missing.

Table 3. – *Damage to loblolly pine needles by midges after five applications of azinphosmethyl and two solvents at high (1.0 percent) and low (0.2 percent) concentrations*[1]

Treatment	High concentration			Low concentration		
	Number of needles	Average number of lesions	Infested fascicles[2] (percent)	Number of needles	Average number of lesions	Infested fascicles[2] (percent)
Guthion wettable powder®	333	1.2	6.0	314	1.2	6.0
Guthion 2L®	341	4.6	23.0	[3] 322	1.4	7.0
2L solvent	323	5.8	29.0	309	2.4	12.0
Guthion 2S®	322	3.4	17.0	319	1.8	9.0
2S solvent	318	5.6	28.0	325	2.8	14.0
Control	322	3.6	18.0	318	2.2	11.0

[1] Materials applied five times during May 20 to Oct. 13, 1976.
[2] Based on 20 needle fascicles/tree and 5 trees/treatment for each concentration.
[3] In one case the primary branch was missing, and needles were taken from longest secondary.

Our data also suggests that azinphosmethyl is unlikely to have a direct role in the dieback troubling southern pine seed orchards. Use of this chemical could possibly aggravate dieback, but it does not cause it.

The 1.0 percent concentration is five times the current rate used with hydraulic spray equipment to control coneworms and seedworms in southern pine seed orchards. Consequently, the risk of phytotoxicity under existing practices is minimal, but the long-term effects from perennial use of azinphosmethyl are still unknown. Whether the detected growth losses should be categorized as symptoms of phytotoxicity really depends upon whether these reductions have a lasting and harmful effect on the tree.

Literature Cited

1. Condrashoff, S. F.
1962. Bionomics of three closely related species of *Contarinia* Rond. Can. Entomol. 94: 376-394.
2. Davis, W. C., G. Y. Young, and L. W. Orr.
1939. Needle droop of pine. J. For. 37: 884-887.
3. DeBoo, R. F., L. M. Campbell, J. L. LaPlante, and L. P. Daviault.
1973. Plantation research: VIII. The pine needle midge, *Contarinia baeri*, (Diptera: Cecidomyiidae) a new insect pest of Scots pine. Chem. Control Res. Inst., Ottawa. Inf. Rep. CC-X-41. 31 p.
4. Dwinell, L. D.
1976. A dieback of loblolly pine in seed orchards. Proc. Am. Phytopathol. Soc. 3: 335.
5. Haddow, W. R.
1941. Needle blight and late fall browning of red pine (*Pinus resinosa* (Ait.) caused by a gall midge (Cecidomyiidae) and the fungus *Pullularia pullans* (DeBary). Trans. R. Can. Inst. 23: 161-189.
6. N. C. State University, School of Forest Resources.
1976. Damage within seed orchards, p. 54-66. *In* Twentieth Annu. Rep. Coop. Tree Improv. and Hardwood Res. Programs.
7. Patton, R. F., and A. J. Riker.
1954. Needle droop and needle blight of red pine. J. For. 52: 412-418.