Bifenox: A Promising New Herbicide for Southern Pine Nurseries

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ABSTRACT. Preemergence tests over a three-year period at 11 forest nurseries indicate that bifenox at 1.5, 3, or 6 pounds active ingredient per acre provides good weed control without causing injury to loblolly (Pinus taeda *L.), slash* (Pinus elliottii *Engelm.), shortleaf* (Pinus echinata *Mill.) and longleaf pine* (Pinus palustris *Mill.). The lower rates did not harm eastern white pine* (Pinus strobus *L.), but the 6 pound per acre rate reduced seedling density. At most locations bifenox at 3 pounds per acre provided longer lasting weed control than diphenamid at 4 pounds per acre. Postemergence applications of bifenox at 2 or 4 pounds per acre controlled small succulent weeds at eight forest nurseries without injuring 3- to 10-week old seedlings of loblolly, slash, and eastern white pine.*[1]

Weeds are considered the most important pest in forest nurseries (Miller *et al.* 1975). Controlling weeds by hand often constitutes a large portion of the total cost of seedling production. Many nurseries spend at least 10 percent of their production budget on handweeding labor and may spend as much as 90 percent (Abbott and Fitch 1977). In 1975, southeastern forest nurseries expended more than $410,000 for handweeding labor and more than $170,000 for mineral spirits (South *et al.* 1976a). The cost of fumigation with methyl bromide exceeded $370,000. Herbicides could provide an effective and economical means of controlling weeds, but the amended Federal Insecticide, Fungicide, and Rodenticide Act prohibits the use of any herbicide in a manner inconsistent with the labeling instructions. Because of insignificant market potential and high liability involved in tree seedling crops, chemical producers cannot be expected to assume leadership in screening herbicides or collecting data required for registration.

In the early 1970's, the Forest Nursery Weed Control Cooperative at Auburn University began to confront this problem. Data from uniform herbicide studies throughout the Southeast were used to support the registration of diphenamid (Enide 50W). This was the first herbicide registered specifically for preemergence application on loblolly and slash pine seedbeds. Although this herbicide is effective on grasses and a few broadleaves, control is limited to only a few

[1] Work supported in part under Memorandum of Agreement, 42–92 with the Southeastern Area, State and Private Forestry, Forest Service, USDA, and under cooperation of the State Forestry Organizations of Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, North Carolina, Oklahoma, Mississippi, South Carolina, Tennessee, and Virginia.

weeks. Efforts have continued to register other, more effective, longer lasting herbicides. Three years' data indicate that bifenox (Modown) is a herbicide that is safe for use in southern pine nurseries.

Bifenox is primarily a broadleaf herbicide that controls common nursery weeds such as pigweeds (*Amaranthus sp.*), common lambsquarters (*Chenopodium album* L.), purslane (*Portulaca oleracea* L.), Florida pusley (*Richardia scabra* L.), and carpetweed (*Mollugo verticillata* L.). Bifenox also controls certain grasses such as crabgrass (*Digitaria sp.*) and goosegrass (*Eleusine indica* (L.) Gaertn.). This herbicide is degraded by chemical and biological processes in the soil; its half-life is seven to 14 days (Weed Science Society of America 1974). Selectivity may result from susceptible species absorbing and translocating more bifenox than do resistant species (Leather 1975).

PREEMERGENCE TESTS

Twenty-six preemergence experiments involving bifenox were conducted from 1974 to 1976 in nine states at 11 state nurseries. Bifenox was tested at 1.5 and 3 pounds per acre in 1974; 3 and 6 pounds per acre in 1975; and 3 pounds per acre in 1976. Diphenamid was tested each year at 4 pounds per acre. The pine species in the experiments were loblolly (at eight locations), slash (at three locations), shortleaf (at two locations), longleaf (at one location), and eastern white pine (at one location). Herbicide treatments with two control plots (plot size 6 × 50 feet) were applied to nonfumigated soil in a randomized complete block design with four replications at each nursery.

Herbicides were applied with a backpack CO_2 sprayer after seeding and mulching. Seedbeds were irrigated with ½ to ¾ inches of water immediately after spraying. Handweeding times were recorded to evaluate weed control. Percent weed control was determined by the following formula: percent weed control = [1 − (handweeding time for herbicide treatment ÷ handweeding time for the control plot)] × 100. Seedling samples were counted and weighed at the end of the growing season to evaluate seedling tolerance to each treatment.

Ten postemergence experiments were conducted from 1975 to 1976 at eight state nurseries. Bifenox at 2 and 4 pounds per acre was applied 3 to 10 weeks after seeding. Design and application were similar to the preemergence studies, but irrigation was delayed until 24 hours after herbicide application. The pine species were loblolly (four locations), slash (three locations), and eastern white pine (one location).

RESULTS

Preemergence Treatment

Effective weed control was demonstrated at most locations by bifenox (Table 1). The main exceptions were in situations where weed populations on the control plots were too low or too variable to provide valid weeding time comparisons (Munson Nursery, FL 1974, 1975; Claridge Nursery, NC 1976) or where heavy rains eradicated treatment effects (Pinson Nursery, TN 1974, 1975). In 1974, bifenox at 1.5 and 3 pounds per acre provided good entire season weed control and gave longer control at most locations than diphenamid at 4 pounds per acre. Figure 1 illustrates the relative differences in weed control between bifenox and diphenamid. Since no injury was observed for either rate in 1974, 3 and 6 pound per acre rates of bifenox were examined in 1975. Data for the 1.5, 3, and 6 pound per acre rates have been reported previously (South *et al.* 1976b). No reduction in seedling yields or seedling weights was observed, except at the Edwards Nursery in North Carolina where the 6 pound rate reduced the density of eastern white pine seedlings from 20 to 13 per square foot. Excellent full season weed control resulted from both rates of bifenox applied in 1975. In 1976, the 3 pound

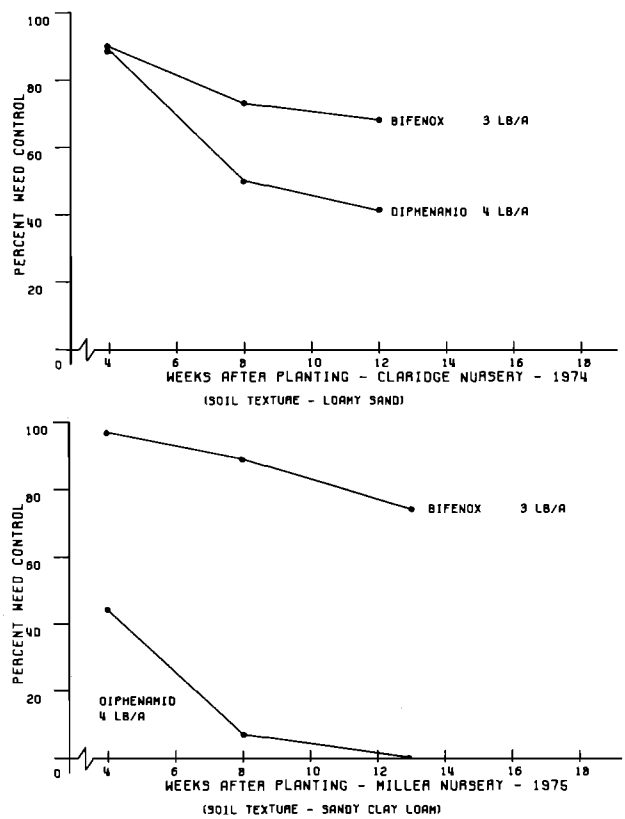

Figure 1. Preemergence weed control with diphenamid and bifenox at two nurseries.

per acre rate of bifenox provided excellent full season weed control at five of the six nurseries. At the Kentucky Dam Nursery, the bifenox treatment significantly improved density of plantable seedlings, undoubtedly due to reduction in weed competition and seedling loss during handweeding.

Table 1. The effects of preemergence applications of bifenox and diphenamid on weed control and density of pine seedlings

Nursery	State	Species	Planting date	Soil texture	pH	Percent organic matter	Percent weed control for entire season		Number of plantable seedlings per square foot[2]		
							bifenox 3 lb/acre	diphenamid 4 lb/acre	Controls[1]	bifenox 3 lb/acre	diphenamid 4 lb/acre
Miller	AL	Slash	4/24/74	Sandy Loam	4.8	2.5	87	22	28	25	29
		Slash	5/23/75	Sandy Clay Loam	4.6	2.4	91	27	17	21	17
		Loblolly	4/22/76	Clay Loam	5.2	1.9	97	12	13	15	14
Baucum	AR	Loblolly	5/7/74	Sandy Loam	5.4	1.6	41	0	28	23	29
		Loblolly	5/13/75	Loamy Sand	5.2	1.4	84	80	23	24	22
		Shortleaf	4/28/76	Loam	5.3	.8	76	55	14	14	17
Munson	FL	Slash	5/13/74	Loamy Sand	5.9	1.7	0	34	14	13	15
		Slash	4/22/75	Loamy Sand	5.2	2.3	19	59	26	24	25
Kentucky Dam	KY	Loblolly	5/8/74	Sandy Loam	6.0	2.3	66	60	—	—	—
		Loblolly	6/3/75	Sandy Loam	5.4	2.3	57	38	—	—	—
		Loblolly	5/4/76	Clay Loam	5.2	1.2	97	0	10	24*	15
Columbia	LA	Loblolly	5/1/74	Sandy Loam	5.4	1.9	78	83	17	13	15
		Loblolly	5/15/75	Sandy Loam	4.9	1.8	82	76	16	28	26
Waynesboro	MS	Loblolly	5/1/74	Sandy Loam	5.2	5.2	39	18	19	22	20
Claridge	NC	Loblolly	5/14/74	Loamy Sand	5.1	2.1	76	57	25	25	22
		Loblolly	4/24/75	Loamy Sand	5.5	2.2	84	72	34	36	34
		Slash	4/21/76	Sandy Loam	6.1	1.2	46	53	20	21	20
Edwards	NC	Eastern White	5/6/74	Loamy Sand	5.2	2.1	37	33	25	24	28
		Eastern White	4/29/75	Loamy Sand	5.1	1.7	82	67	20	16	19
Tilghman	SC	Loblolly	3/20/74	Sandy Loam	6.0	4.4	25	0	27	23	22
		Longleaf	3/20/74	Sandy Loam	6.0	4.4	22	6	8	9	8
Coastal	SC	Loblolly	4/2/75	Sand	5.5	1.2	71	4	21	22	20
		Loblolly	4/6/76	Sandy Loam	5.6	1.3	98	34	15	18	13
Pinson	TN	Shortleaf	4/29/74	Loam	5.9	2.3	7	0	7	7	5
		Shortleaf	4/17/75	Loam	5.9	2.3	8	0	14	14	14
		Shortleaf	4/22/76	Silty Clay Loam	5.2	1.1	90	37	26	31	29

[1] *Average of two controls.*

[2] *An asterisk indicates a significant difference from the controls on the same row at the 5 percent level of probability. Means were compared by Duncan's New Multiple Range test.*

Table 2. The effects of a postemergence application of bifenox on weed control and density of pine seedlings

Nursery	State	Species	Planting date	Date treated	Soil texture	pH	Percent organic matter	Percent weed control for entire season		Number of plantable seedlings per square foot[2]		
								bifenox 2 lb/acre	bifenox 4 lb/acre	Controls[1]	bifenox 2 lb/acre	bifenox 4 lb/acre
Miller	AL	Slash	5/23/75	6/17/75	Sandy Clay Loam	4.6	2.4	91	90	15	16	14
		Slash	4/22/76	5/31/76	Clay Loam	5.2	1.9	47	50	20	20	23
Munson	FL	Slash	4/26/76	5/31/76	Sandy Clay Loam	5.6	1.3	95	81	12	11	13
Herty	GA	Loblolly	4/8/76	5/18/76	Sandy Clay Loam	6.4	.8	38	33	17	16	16
Columbia	LA	Loblolly	5/1/76	6/10/76	Silt Loam	5.1	1.3	21	0	5	8	5
Waynesboro	MS	Slash	4/16/76	5/17/76	Sandy Clay Loam	6.0	1.8	72	82	23	26	26
Edwards	NC	Eastern White	4/29/76	5/30/76	Sandy Clay Loam	5.5	1.3	38	46	29	21	24
Coastal	SC	Loblolly	4/2/75	6/13/75	Sand	5.5	1.2	—	—	22	21	22
		Loblolly	4/6/76	5/13/76	Sandy Loam	5.6	1.3	64	76	19	23	20
New Kent	VA	Loblolly	4/29/76	6/4/76	Sandy Loam	5.0	2.9	49	85	19	17	19

[1] *Average of two controls.*

[2] *Means on the same row were compared by Duncan's New Multiple Range test and the herbicide treatments were not significantly different from both controls at the 5-percent level of probability.*

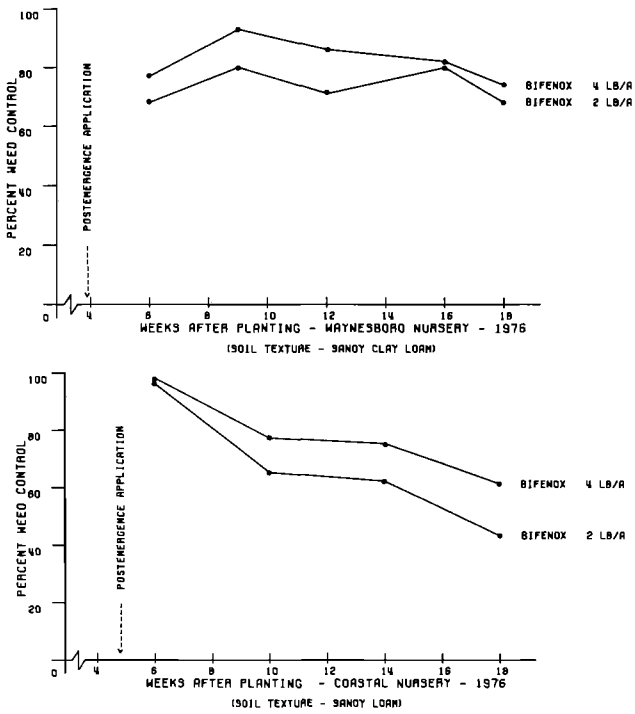

Figure 2. Postemergence weed control with bifenox at two nurseries.

Postemergence Treatment

The efficacy of postemergence treatments of bifenox varied among nurseries and was dependent on the weed species present and the stage of weed development at treatment. Weed control was better when small, succulent weeds were treated. Weed control was excellent at the Alabama nursery in 1975 and at the Florida nursery in 1976 where only small weeds were present at treatment (Table 2).

Figure 2 illustrates the weed control obtained at the nurseries in Mississippi and South Carolina. However, at the Louisiana nursery where bermudagrass (*Cynodon datylon* (L.) Pers.) was established before treatment, weed control was ineffective. No injury was observed for any of the pine species examined.

DISCUSSION

On February 18, 1976, the Forest Nursery Weed Control Cooperative submitted data to support the registration of bifenox for preemergence use in forest nurseries. The Environmental Protection Agency approved this registration on September 22, 1977. Nurserymen in the Southeast will now be able to use bifenox legally as a preemergence treatment on loblolly, slash, shortleaf, longleaf, and eastern white pines. Though the herbicide label states that bifenox should not be applied over hydromulch or sawdust mulch, recent tests have shown that good weed control can be obtained from applying bifenox on these mulches.

Data supporting the registration of bifenox for postemergence application will be submitted by the chemical company to the Environmental Protection Agency before 1978. Special local need labels for postemergence applications of bifenox on pine seedbeds have been approved in Alabama, Arkansas, Georgia, and South Carolina.

The use of effective herbicides such a bifenox will reduce the need for handweeding, mineral spirits, and methyl bromide and will probably save the Southeastern nurserymen $250,000 per year in weed control costs.

Pesticide Precautionary Statement

This paper reports research involving pesticides. it does not contain recommendations for their use. All uses of pesticides must be registered by appropriate state or federal agencies before they can be recommended. Caution: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal or surplus pesticides and pesticide containers.

Literature Cited

ABBOTT, H. G., and S. D. FITCH. 1977. Forest nursery practices in the United States. J. For. 75: 141–145.

LEATHER, G. R. 1975. Absorption, distribution and metabolism of bifenox. Ph.D. Thesis, Virginia Polytechnic Institute and State University, Blacksburg, Va. 81 p.

MILLER, R. S. *et al.* 1975. Forest pest control. National Academy of Science. Env. Studies Board. Washington, D.C. 170 p.

SOUTH, D., R. H. CROWLEY, and D. H. GJERSTAD. 1976a. Herbicide weed control results in pine seedbeds. p. 95–106. *In* Proceedings, Southeastern Nurserymen's Conferences. U.S. Forest Service.

——— and ———. 1976b. Recent herbicide weed control results in pine seedbeds. p. 300–308. *In* Proceedings of Southern Weed Science Society Twenty-Ninth Annual Meeting, Dallas, Texas.

WEED SCIENCE SOCIETY OF AMERICA, 1974. Herbicide Handbook, 3rd ed. Champaign, Illinois, 430 p.

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