TCMTB USE IN FOREST NURSERIES

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TCMTB is the designation assigned to a technical grade chemical raw material which contains a minimum of 80 percent of 2-(thiocyanomethylthio) benzothiazole. This chemical was discovered at Buckman Laboratories, Inc., where tests indicated it to be the most promosing member of a group of new chemicals synthesized in a research program directed at finding new agricultural pesticides with a spectrum of useful biological activity.

TCMTB was tested in the form of two formulations which were distributed at different times under the identification of Busan 72. The first formulation contained 40 percent 2-(thiocyanomethylthio) benzothiazole, and the second contained 60 percent of this active ingredient.

TCMTB has shown activity in in vivo and in vitro greenhouse-type tests against bacteria, fungi, nematodes, and insects. A list of the test organisms against which it has shown effectiveness is provided by the Agricultural Releases of Buckman Laboratories, Inc. Different TCMTB formulations have been used in experiments with soil and seed treatments of barley, cotton (acid and machine delinted), field peas, lima beans, oats, peanuts, etc. Data from those experiments confirm TCMTB as a pesticide for agricultural use.

This presentation covers results obtained with TCMTB when used in forest nurseries as a soil, seed, and post-emergence treatment. It deals mainly with the experiments conducted by Mr. P. Adams, Director of Reforestation, Arkansas State Forestry Commission, Little Rock, Arkansas, and the speaker. Reference is also made to the experimental work of Mr. C. *J.* Eden, Forester, Department of Conservation, Division of Forestry, California, and Mr. C. L. Gehron, Beauregard Nursery Superintendent, Louisiana Forestry Commission.

Mr. Adams and the speaker prepared two soil experiments, one seed experiment, and one post-emergence experiment with different TCMTB formulations.

EXAMPLES 1 and 2 (SOIL EXPERIMENTS)

In the first soil experiment, a Busan 72:water suspension was prepared containing 0.1 milliliter of Busan 72 in 200 milliliters of suspension. Proper amounts of this suspension then were used for the pre-emergence treatment of two different types of soils, the so-called Baucum and Bluff City soils.

The rates used were 0.5, 1, 3, and 5 pounds of active ingredient per acre (0.56, 1.12, 3.36, and 5.60 kilograms per hectare). Each soil was placed inside so-called "plastic bullets or fingers" in the amount of 24 grams, and three stratified pine seeds were planted in each "bullet." The suspensions of Busan 72 were then applied to the surface of the soil at the upper end of the plastic "bullet." The "bullets" treated with Busan 72 were kept at a temperature of around 70°F. The "bullets" received proper watering by means of a hand sprayer. The results of the reading made 25 days after the treatment are presented in table 1, which gives the results for stratified pine seeds tested in Baucum soil and Bluff City soil.

A second soil experiment was prepared under the same conditions as the first experiment, except that a so-called potting soil (BACCTO, Michigan Peat Company) was placed inside plastic "bullets" previously used with regular Bluff City or Baucum soil. In this experiment, it was observed that the seeds which germinated were only those closer to the heating unit used to keep the plastic "bullets" at

Table 1.--Results for stratified pine seeds planted in untreated (control) Baucum and Bluff City soils and in these soils treated with TCMTB (Busan 72)

Treatment	Active in (per acre)1/	Bullets per treatment	Seeds germinated (of total seeds planted)	Of seeds germinated	
	Pounds	Number	Percent	Seedlings dead	Seedlings growing
				Percent	
BAUCUM SOIL					
Control	0.0	122	10.1	40.5	59.5
Busan 72	0.5	147	18.1	17.5	82.5
Busan 72	1.0	146	16.7	8.2	91.8
Busan 72	5.0	165	14.9	2.7	97.3
BLUFF CITY SOIL					
Control	0.0	319	12.4	31.9	68.1
Busan 72	3.0	196	10.9	3.1	96.9

1/ One pound of active ingredient per acre = 1.12 kilograms of active ingredient per hectare.

70°F. Therefore, the results are presented on the basis of percentage of seedlings growing to total seeds planted and also the percentage of seedlings growing to seeds planted closer to the heating units.

The treatments in this second experiment were an untreated control and soil treatment to 5 pounds of active ingredient per acre (5.60 kilograms per hectare). Three pine seeds were planted in each "bullet." The results of the readings made 42 days after planting show the Busan 72-treated "bullets" to have better seedling stand than the untreated "bullets." The results are summarized in table 2.

The results of these Busan 72 soil experiments show: first, that TCMTB can be used to protect seeds of pine planted in plastic "bullets" and, second, that Busan 72 should be used as a soil treatment (pre-emergence) on nursery beds.

During the spring of 1968, Mr. Adams applied Busan 72 as a soil pre-emergence treatment in the nurseries under his supervision with good disease control. The treatment used was 3.8 pounds of active ingredient in 120 gallons of water per acre (4.25 kilograms in 1,120 liters per hectare).

EXAMPLE 3 (SEED TREATMENT)

Busan 72 was also tested as a seed treatment on pines by Mr. Adams and the speaker. A pine seed treatment experiment was prepared on stratified and nonstratified pine seeds. These types of seeds, 50 milliliters of each, were treated with 0.4 milliliter of a suspension containing 1 part of Busan 72 plus 24 parts of water. The seeds were planted in Baucum soil. Mr. Adams reported that seedlings growing from untreated pine seeds die at the rate of 50 to 100 percent of the total seeds planted.

The results of the seed treatment were:

Treatment	Seedlings growing	Seedlings dead
Stratified Busan 72-treated seed	64	6
Nonstratified Busan 72-treated seed	0	0

It should be noted that the tests of nonstratified seeds were made only to determine whether treatment with TCMTB would eliminate the need for stratification.

Table 2.--Results for stratified pine seeds planted in untreated (control) potting soil and the same soil treated with TCMTB (Busan 72)

Treatment	Active ingredient (per acre)[1/]	Bullets per treatment		Seeds germinated (of total seeds planted)		Of seeds germinated: Seedlings dead		Of seeds germinated: Seedlings growing	
		Total	Warmer side	Total	Warmer side	Total	Warmer side	Total	Warmer side
	Pounds	Number		Percent		Percent		Percent	
Control	0	96	40	0.0	0.0	0.0	0.0	0.0	0.0
Busan 72	5	92	52	7.97	[2/]11.5	0	0	7.97	[2/]11.5
Busan 72	5	84	36	8.33	[2/]19.44	0	0	8.33	[2/]19.44

1/ One pound of active ingredient per acre = 1.12 kilograms of active ingredient per hectare.

2/ The difference in the percent germination, considering the warmer side of replications 1 and 2, is due to the different amount of bullets counted in each replication as being closer to the heating unit.

EXAMPLE 4 (SEED TREATMENT)

TCMTB has been tested as a seed treatment on Abies concolor by Mr. Eden. TCMTB *was* tested as the formulation known as Busan 72 (60 percent of 2-(thiocyanomethylthio)benzothiazole). Mr. Eden has reported good results from his experiments. He obtained a twofold increase in the percentage of seedlings growing from seeds planted of white fir (A. concolor) when the seeds were treated before stratification with 0.5 fluid ounce (14.8 milliliters) of Busan 72 per bushel (35.24 liters) as compared with that percentage of the control (untreated seed). After 14 days, *Mr.* Eden's results were 56.7 percent for treated seeds as compared with 28.3 percent for untreated seeds. At the end of the regular germination period of 28 days, the percentage of seedlings growing from seeds planted were 53 percent for the control (untreated seeds) and 65.3 percent for the seeds treated before stratification with 0.5 fluid ounce (14.8 milliliters) of Busan 72 per bushel (35.24 liters). Mr. Eden has mentioned that the twofold increase in the percentage of seedlings growing from seeds planted in the first 2 weeks of the regular germination period should be significant as these seedlings should survive best and be the more vigorous trees.

The following *is* the procedure used by Mr. Eden:

> All seeds used were moist-chilled (stratified) in vermiculite at temperatures of 33^{0} - 36°F. for a period of 28 days. Germination tests were run in a Harrison Germinator by alternating light and temperatures; that is , 8 hours with light at 75°F. and 16 hours without light at 67°F. Six replications of 50 seeds each were tested.

EXAMPLE 5 (POST-EMERGENCE EXPERIMENTS)

Mr. Adams and the speaker prepared an experiment to determine if TCMTB could be used as a post-emergence treatment for pine disease control. TCMTB was tested in the form of four formulation in this experiment.

At this time, it should be mentioned that Buckman Laboratories, Inc., will be selling TCMTB to a group of selected agricultural formulators who, in turn, will prepare agricultural formulations adapted to specific agricultural conditions.

In this post-emergence experiment, 100-square-foot plots (9.29 square meters) were prepared on pine beds eight rows wide. The control plots (untreated) had 50 square feet (4.65 square meters), and they were placed between the treated plots. The post-emergence treatment was made 19 days after bed planting. Each treatment was applied to the beds in the form of water suspensions using equivalent amounts of 43.8 gallons per acre (407.5 liters per hectare) by means of a hand

sprayer covering a strip of about 20 inches wide.

The results of this experiment are presented as percentages of seedlings dead and seedlings growing, based on the total seedlings emergence. For determining the seedlings dead, seven different counts were made over a period of 36 days. Seedlings growing were the number of healthy and normal plants growing at the end of 36 days plus those healthy seedlings destroyed by insects. The countings were made on a 5- x 1-square-foot areas on the treated plots.

The results obtained from this experiment are summarized in table 3, and an interpretation of these results follows:

Phytotoxicity was observed in the treatments tested in this experiment except in the case of the formulation AF2 at the rate of 1.5 pounds of active ingredient per acre (1.68 kilograms per hectare). Mr. Adams observed that the spraying equipment used and the amount of water applied per acre reduced the pine foliage phytotoxicity caused by Busan 72. When applying Busan 72:water dispersions, it was observed that, unless proper agitation is maintained, the phytotoxicity increases closer to the end of the spraying. The reason was that the Busan 72 formulation accumulated on the bottom of the sprayer. This explains the results obtained for this experiment with Busan 72 at rates of 1.5 and 2 pounds of active ingredient per acre (1.68 and 2.24 kilograms per hectare). These observations were confirmed by Mr. Gehron who found that 1 pint (0.75 pounds of active ingredient per acre or 0.8 kilograms per hectare) of Busan 72 in 100 gallons of water per acre (935 liters per hectare) can be sprayed on pine seedlings during several weeks without phytotoxicity.

The TCMTB formulation called AF2 gave good disease control when applied post-emergence on pine seedlings at a rate of 1.5 pounds of active ingredient per acre (1.68 kilograms per hectare). Therefore, it can be said that the results from this post-emergence experiment are an encouraging clue for future work with other TCMTB formulations.

SUMMARY

Results of tests of TCMTB for soil and seed treatment in forest nurseries have been favorable. During the spring of 1968, extensive use of TCMTB in the form of Busan 72 throughout the forest nurseries of one state has provided good disease control. Similar results have been obtained with different TCMTB formulations as seed and soil treatments for a number of other crops.

Note: For more information on Busan 72 write for Agricultural Release 268-4 available from: Buckman Laboratories, Inc., Research and Development Department, 1256 North McLean Blvd., Memphis, Tennessee 38108.

Table 3.--Results for untreated pine seedlings and those treated post-emergence with TCMTB (AF2, Busan 72, AF3, and AF4)

Treatment	Rate of active ingredient (per acre)[1]	Average seedlings emergence	Of seedling emergence	
			Seedlings dead	Seedlings growing
	Pounds	Number	Percent	
Control	0.0	310	16.8	83.2
AF2	1.5	[2] 292	11.6	88.4
	2.0	[2] 340	13.5	86.5
	3.0	[2] 316	21.5	78.5
	4.0	[2] 378	26.2	73.8
	5.0	[2] 223	61.0	39.0
Busan 72	1.5	299	18.1	81.9
	2.0	312	22.8	77.2
	3.0	284	24.3	75.7
	4.0	266	30.1	69.9
	5.0	284	35.2	64.8
AF3	1.5	304	17.8	82.2
	2.0	315	15.2	84.8
	3.0	246	31.7	68.3
	4.0	298	29.2	70.8
	5.0	248	43.5	56.5
AF4	1.5	299	19.7	80.3
	2.0	305	13.1	86.9
	3.0	287	23.3	76.7
	4.0	243	36.2	63.8
	5.0	243	34.6	65.4

1/ One pound of active ingredient per acre 1.12 kilograms of active ingredient per hectare.

2/ There was an average of 14, 4, 2, 1, and 1 seedlings destroyed by insects on the AF2 treatments of 1.5, 2, 3, 4, and 5 pounds of active ingredient per acre, respectively. The insecticide chlordane was applied at a rate of 1.5 pints per acre to control the insects (worms) attacking the pine seedlings.