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EFFECTS OF TETRAMINE USED FOR RODENT CONTROL IN DIRECT SEEDING OF DOUGLAS-FIR

By

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Rodent control is one of the most critical problems in reforestation by direct seeding. Several different types of rodenticides, baits, and repellents have been developed, but none have been completely satisfactory.

The current practice is to bait the area with a poisoned cereal grain to reduce rodent population before artificial seeding. This method has the following disadvantages: (1) It requires at least two coverages, one for baiting and one for seeding, with a corresponding increase in labor and expense; (2) autumn poisoning will not keep the area free from rodents until the seed germinates the following spring; (3) many rodenticides now in use are a hazard to beneficial wildlife; (4) wide buffer strips must be baited to prevent invasion.

A more desirable method--and one that shows considerable promise--would be to treat the tree seed itself. The chemical would not have to be lethal; in fact, less seed would be lost if it were a true repellent. To be fully effective, such a treatment should prevent rodents from destroying the seed and yet not reduce the germination or growing capacity.

Experiments at the U. S. Fish and Wildlife Service Research Laboratory at Denver, Colorado, under the direction of Donald A. Spencer, and evidence from limited field tests indicate that tetramethylene disulpho tetramine

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1/ This paper is based on a cooperative study jointly conducted by the U. S. Fish and Wildlife Service, the Washington State Division of Forestry, and the Pacific Northwest Forest and Range Experiment Station. Credit for the work on tetramine and rodents is due the Wildlife Research Laboratory in Denver, Colorado. Seed, helicopter service, technical assistance, and a site for the test were contributed by the State Division of Forestry. Collection and analysis of data, and publication of results were assigned to the experiment station.

(generally called tetramine) may meet most of these requirements. Tetramine in small doses is highly lethal to rodents, and it is an effective repellent. Consequently, it kills a few of the mice and stops the remainder from feeding on the treated seed. Tetramine has sometimes been slightly injurious to the seed, but this failing is being corrected by continued research and improved treatment techniques.2/

The Study

A series of large-scale, realistic field tests throughout the United States were planned in 1951 to study the effects of tetramine. A 100-acre block in the Capitol State Forest near Olympia, Washington, was one of several areas selected for these tests.2/ Similar studies are also being conducted in the Northwest by the State of Oregon and by private timber companies. The specific objectives of this experiment were: (1) to determine the effectiveness of tetramine, used as a direct treatment on Douglas-fir seed, in insuring satisfactory seedling establishment in the presence of heavy rodent populations; (2) to measure the effect of tetramine on seed germination and seedling survival; (3) to study rodents on the area.

Location.--The 100-acre tetramine test area is 12 miles west of Olympia, Washington, in sec. 17, T. 17 N., R. 4 W., W.M., at an elevation of approximately 1,500 feet. The entire area was logged several years ago and heavily burned in 1938 and 1941. It is still devoid of coniferous reproduction except on the north slopes, where a few seedlings are becoming established. Weeds, short grasses, low brush, moss, and numerous herbaceous plants make up most of the ground cover. Slopes up to 40 or 50 percent with north, west, and south aspects are common throughout the block. In general, the site is typical of the rather adverse conditions found on thousands of acres in Washington that have not restocked naturally.

Rodent Census.--Late in October, before seeding, a rodent census comprising 1,070 trap nights was made on the 100 acres. Live traps were used, and every animal caught was ear tagged, then released. Deer mice and meadow mice were the most numerous, but jumping mice, shrews, chipmunks, and weasels were also caught. A permanent line of 76 staked trap locations was used again in three later censuses--November, March, and May. Traps were set for three successive nights each time, making a total of 1,754 trap nights for the four censuses.

Seeding.--On October 29, 1951, a helicopter seeded the 100-acre test area at the rate of three-fourths pound, or approximately 30,000 seeds to the acre. The 75 pounds of Douglas-fir seed used for the tetramine treatment showed a germination of 79 percent. In order to assure more uniform seed distribution, the area was cross-flown three times, each time from a different direction. Immediately after the flight, an on-the-ground examination revealed seed distribution to be uniform.

2/ Spencer, Donald A., and Kverno, Nelson B. Research in rodent control to promote reforestation by direct seeding. U. S. Fish and Wildlife Service. Progress Report No. 3. 54 pp. August 1952.

Plot Installation.--On November 6 and 7, 1951, centers for 200 mil-acre plots were marked with cedar stakes, and 80 dome-shaped screen exclosures were installed. Plots are 40 feet apart, horizontal distance, in 4 rows that cross the 100 acres. On every fifth plot, a pair of wire screens were installed to test carefully the effects of tetramine. In half of these exclosures, the 10 seeds placed under each screen were lightly covered with soil; thus four variations were tested under the wire exclosures:

1. Untreated seed, not covered with soil
2. Tetramine-treated seed, not covered with soil
3. Untreated seed, covered with soil
4. Tetramine-treated seed, covered with soil

Germination and Survival Counts.--Germination and survival of seedlings were checked three times during 1952: May 20, June 23, and October 7. Each seedling found on the mil-acre plots was marked with a wire stake and tallied on the field sheets. At each subsequent examination of the plots, all wire markers were checked. If the seedling was still alive, it was noted in the field tally. If it had died since the last examination, the marker was removed and the seedling was tallied under mortality. In addition, the mil-acre plots were carefully searched for any new seedlings that might have been slow in germinating or had been overlooked in the previous examination. In this way an accurate record of every seedling on the plots was carried through the first year. Germination and survival under the screened exclosures were easy to determine. Each screen contained 10 seeds. The wire mesh afforded full protection and still gave a good view of all the seedlings beneath. Without disturbing the exclosures, the seedlings were tallied each time the plots were checked. The screens were removed after the October 7 examination so that the seedlings could grow normally.

Results and Observations

Rodent Populations.--The four censuses taken on the 100 acres showed a heavy population of mice and other rodents. Without effective controls, these rodents would have been a serious threat to any attempt at reforestation by direct seeding.

Four hundred and sixty small mammals (including retakes) were captured during the first census in 1,070 trap nights. A summary of the catch from the 76 permanent trap sites used for all four censuses is shown below (each census was for three consecutive nights):

Mammalian Species	October	November	March	May
Deer mice (Peromyscus)	35	32	9	24
Meadow mice (Microtus) - two species	20	15	10	5
Chipmunks (Tamias)	2	0	0	0
Jumping mice (Zapus)	1	0	0	1/15
Shrew (Sorex) - two species	2/0	0	3	22

1/ Jumping mice were in hibernation and did not show until the May trapping.

2/ Live-cage traps were used during the first two studies that did not capture the very small shrews as effectively as the snap traps used in the last two trappings.

Seedling Establishment.--At the end of the first growing season the 200 mil-acre sample plots showed a total of 835 surviving Douglas-fir seedlings to the acre (table 1). During the same period, 555 seedlings died on each acre. Had all seedlings lived through the summer, the total would have been 1,390 per acre.

Table 1.--Seedling establishment on 200 mil-acre plots in the 100-acre tetramine test area, 1952

Date of examination	Mil-acre plots stocked		Seedlings				
			New seedlings	Mortality		Live total	Live total per acre
	No.	Pct.	No.	No.	Ptc.	No.	No.
May 20	73	36.5	126			126	630
June 23	99	49.5	107	28	22.2	205	1,025
October 7	81	40.5	45	83	40.5	167	835
Total or average			278	111	47.6		
Per-acre basis			1,390	555			

Of the 233 seedlings staked during the first two examinations, 111 were dead by October 7; thus the mortality was 111/233 or 47.6 percent. At the end of the growing season 81 of the 200 plots still had at least one live seedling, making the stocking 40.5 percent.

The best germination occurred on south slopes with exposed, gravelly soil. On north slopes with heavy sod and moss, seedling establishment was very poor.

Each time the test area was examined, a check was also made on the unseeded slopes adjacent to the 100 acres. No seedlings were found outside the test area; therefore it can be assumed that no seed from natural sources fell on the 100 acres. However, sometime in the past, seed from trees a mile or more away must have blown in and become established on the 100-acre test block, for a few Douglas-fir seedlings of various sizes are now growing on the north slopes.

Effects of Tetramine on Germination and Survival.--Tetramine as used in this treatment had a detrimental effect on both germination and survival (table 2). The U. S. Fish and Wildlife Service found that this effect was due to an impervious coating of dissolved pitch and resins left on the seed coat during the acetone-tetramine treatment. They are now correcting this failing by an improved treatment technique, as evidenced by encouraging results from 1953 tetramine tests near Mayfield, Washington.

Table 2.--Effects of tetramine treatment on Douglas-fir seed (basis 74 screened exclosures)

Date	Treated (total 370 seeds)					Untreated (total 370 seeds)				
	Live total	Seeds germinated		Mortality		Live total	Seeds germinated		Mortality	
1952	No.	No.	Pct.	No.	Pct.	No.	No.	Pct.	No.	Pct.
May 20	122	122	33.0			176	176	47.6		
June 23	97	9	2.4	34	27.9	168	20	5.4	28	15.9
October 7	76	1	.3	22	22.7	136	4	1.1	36	21.4
Totals	76	132	35.7	56	42.7	136	200	54.1	64	32.0

Germination of the treated seed was 35.7 percent; of the untreated seed, 54.1 percent. Mortality in the same test was 42.4 percent for the treated seed and 32 percent for the control.

Another result of the study was the finding that when tetramine-treated Douglas-fir seed was lightly covered with soil, germination was increased and the mortality reduced (table 3). The soil covering had no apparent effect on the untreated seed.

Table 3.--Germination and survival as affected by lightly covering seeds with soil (basis 74 screened exclosures)

Item	Covered				Uncovered			
	Tetramine treated		Untreated		Tetramine treated		Untreated	
	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
Planted	190	100	190	100	180	100	180	100
Germination	77	40.5	101	53.2	55	30.6	99	55.0
Mortality	29	37.7	32	31.7	27	49.1	30	30.3
Survival	48	62.3	69	68.3	28	50.9	69	69.7

Adequacy of Sample

One of the questions that always arises in designing an experiment is, how many plots will be needed to properly sample the area? Without some experience as a background, it is difficult to determine the required number. The statistical analysis of the data from this first field test will serve as a helpful guide in planning similar experiments.

A statistical analysis showed that the average number of seedlings germinating per plot, as determined from the 200 mil-acre plots, is subject to a sampling error of 10 percent, which is probably better than needed for such a test. Other data from the analysis are listed below:

Number of mil-acre plots		200
Average number of seedlings found per plot		1.39
Standard deviation		1.95
Standard error		± 0.138
Total number of seedlings germinated per acre	1,390	± 138
Sampling error using 200 plots		10 percent
Sampling error using 100 plots		14 percent
Sampling error using 49 plots		20 percent

The variation that occurred was due to differences in ground cover, slope, aspect, seed distribution, and probably several other factors. Even with these rather extreme variations, the analysis shows that the 200 plots were a highly adequate sample, within an error of 10 percent. If the test were to be conducted where conditions are more uniform, or if less accuracy were desired, from 50 to 100 plots would be sufficient.

Conclusions and Summary

The field test of tetramine-treated Douglas-fir seed on the Capitol State Forest has yielded much valuable information. Results at the end of the first growing season may be summarized as follows:

(1) Tetramine appears to be effective in controlling rodents under normal field conditions. Although Peromyscus, Microtus, and other rodents were numerous throughout the test area, an average of 1,390 seedlings per acre was found.

(2) At the end of the growing season 40.5 percent of the mil-acre plots were stocked with at least one seedling. On October 7, 1952, 835 seedlings to the acre were still living. Mortality during the summer was 47.6 percent.

(3) Tetramine as used in this treatment reduced both germination and survival. This failing is now being corrected by improved treatment techniques.

	Percent germination	Percent mortality
Tetramine treated	35.7	42.4
Control	54.1	32.0

(4) Covering the tetramine-treated seed with soil caused a slight increase in both germination and survival. It had no effect on untreated seed.

	Percent germination	Percent mortality
Covered with soil	40.5	37.7
Not covered with soil	30.6	49.1

(5) An examination of check areas outside the test block showed that no seed from natural sources affected the results of the experiment.

(6) A statistical analysis of the data showed that the sampling was highly adequate, giving an error of less than 10 percent: S.D. = 1.95; S.E. = ± 0.138.