A REVIEW OF WEEDICIDE RESEARCH AT THE FOREST RESEARCH INSTITUTE NURSERY UP TO 1966

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Summary

An account is given of chemical weed-control research in a conifer nursery situated on sands of pumice derivation, low in natural organic content, in the central North Island of New Zealand. The use of mineral oil sprays for pre- and post-emergence weed control in pine and Douglas fir, generally adopted after research at this nursery, had largely replaced hand-weeding by 1957. The oils are now being superseded by soil-sterilant chemicals such as propazine, in conjunction with specific grass killers such as dacthal, promising a further major advance in nursery weed control. Research on accumulation of toxic residues, the compatibility of chemicals, requirements and tolerances of individual tree species, and on new chemicals and their limitations and mode of action is continuous, and will increase as facilities improve within the next decade.

EARLY RESEARCH (1954-57)

AS LATE AS 1957, virtually all weeding in Forest Service nurseries was done by hand, although research in chemical methods of weed control had begun at the Institute nursery in 1954.

One approach, soon abandoned, was the application of excess inorganic fertilizers as surface dressings. The second investigation covered the use of light mineral oils containing various percentages of aromatics as contact scorch killers of moderate selectivity for use on conifer seedlings. Pilot trials in the Rotorua area led to Dominion-wide testing. From the information returned by collaborating nurserymen on standardized spray-data sheets, prescriptions were circulated in 1957 and 1958, recommending the general use of these oil sprays: 22% aromatics for pre- and early post-emergence, and 18% for post-emergence spraying, commencing about five weeks after completion of emergence. Recommended rates were between 30 and 50 gal, according to local experience and conditions. Success with these oils was highly dependent on stage of weed growth and on weather. Best conditions occurred when air temperatures reached the fifties and continued to rise after spraying, accompanied by a marked reduction in humidity. Development of this technique for weed control fortunately coincided with the discovery by the Institute of successful bird-repellent seed coatings, so that seedbeds no longer had to be cluttered with bird-protection paraphernalia. An immediate reduction in weeding costs and seasonal labour requirements followed.

The oils had some disadvantages, being volatile contact killers and unsuitable for some conifer species. Weed seeds on and near the surface remained viable, and repeated oil applications were required to deal with successive weed crops. As many as seven

sprayings in one season were not uncommon, resulting in considerable cumulative costs. The control afforded by the oils was not only temporary: it was very limited in the damp, cold weather of late autumn to early spring. Even in late spring and full summer, conditions had to be optimum to ensure greatest effectiveness, and this could mean enforced delays that allowed the weeds to get out of hand. Oil sprays were a vast improvement over hand weeding, but were by no means the final answer.

LATER RESEARCH (1958-62)

In 1958, trials were started with a recently introduced 50% active, commercial simazine formulation. This was sprayed between lines of conifer transplants representing a wide range of forest species, and demonstrated the efficiency of the slow-leaching, soil-sterilant type of chemical in providing long-term weed control extending throughout the winter.

Further trials were established in seedling beds of *Pinus radiata*, *P. strobus*, *P. nigra* and Douglas fir (*Pseudotsuga menziesii*). Rates up to 1½ lb in 40 gal water were applied at various intervals after emergence commenced.* Results were promising in the pines, but Douglas fir showed considerable susceptibility when simazine was applied as late as six weeks after first emergence. Application under various weather and soil conditions showed simazine to be effective except when applied to dry, dusty soil. Weed control often exceeded four months, but there was no kill of grass seedlings.

One experiment showed that simazine could be applied at 1½ lb alone, or immediately after a 30 gal application of 22% aromatic oil, to seedbeds immediately after sowing *Pinus radiata* seed. Seed pushed into the soil with the micropyle end downwards and the tops just flush with the surface germinated and developed normally, despite intensive watering to simulate heavy rainfall. This trial was carried out simultaneously at three nurseries in the Bay of Plenty.

Trials both large and small with simazine had extended to most forest nurseries by 1962. Reports on the experiences of most users were compiled for an Institute symposium (Beveridge and Hedderwick, 1962). There was general agreement that the triazines held promise as post-emergence weedicides, but there were also a number of well-justified reservations. One of the dangers lay in the possibility that toxic residues would accumulate in the soil after repeated applications of these almost insoluble chemicals. Another common experience was the greater susceptibility of Douglas fir, and of pines other than *Pinus radiata*. The ineffectiveness of the triazines against grasses, summer grass (*Panicum capillare*) in particular, also constituted a major drawback.

RECENT RESEARCH (1962-66)

Recent research projects are outlined below. The ultimate objective is to draw up a spray programme tailored to suit individual species growing under different soil and climatic regimes.

* All application rates are given in terms of pounds of active ingredient per acre, and volumes in gallons per acre, unless specifically stated otherwise. Volumes of water used as a carrier for chemicals are of the order of 40 gal per acre.

TRIAZINES AS PRE-EMERGENCE SPRAYS

The problem of weed control at and soon after emergence, when the seedlings are most susceptible to chemical injury, prompted further tests with the triazine as pre-emergence sprays. These experiments have confirmed that the safest time to apply simazine and propazine as pre-emergence treatments is immediately after sowing. Application during or shortly after emergence causes the greatest damage. Propazine is the milder on conifer seed, and is not harmful when used at 1 lb directly after spring sowing; it has caused some mild growth depression in *Pinus contorta*, *P. nigra* and Douglas fir, but not in *P. radiata* when applied at $\frac{1}{2}$ and 1 lb after an autumn (January) sowing. Simazine at 1 lb applied immediately after spring sowing (late October) was harmful to *P. contorta* and *P. nigra*, but not to Douglas fir or *P. radiata*. Propazine, either by itself or in conjunction with other chemicals, shows distinct promise for use between sowing and emergence, at least for *P. radiata* seedbeds.

TRIAZINES AS POST-EMERGENCE SPRAYS

Other tests were initiated to define more closely the optimum rates and timing of post-emergence applications for particular species, and to compare the effects of simazine and propazine.

Applied as a post-emergence spray, propazine again proved milder than simazine in its effect on conifer seedlings, but was an equally effective weedkiller. Propazine applied at 1 lb three weeks after emergence has caused no damage to the species tested—*Pinus radiata*, *P. nigra*, *P. contorta* and Douglas fir—but applied two weeks after total emergence, only proved safe at $\frac{1}{2}$ lb for the three latter species, although still safe at 1 lb for *Pinus radiata*. Good weed control, except of summer grass, is achieved at $\frac{1}{2}$ lb for a minimum of four weeks, commencing with a weed-free bed. Applied two weeks after total emergence, simazine at $\frac{1}{2}$ lb destroyed *Pinus contorta* and damaged the other species, whilst atrazine at this rate destroyed all species tested.

TOXIC RESIDUE ACCUMULATIONS FROM REPEATED TRIAZINE APPLICATIONS

In permanent plots sprayed with simazine and propazine twice a year after emergence, for two successive years at rates varying up to an annual total of 6 lb, no damage has been noted in any of the four conifers tested—*Pinus radiata*, *P. contorta*, *P. nigra* and Douglas fir—when they were sown again in the same plots during the third year of the experiment. The trial continues.

LINURON — A POSSIBLE ALTERNATIVE TO PROPAGINE FOR DOUGLAS FIR

Preliminary work showed that 50% active linuron is an effective weedkiller, not particularly damaging to grasses, but at the higher rates initially tested it caused very considerable damage to conifer seedlings of the four main species. Lower rates were employed in later trials. Applied immediately after sowing, $\frac{1}{16}$ lb caused no damage to emergent seedlings of *Pinus radiata* and Douglas fir, but slight damage to *Pinus nigra* and *P. contorta*. At $\frac{1}{8}$ lb *Pinus radiata* remained unscathed, Douglas fir suffered slight damage, and *Pinus contorta* and *P. nigra* suffered more severely. Applied three weeks after total emergence, linuron caused no damage to the four conifers at rates of $\frac{1}{8}$ and $\frac{1}{4}$ lb. At six weeks after total emergence

no damage occurred at rates of $\frac{1}{4}$ and $\frac{1}{2}$ lb. At these low rates weed control is limited to about a fortnight, clovers (*Trifolium* spp.) and twin cress (*Coronopus didymus*) soon invading the beds.

PREVENTION OF TRIAZINE LEACHING

Recently the possibility was investigated of preventing simazine and propazine from being leached through sandy soils into the rooting zones of seedling trees. Surface applications of bitumen, clay, and mixtures of clay and duff and of sawdust and gelatine were unsuccessful, although bitumen by itself exerted a measure of weed control.

THE USE OF ACTIVATED CHARCOAL AS A TRIAZINE NEUTRALIZER

The effectiveness of a barrier zone of activated charcoal between the seed and the triazine-sprayed surface of the bed was explored by: (a) placing a layer of charcoal immediately above the seed in the drill, (b) using a charcoal-soil mixture as a seed-covering medium, and (c) applying a layer of charcoal to the bed surface before adding a light covering of soil. All methods were a failure because the high intensity of charcoal-absorbed solar radiation proved too much for even the hardy *Pinus radiata* in this mid-December trial. Further investigations are planned.

THE ROLE OF SPECIFIC GRASS-KILLING CHEMICALS

Triazines do not control summer grass, which is a serious weed in the Rotorua district from November through the summer. Dacthal and trifluralin, two chemicals that promise to fill this need, are being tested.

Dacthal, 75% active, at 10 lb has proved particularly successful against summer grass, and has been used without ill-effect on the four main conifer species when applied three weeks after total emergence. When it was followed by propazine at $\frac{1}{2}$ lb or 1 lb, complete weed control was achieved. Dacthal at 10 lb as a pre-emergence spray immediately after sowing or at the time of first emergence depressed growth in Douglas fir, but was not harmful to the three pines.

Trifluralin, 48% active, has been tested by spraying it on the soil surface at rates of 3 lb and 4 lb. One of these screening trials involved grasses, the other an overall spraying of seedling conifers. Grass control was good, but the conifers sprayed three weeks after total emergence later showed stunted growth and thickened, glaucous secondary foliage. Trials with trifluralin incorporated in the soil, a more promising technique, will be carried out this spring.

CONTINUING RESEARCH

The Forest Research Institute nursery has undergone an almost complete metamorphosis during the past 18 months, and now has new buildings set in a new nursery. Greater facilities for laboratory, phytotron, and field experiments ensure that research in forest-weed control will expand.

New materials for highly specialized, broad-spectrum, and total vegetation control are constantly coming forward. These materials

have usually been formulated, screened, tested, and marketed for weed control in specific agricultural crops, but not for forest nurseries. Occasionally the literature accompanying the new chemical includes results of screening tests for a range of trees and shrubs — usually ornamentals — grown under North American and European conditions. For New Zealand use, these chemicals have to be approached cautiously, and research is essential before any recommendations for their wider adoption can be made.

REFERENCE

- Beveridge, A. E.; Hedderwick, G. W. (compilers and editors), 1962: *Chemical methods of vegetation control in New Zealand forestry; proceedings of a discussion held at the Forest Research Institute, 1962*. The Institute, Rotorua [Xerox].