CONTROL OF ANNUAL THISTLES IN ESTABLISHING RADIATA PINE

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Summary

Trial results and current practical usage of broadcast treatments of mixtures of picloram and 2,4,5-T for control of annual thistles among radiata pine (*Pinus radiata*) applied following planting are discussed. A mixture of 1.5 oz picloram plus 4 oz 2,4,5-T (both amine salts) or 1 oz picloram (potassium salt) plus 4 oz 2,4,5-T (iso-octyl ester) gave satisfactory thistle control, with acceptable tree tolerance when broadcast applied while trees were dormant following planting or when commencing growth in spring. Tolerance of radiata pine to the picloram/2,4,5-T formulations was greater than to 2,4,5-T alone at rates required for thistle control.

INTRODUCTION

IN RECENT YEARS, the aim of forest site preparation has been to obtain complete or near complete removal of competing vegetation before planting. These sites may often be rapidly recolonized by a variety of broadleaf plants and grasses. While some broadleaf plants have a useful function as "nurse" plants protecting establishing young trees from exposure, others are detrimental as they compete strongly for light, moisture and nutrients, or cause mechanical damage to young trees.

Annual thistles, especially Scotch thistle (*Cirsium vulgare*), are problem weeds on about 10,000 acres annually. They may often cause severe mechanical damage to the young trees or, if sufficiently dense, suppress tree growth. The standard method of releasing young trees from broadleaf weeds is by aerial application of the amine salt of 2,4,5-T (1.5 lb) or the ester of 2,4.5-T (up to 0.9 lb), but this has not consistently given satisfactory results. Preest (1966) and Bachelard and Boughton (1967) reported greater tolerance of radiata pine (*Pinus radiata*) to picloram than to the ester of 2,4,5-T at rates required to suppress competing broadleaf weeds adequately for tree release.

This paper reports on trials conducted in 1969-70 to evaluate the herbicidal efficiency of two formulations containing picloram and 2,4,5-T on annual thistles at rates tolerated by newly established radiata pine.

EXPERIMENTAL

Replicated small plot broadcast applications were made with a precision sprayer applying 20 gal of water per acre to 1/200 acre plots (31 ft × 7 ft) at 30 lb/sq.in. pressure. Rates of application are expressed as ounces active ingredient per acre. Visual evaluations of thistle control were carried out by at least two independent observers, using a 0 to 10 rating scale (0 = no control, 10 = complete thistle control).

In addition, counts of surviving thistles were made. The 0 to 10 scale was also used for assessment of tree tolerance (0 = completely stunted or dead, 10 = no visible growth suppression and no morphological effects). Ratings of tree tolerance below 7 indicate morphological effects which could permanently affect tree quality.

In the tolerance trials, tree heights were measured at the time of treatment and several times during the following six months. Growth measurements were expressed as proportional increase in the above ground height over the original height at the commencement of the trial.

Trials 225 and 352 were designed to assess Scotch thistle control and tree tolerance. Trial 051 measured effect of herbicide treatment and stage of growth on subsequent pine tolerance and overall growth. The various trial conditions are summarized in Table 1.

TABLE 1: SUMMARY OF TRIAL CONDITIONS

Trial No.	*Location*	*Trees Planted*	*Stage of Trees at Treatment*	*Thistle Infestation*
225	Whakamaru	Sept. 1969	Just commencing active growth (1/11/69)	Heavy—20% of ground cover. Seedlings up to 6 to 8 true leaves.
352	Whakamaru	Jul. 1969	Second year's active growth just commenced. 1-2 in. new leaders (20/11/70)	Moderate—15% ground cover. Early seedhead stage.
051	North Taranaki	Aug. 1970	During year of planting. Three stages: (a) Spring—trees dormant (31/8/70) (b) Moderately active after "flushing"—1½ in. new leaders (19/11/70) (c) Very active summer growth—6 in. new leaders (19/1/71)	None—trees maintained free of weed competition by directed application of 2,2-DPA (7.5 lb) + amitrole (4.0 lb).

RESULTS AND DISCUSSION

Thistle Control

The data obtained are summarized in Table 2.

In both trials, excellent control of thistles was obtained with picloram/2,4,5-T (amine) 1.5 + 4 oz, and picloram/2,4,5-T (ester) 1 + 4 oz. The amine salt of 2,4,5-T did not perform as consistently or as effectively as the picloram/2,4,5-T mixtures, while the ester of 2,4,5-T was equal to the picloram/2,4,5-T mixtures. Tree tolerance was adequate for all treatments and any morphological effects evident in the early evaluations had largely disappeared at the final inspections.

TABLE 2: THISTLE CONTROL AND TREE TOLERANCE

Treatment (oz)	Mean Visual Ratings: Thistle Control (5 wk)	Pine Tolerance (5 wk)	Pine Tolerance (13 wk)	Mean No. Thistles per plot (13 wk)
Trial 225:				
2,4,5-T (amine) 12	0	8.7	8.9	208
2,4,5-T (amine) 24	7.5	9.0	9.0	15
picloram 0.75/2,4,5-T (amine) 2	8.0	7.5	8.8	65
picloram 1.5/2,4,5-T (amine) 4	10	7.7	8.5	1
picloram 3/2,4,5-T (amine) 8	10	7.2	7.6	0
picloram 0.5/2,4,5-T (ester) 2	9.2	9.0	8.1	0
picloram 1/2,4,5-T (ester) 4	9.2	8.0	8.6	1
picloram 2/2,4,5-T (ester) 8	10	7.2	7.5	0
Control	0	10	10	127
Trial 352:				
2,4,5-T (amine) 12	8.5	10	10	8
2,4,5-T (ester) 16	10	8.8	10	6
picloram 0.75/2,4,5-T (amine) 2	10	9.0	10	0
picloram 1.5/2,4,5-T (amine) 4	8.5	9.2	10	0
picloram 3/2,4,5-T (amine) 8	9.5	8.5	10	0
picloram 0.5/2,4,5-T (ester) 2	7.0	9.5	10	0
picloram 1/2,4,5-T (ester) 4	10	8.8	10	4
picloram 2/2,4,5-T (ester) 8	10	8.0	10	0
Control	0	10	10	60

Tree Growth and Tolerance

Some of the tolerance and growth data obtained are summarized in Table 3.

Growth following applications to first-year trees during dormancy and after "flushing" were similar to untreated control for all treatments except those of 2,4,5-T (ester) applied in August which may have stimulated growth. However, when applications were made in January to trees supporting 6 in. of new leaders and growing vigorously, 2,4,5-T (ester) tended to depress growth at all rates. This was probably due to shoot dieback observed in these treatments. None of the remaining treatments affected overall growth except picloram 4 oz/2,4,5-T (ester) 16 oz which also tended to depress growth when applied in January.

The different formulations produced distinctive morphological effects on the trees. These effects were the most important factor in evaluating tolerance as they could lead to malformation in subsequent growth. All formulations caused initial mild chlorosis, sometimes twisting, and a flattening or rosetting of the needles near the terminal bud. 2,4,5-T (ester) applied at the high rates or during active summer growth caused needle burning and dieback of the leaders. Both formulations of picloram/2,4,5-T caused slight swelling of the apex and associated development of small, scale-like needles on some trees (especially when trees were dormant); or stimulation of lateral branching close to the apex. Excessive overdosage of picloram/2,4,5-T can cause complete inhibition of the

TABLE 3: TRIAL 051—GROWTH INCREMENT ON FIRST-YEAR TREES

Growth Stage of Pines	*Treatment (oz)*	*Tree Tolerance Mean visual rating (13 wk)*	*Growth Increment Since Spring "Flush" (25 wk)*	*(33 wk)*
Trees dormant (Aug.)	2,4,5-T (ester) 8	9.4	2.2	2.6
	2,4,5-T (ester) 16	8.5	2.1	2.6
	2,4,5-T (ester) 32	9.0	2.1	2.6
	picloram 1.5/2,4,5-T (amine) 4	8.6	1.9	2.4
	picloram 3/2,4,5-T (amine) 8	8.9	2.0	2.4
	picloram 6/2,4,5-T (amine) 16	7.8	1.6	2.0
	picloram 1/2,4,5-T (ester) 4	8.1	1.9	2.3
	picloram 2/2,4,5-T (ester) 8	7.8	2.1	2.5
	picloram 4/2,4,5-T (ester) 16	7.8	1.6	2.0
	Control	8.8	1.8	2.2
Moderately active after spring 'flush"— 1½ in. new leaders (Nov.)	2,4,5-T (ester) 8	10	1.6	1.9
	2,4,5-T (ester) 16	10	1.7	2.0
	2,4,5-T (ester) 32	10	1.8	2.2
	picloram 1.5/2,4,5-T (amine) 4	10	1.9	2.3
	picloram 3/2,4,5-T (amine) 8	10	1.9	2.3
	picloram 6/2,4,5-T (amine) 16	10	1.7	1.9
	picloram 1/2,4,5-T (ester) 4	10	1.8	2.2
	picloram 2/2,4,5-T (ester) 8	10	1.7	2.0
	picloram 4/2,4,5-T (ester) 16	10	1.7	2.2
	Control	10	1.8	2.1
Very active summer growth— 6 in. leaders (Jan.)	2,4,5-T (ester) 8	6.8	1.3	1.5
	2,4,5-T (ester) 16	6.2	1.4	1.7
	2,4,5-T (ester) 32	4.5	1.3	1.4
	picloram 1.5/2,4,5-T (amine) 4	7.5	1.5	1.8
	picloram 3/2,4,5-T (amine) 8	7.4	1.4	1.8
	picloram 6/2,4,5-T (amine) 16	6.8	1.4	1.8
	picloram 1/2,4,5-T (ester) 4	7.8	1.6	2.1
	picloram 2/2,4,5-T (ester) 8	7.0	1.5	1.8
	picloram 4/2,4,5-T (ester) 16	6.3	1.3	1.5
	Control	9.6	1.5	1.9

terminal bud and marked swelling of the leader, although none of the treatments used caused this effect.

Applications to first-year trees during dormancy produced very mild effects which had completely disappeared within four months, and all November treatments produced even fewer effects. Treatments applied when trees were growing very actively (January) produced marked morphological effects. Only picloram 1.5 oz/2,4,5-T (amine) 4 oz and picloram 1 oz/2,4,5-T (ester) 4 oz were tolerated adequately, while picloram 3 oz/2,4,5-T (amine) 8 oz and picloram 2 oz/2,4,5-T (ester) 8 oz were marginally acceptable. The higher rates of 2,4,5-T (ester) caused marked leader dieback (up to 46%), burning of new needles, and twisting. All picloram/2,4,5-T mixtures caused initial chlorosis and mild twisting. Picloram 4 oz/2,4,5-T (ester) 16 oz caused slight needle burning and picloram 6 oz/2,4,5-T (amine) 16 oz caused some temporary terminal bud suppression but no bud swelling.

In a further trial, not detailed in this paper, growth of second-year radiata pine was not appreciably affected by any of the treatments applied in early spring or during peak growth in summer. However, morphological effects of the herbicides were more marked and more persistent than on first-year trees, and response of individual trees was more variable. The highest rates adequately tolerated following spring application were the ester of 2,4,5-T (16 oz) picloram 3 oz/2,4,5-T (amine) 8 oz and picloram 2 oz/2,4,5-T (ester) 8 oz.

In actual broadcast aerial applications, A. Bowers (pers. comm.) reports excellent Scotch thistle control following mid-September treatment over newly planted 1/0 radiata pines with picloram 1.5 oz/2,4,5-T (amine) 4 oz in 5 gal of water per acre. Four random 100 sq.ft samples in the treated area revealed no surviving thistles, while similar sampling in an adjacent untreated area produced a mean population of 27 thistles per sample.

CONCLUSIONS

This trial series demonstrates the superiority of picloram/2,4,5-T formulations over the amine salt of 2,4,5-T in thistle control, and the ester of 2,4,5-T in tree tolerance when the latter is applied in the summer. Although no large differences in tree growth rates were observed with the different formulations, marked differences in morphological effects occurred, with the ester of 2,4,5-T causing serious damage when applied to rapidly growing trees. Picloram/2,4,5-T (amine) and picloram/2,4,5-T (ester) show similar tolerance to the ester of 2,4,5-T in early spring treatments but show an improved tolerance when applied to actively growing trees. They therefore offer a wider margin of safety in timing of application than the ester of 2,4,5-T alone.

Picloram/2,4,5-T (ester) down to 0.5 + 2 oz has given effective thistle control. However, because of variable on-target recovery of herbicides with hill country aerial applications, rates of picloram 1.5 oz/2,4,5-T (amine) 4 oz or picloram 1 oz/2,4,5-T (ester) 4 oz are recommended. The tolerance data obtained indicate that these dosages could be safely applied to first- and second-year trees at all growth stages. However, only during dormancy and in early spring do second-year trees exhibit the generally desirable double-dose safety margin. Fortunately, this coincides with completion of thistle germination just prior to the rosette expansion stage when interplant competition can reduce pine survival. As in agricultural crops, the greatest crop benefit is obtained by control of weeds at the earliest possible stage before they actively compete with the crop. The phenomenon of greatest pine tolerance to growth-regulator type herbicides occurring soon after planting is curiously contrary to experience in agricultural crop weed control. This is apparently related to growth rate of pines at the time of treatment and warrants further study. These experiments should also be repeated with other conifer species, especially Douglas fir (*Pseudotsuga menziesii*).

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