DEPARTMENTAL TRIALS WITH PICLORAM

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Summary

The effects of picloram on specific weed species are mentioned, together with brief discussion on practical means of control. It appeared that the minimum rate required for complete control was 0.5 lb a.i./acre for *Equisetum arvense* and *Phytolacca octandra*, 1 lb for *Rubus* spp. and *Lonicera japonica*, 1.5 lb for *Hypericum androsaemum*, while *Ulex europaeus* required more than 2 lb. *Rosa rubiginosa* was also susceptible. In pasture, 8 oz controlled *Rumex* spp., and 10 oz was the minimum rate for *Cirsium arvense* in the vegetative stage. Established *Trifolium repens* was eliminated by 3 oz and residual effects remain in the soil for at least 12 months. Without damaging fine turf grasses, 2 oz controlled most hard-to-kill broadleaf weeds. It has limited application in crops, as there is little margin of selectivity. Possible areas of use could be cereals and leafy brassicas. Picloram was shown to be more toxic than dicamba or 2,3,6-TBA.

INTRODUCTION

IN THIS PAPER, an attempt is made to bring up to date the largely interim results presented previously (Patterson, 1964). The results mentioned are from experimental work being carried out by various officers within the N.Z. Department of Agriculture. Elsewhere in the *Proceedings*, Leonard (1965) gives details of work he has carried out with picloram in the control of sweet brier (*Rosa rubiginosa*) and gorse (*Ulex europaeus*). There are over 100 trials in progress, and only results of major importance can be given in any detail.

All rates mentioned are expressed in terms of active ingredient per acre. Except where stated otherwise, the potassium salt of picloram was used, and refers to the product "Tordon"* containing 17.3% w/v.

CONTROL OF SCRUB WEEDS

BLACKBERRY (*Rubus* spp.)

A late April application of 3 lb of 2,4,5-T to low-growing blackberry, gave a complete defoliation, but within 12 months the plants had regrown normally. However, promising control was obtained with an application of 3 lb of the butoxyethanol ester of 2,4,5-T plus 0.75 lb of picloram. At 1 year this had allowed only a little recovery from the rootstock, all previously treated canes being dead. A mixture of the amine salts of 2,4-D and picloram at 2.8 lb plus 0.75 lb, respectively, gave poor permanent control. Picloram at 0.75 lb gave fairly good control but some normal regrowth occurred. Well-grown bushes of the East Coast variety treated in late January with 4 lb of 2,4,5-T showed prolific basal

* Registered trademark of the Dow Chemical Company, U.S.A.

regrowth within 9 months. Dicamba and 2,3,6-TBA each at 15 lb gave good control but did not completely prevent regrowth, which was distorted. Amitrole-T at 4 lb did not prevent vigorous new leaf growth from previously treated canes. However, there was little regrowth from applications of 1.44 and 2.9 lb of picloram.

BRACKEN FERN (*Pteridium esculentum*)

Picloram at 1.44 lb in one trial gave an initial kill of fronds but after 15 months the treated areas were covered with new fronds. Other treatments were somewhat similar. In another trial 1.73 lb of picloram gave a 100% kill with only a few deformed yellow stalks remaining. A rate of 0.87 lb was only half as effective.

CAPE IVY (*Senecio mikanioides*)

Picloram at 0.5 lb gave a 100% kill, as did a mixture of the amine salts of 2,4-D and picloram at 2.4 lb plus 0.65 lb respectively, but dicamba at 2 lb gave only an initial foliage kill.

GORSE (*Ulex europaeus*)

Table 1 shows the results from 5 replicated and randomized trials in the South Island, of which 4 were carried out by F. A. Meeklah at Invermay. The rate of carrier used in the first 4 trials was 120 gal water per acre applied by a portable mist blower.

TABLE 1: PERCENTAGE KILL OF GORSE (MAIN TRIALS)

Trial Details					
Date sprayed	Dec. 3	Feb. 12	Feb. 13	Feb. 18	Mar. 31
Amt. of flowers	Many	None	None	None	Some
Observations made	12 mon.	15 mon.	10 mon.	15 mon.	12 mon.
Treatment (lb)					
2,4,5-T (butyl ester) 3.6	70	90	95	95	—
2,4,5-T (butyl ester) 4.0	—	—	—	—	30
Picloram 0.36	—	10	10	—	—
Picloram 0.72	30	10	10	10	—
Picloram 1.44	50	55	65	20	—
Picloram 1.73	—	—	—	—	50
Picloram 2.9	85	—	—	55	95

In the Wellington district, in replicated pilot trials including monthly sprayings, picloram was inferior to the butoxyethanol ester of 2,4,5-T for foliage and stem kill after 9 to 12 months, as shown in Table 2.

TABLE 2: AVERAGE PERCENTAGE KILL OF GORSE (PILOT TRIALS)

	2,4,5-T 4 lb	*Picloram 1.44 lb*
SINGLE BUSHES		
October-November	75	30
December-February	70	20
March-April	45	10
PLOTS		
November	80	65
February	80	50

There was some variability, particularly with single bushes, but the table shows the relative susceptibility of gorse to the two materials. In a recent trial, promising results have been obtained from 10 and 20 g of 2% active pellets per bush as a basal application near the root of the bush.

Thus it appears that spray applications of picloram are not as effective as 2,4,5-T for a general foliage kill or brown-off of gorse, unless rates of over 2 lb are employed. The regrowth occurring from both treatments are fairly normal except that at the higher rates picloram causes proliferation. From other more recent trials, it is yet too early to evaluate the relative effectiveness of combining the ester or amine salt formulations of 2,4,5-T with picloram as against the use of higher rates of 2,4,5-T.

Honeysuckle (*Lonicera japonica*)

Picloram at 1.44 lb gave complete control of mature honeysuckle, but 0.72 lb was not nearly as effective. However, these rates checked the barberry (*Berberis vulgaris*) hedge and retarded the growth of new shoots in the spring. Dicamba and 2,3,6-TBA were not satisfactory, even at 10 lb.

Horsetail (*Equisetum arvense*)

This is susceptible to picloram at about 0.5 lb, whether alone or in mixture with 2,4-D.

Inkweed (*Phytolacca octandra*)

A late January application of 1.44 lb of picloram to inkweed in the early fruiting stage gave a complete kill. A 4 lb rate of dicamba although initially giving a complete defoliation and an apparent kill of stems, was not sufficient to prevent vigorous regrowth. Applications of 0.72 lb picloram in April at the green berry stage also gave complete kills, as did a mixture of the amine salts of 2,4-D and picloram at 2.4 plus 0.65 lb respectively. Dicamba at 4 lb was almost as effective, but the ethyl ester of 2,4-D at 2.4 lb was not.

Sweet Brier (*Rosa rubiginosa*)

Most of the experimental results on sweet brier are reported elsewhere by Leonard (1965), where picloram is shown to be a most promising chemical in spray applications to sweet brier. It can be applied either as an overall spray or in concentrations of about 1:100 in water for spot spraying. A method of application shown to have great promise is that of basal application either of picloram or 2,3,6-TBA formulated in pellets. These are dependent upon rainfall and soil moisture to penetrate the root zones, for translocation within the plant system. In some trials pellets have remained on the surface for 2 to 3 months before rain fell to activate them. In contrast, sprays cause a fairly rapid defoliation to take place. In two trials being conducted by F. A. Meeklah, picloram pellets are giving better control than 2,3,6-TBA at equivalent rates. This is shown in Table 3, for Trial A treated August 18, 1964, and Trial B on September 3, 1964, when all brier had green leaf buds.

TABLE 3: PERCENTAGE GREEN GROWTH OF SWEET BRIER AFTER 8 MONTHS

Treatment (g/bush)	*Trial A* 0	2	4	8	*Trial B* 0	2	4	8
Picloram	—	—	0	0	—	—	0	4
2,3,6-TBA	—	84	52	—	—	30	2	—
Untreated	100	—	—	—	58	—	—	—

In Trial B the percentage of green growth for the untreated is less than 100 as some of the bushes were affected, probably by being near to treated areas. A distinct feature of the picloram treatments was an area of about 20 sq. ft of dead vegetation occurring beneath each bush. This was not so marked with 2,3,6-TBA. As spray applications, results show that equivalent rates of dicamba are slightly better than 2,3,6-TBA but not as effective as picloram.

TUTSAN (*Hypericum androsaemum*)

An attempt is made to summarize the results of 13 simple trials where similar treatments were not used throughout. The butoxyethanol ester of 2,4,5-T gave a rapid knockdown of foliage and smaller branches, but basal regrowth occurred in the spring. Any kill obtained was generally of the smaller bushes. There was no difference between the 1 and 2 lb rates, or in the addition of a sticker. It also appeared that the amine salt of 2,4,5-T at rates of up to 2 lb were just as ineffective as the ester.

Though appearing slower acting, picloram was permanent in its effect, particularly at the higher rates, as shown by the dead roots and foliage, with no subsequent regrowth. Rates of 1.44 lb gave complete kills, and lower rates of 0.5 and 0.75 lb were not quite as good. With a view to reducing cost, lower rates of picloram were combined with 2,4,5-T as well as 2,4-D. In general, the mixture containing 2,4,5-T gave better control than those with 2,4-D at similar rates or concentrations. In the only trial where a direct comparison was made, the addition of the amine salt of 2,4,5-T to picloram did not increase the degree of kill over that obtained with picloram alone. It appears that the minimum rate of picloram in any mixture necessary for a good kill was about 0.5 lb. Applying 2,4,5-T at a concentration of 1:25 v/v gave no permanent kill, but a commercial picloram/2,4-D mixture containing 5% and 20% w/v, respectively, applied at 1:25 v/v gave 100% kill 8 months later, and 1:50 a 50% kill. Wherever picloram was used, clovers (*Trifolium* spp.) were killed and were not present 12 months later, whereas clovers were only temporarily affected by 2,4,5-T. Table 4 shows the average percentage kill obtained from picloram, 2,4,5-T and some of the various combinations of these two materials, when applied at various stages of growth.

Rain on April 8 reduced the kill in the fourth trial.

Other materials such as borax and amitrole-T gave some knockdown but regrowth soon took place. The use of 2,3,6-TBA and particularly dicamba looked promising after good foliage kills, but rates of up to 20 lb did not prevent regrowth occurring.

TABLE 4: AVERAGE PERCENTAGE KILL OF TUTSAN

Trial Details							
Date sprayed	Nov. 17	Nov. 20	Feb. 10	Apr. 7	Apr. 9	Aug. 17	Sep. 11
Stage of growth	Flow. Comm.	Flow. Comm.	Setting Seed	Berries	Berries	Spring Shoots	Veg.
Observations made	6 mon.	12 mon.	9 mon.	9 mon.	11 mon.	9 mon.	5 mon.
Treatment (lb)							
Picloram 0.25	—	—	—	—	50	—	—
Picloram 0.36	—	—	—	20	—	—	—
Picloram 0.5	30	—	—	—	90	—	—
Picloram 0.72	—	100	—	30	—	50	50
Picloram 1.44	100	100	100	—	—	80	100
2,4,5-T (ester) 2	50	25	10	—	0	0	0
2,4,5-T (amine) 2	—	—	—	0	—	—	—
Picloram 0.25/2,4,5-T 1	45	—	—	20	10	—	—
Picloram 0.36/2,4,5-T 2	—	—	—	30	—	—	—
Picloram 0.5/2,4,5-T 1	90	—	—	—	90	—	—
Picloram 0.5/2,4-D 1.9	—	—	—	—	50	—	—

TUTU (*Coriaria* spp.)

In a recent trial a picloram/2,4,5-T mixture gave a 100% defoliation, whereas 2,3,6-TBA was not quite as effective.

WILLOWS (*Salix fragilis*)

Picloram as an aqueous concentration of 1:5 gave a complete kill when painted on freshly cut stumps or applied to a frilled tree of 14 in. diameter. Similar results were obtained with an oil-soluble ester concentrate of 2,4-D sprayed on regrowth and frilled stumps at a concentration of 1:20 of diesel oil.

WEED CONTROL IN PASTURE

DOCKS (*Rumex* spp.)

Picloram at 1.44 lb has given 100% control for over 18 months, whereas the amine salt of 2,4-D gave only a defoliation for 6 to 9 months. The amine salts of 2,4-D and picloram at 1.5 plus 0.4 lb gave a 95% kill. Dicamba at 10 lb gave no permanent control.

CALIFORNIAN THISTLE (*Cirsium arvense*)

Table 5 shows the average reduction of Californian thistles after 12 months in 6 detailed trials.

TABLE 5: AVERAGE PERCENTAGE REDUCTION OF CALIFORNIAN THISTLE NUMBERS

MCPA 1.5 lb	40
Picloram 2.9 oz	45
Picloram 5.8 oz	50
Picloram 11.5 oz	85
Picloram 23.0 oz	95
Picloram 46.0 oz	100
Picloram 6.4/2,4-D 1.6 lb	65
Picloram 9.6/2,4-D 2.4 lb	70

Overall it appears that the minimum rate of picloram required for satisfactory control is about 10 oz. The best control with picloram was obtained when it was applied from the vegetative rosette to the early bud stage, rather than at the flowering stage where the control was much poorer, unless high rates were used. Other materials such as dicamba and 2,3,6-TBA were no better than MCPA unless high rates were used.

MISCELLANEOUS SPECIES

Picloram at 1 lb had no effect on leafy *Iris foetida*. The low-growing plant woodsage (*Teucrium scorodonia*), with a creeping rootstock, was killed by a mixture of the amine salts of 2,4-D and picloram at 2 plus 0.5 lb, respectively.

CLOVER TOLERANCE

In trials where picloram had been applied to pasture swards, 2.9 oz severely reduced the vigour and amount of established white clover (*Trifolium repens*) present, but 5.8 oz eliminated it. Ryegrass (*Lolium perenne*) was not affected by 18.3 oz.

WEED CONTROL IN TURF

A winter application of picloram was found to be more severe on chewings fescue (*Festuca rubra* var. *fallax*) than browntop (*Agrostis tenuis*). The general effect on the grasses by picloram is shown in Table 6.

TABLE 6: EFFECT OF PICLORAM ON TURF GRASSES

Treatment (oz)	*General Effect*	*Length of Time, Vigour Affected*
Picloram 2	None	Nil
Picloram 4	Slight yellowing	4 weeks
Picloram 8	Yellowing, 6 weeks	8 weeks
Picloram 16	Severe	12 weeks

The lowest rate used, 2 oz, killed white clover, chamomile (*Matricaria discoidea*), hawksbeard (*Crepis capillaris*), daisies (*Bellis perennis*), onehunga weed (*Soliva* spp.) but not toad rush (*Juncus bufonius*). It was far superior to MCPA mixtures containing mecoprop and 2,4,5-T. A rate of 8 oz has eliminated waxweed (*Hydrocotyle americana*) and dovesfoot (*Geranium molle*) from lawns. In giving excellent weed control, picloram has caused more bare ground with a consequent increase in moss.

WEED CONTROL IN CROPS

Picloram at 1.5 oz has caused significant yield reductions of linseed, while rates of 3 and 6 oz caused severe distortion with delayed development of the crop. Wheat treated with 2.4 oz picloram at the 8-leaf stage showed no evidence of damage, and the good weed control resulted in significant yield increases. Although this rate gave excellent control of wireweed (*Polygonum aviculare*) and fathen (*Chenopodium album*), lower rates required the addition of the amine salt of 2,4-D for wireweed and redshank (*Polygonum persicaria*). Spurrey (*Spergula arvensis*) was somewhat tolerant. In brassica crops, picloram can be used but with little margin of safety. Californian thistle warrants the addition of picloram to nitrofen. The use of picloram on root brassicas is doubtful as even 1 oz causes abnormalities and decay in soft turnip and swede roots. Leafy brassicas such as choumoellier and kale can tolerate up to about 3 oz.

PROBLEM OF RESIDUES

There was little evidence of residual toxicity to germinating clover seedlings after picloram-treated areas were cultivated and resown. However, in a trial at Hamilton, it was shown that an 80% reduction in white clover occurred from 2.9 oz picloram applied 14 months previously, to a choumoellier crop which 15 weeks later was rotary-hoed to a depth of 4 to 5 in. and then sown. Even the low rate of 0.7 oz gave a 30% reduction. It was observed at the Marton Experimental Area that, 11 months after a low application of picloram to brassicas, potatoes subsequently planted in the rotary-hoed area had damaged foliage. It was also observed (Newton, pers. comm.) that 4 oz of picloram applied to the soil surface, followed later by 3 deep cultivations, caused severe leaf and root malformation on tomatoes transplanted 7 months later.

GENERAL DISCUSSION

Undoubtedly, picloram has found a place among the many herbicides available in New Zealand for the control of a number of difficult-to-kill weeds. A major problem associated with the use of picloram is that of the susceptibility of clovers, either as established plants or germinating seedlings. Therefore, any recommendation made for the use of picloram would have to take this factor into consideration. For thick infestations of susceptible scrub weeds, an aerial application of a mixture of picloram and 2,4,5-T would be required, together with subsequent fertilizers, seed and stocking management to implement final control. Scattered bushes can be treated with pelleted formulations, or spot sprayed to minimize soil residues for subsequent pasture establishment. It appears that gorse is not in the category of inkweed, sweet brier, tutsan or blackberry as being susceptible to picloram. However, further experimental work may prove that economic control of gorse can be obtained with the use of the amine salts of 2,4,5-T and picloram in combination.

In cereal crops, it will probably join the many herbicides already available, but further work is necessary to determine the limit of crop tolerance in the light of reported damage overseas (Friesen *et al.*, 1964) from 4 oz of dicamba. In pastures, spot spraying of Californian thistles will be necessary to avoid eliminating clovers unless used as an overall spray prior to cultivation. It is likely that picloram will be useful for the control of all broadleaf weeds, normally tolerant to hormones, amongst fine turf grasses.

ACKNOWLEDGEMENTS

As the writer carried out only part of the experimental work referred to, he wishes to acknowledge the work of other officers in the Research and Farm Advisory Divisions, and in particular, results from S. Picken and A. Whatman on tutsan, B. Gunning on honeysuckle, and F. A. Meeklah on gorse.

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