OVERSEAS AND NEW ZEALAND FIELD RESULTS WITH "TORDON"*

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Summary

In experimental work conducted to date, "Tordon" has so far proved considerably more active than accepted herbicides for the control of broom (*Cytisus scoparius*), inkweed (*Phytolacca octandra*), blackberry (*Rubus* spp.), sweet brier (*Rosa rubiginosa*), Californian thistle (*Cirsium arvense*) and docks (*Rumex* spp.). When "Tordon" is applied in conjunction with compatible formulations of 2,4-D and 2,4,5-T there is evidence of more complete stem kill than with "Tordon" alone and both appear to contribute to the final result. The toxicity of "Tordon" toward legumes may preclude its use on established pastures except as a spot application.

INTRODUCTION

FOLLOWING the initial introduction of "Tordon" to New Zealand research workers and the preliminary description of its herbicidal properties (Pengelly, 1963), critical field experiments were commenced on a variety of troublesome and hard-to-kill weeds in New Zealand. Because of the perennial habit of many of these weeds, trials have not yet reached their conclusion and the results discussed in this paper must be regarded as interim only. Wherever possible, trials have been evaluated regularly since laying down but, for reasons of brevity, only the most conclusive observations are presented and discussed. All rates refer to lb active material.

BROOM (*Cytisus* spp.)

It is commonly accepted that the broom occurring in the South Island of New Zealand is more difficult to control with phenoxy-acetic herbicides than that in the North Island. This is possibly due to the more severe environmental conditions leading to toughened growth generally obtaining in the south. Two trials are being conducted at Oxford, North Canterbury, to investigate the effects of "Tordon" alone and in combination with 2,4,5-T and 2,4-D. The broom is of a uniform age stand growing on an abandoned railway line and is typical of the "hard-to-kill" infestations common on many gravel soils of the South Island. The following tabulation shows details of the trials:

Trial	Sprayed	Height of Broom	Growth Stage
1	Oct. 6, 1963	2-6 ft	Active, before flowering.
2	Nov. 11, 1963	4-8 ft	Full flower to early pod.

Treatments were applied by means of conventional high pressure equipment at about 250 lb/sq. in. and sprayed just to the point of run-off. Application details are shown in Table 1.

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TABLE 1: APPLICATION DETAILS

Treatment (lb/100 gal)	Estimated Volume Required per acre of Actual Broom		Estimated lb per acre of Actual Broom	
	Trial 1	Trial 2	Trial 1	Trial 2
2,4,5-T (amine) 2.0	450	550	9.0	11.0
2,4,5-T (butoxyethanol ester)	450	550	4.5	5.5
"Tordon" 0.7	450	550	3.2	3.9
"Tordon" 0.35+2,4-D (amine) 1.35	450	550	1.6+6.1	1.9+7.4
"Tordon" 0.35+2,4,5-T (amine) 1.0	450	550	1.6+4.5	1.9+5.5

TABLE 2: EFFECT ON BROOM

Treatment (lb/100 gal)	Brown-off		Trial 1*		Mean		Brown-off		Trial 2†		Mean	
	Stem Kill	Stem Kill	Stem Kill	Stem Kill	Stem Kill	Stem Kill	Stem Kill	Stem Kill	Stem Kill	Stem Kill	Stem Kill	Stem Kill
2,4,5-T (amine) 2.0	6.0	2.4	4.2	4.5	7.5	1.5	4.5	7.7	4.5	7.7	4.5	7.7
2,4,5-T (butoxyethanol ester) 1.0	8.5	4.5	6.5	9.0	9.0	6.4	7.7	9.6	9.0	6.4	7.7	9.6
"Tordon" 0.7	(9.0)	(6.8)	(7.9)	(7.9)	10.0	9.2	9.6	9.7	9.2	9.2	9.6	9.7
"Tordon" 0.35+2,4-D (amine) 1.35	10.0	9.7	9.9	9.9	9.5	9.8	9.7	9.5	9.8	9.8	9.5	9.7
"Tordon" 0.35+2,4,5-T (amine) 1.0	9.8	8.9	9.4	9.4	9.3	9.7	9.5	9.3	9.7	9.7	9.5	9.5

() Very uneven population of broom.

Ratings:

0=No effect. 10=Complete kill. *=After 31 weeks. †=After 27 weeks.

The amine formulation of 2,4,5-T employed in these trials was the triethylamine salt and 2,4-D/"Tordon" was the triisopropanolamine salt. "Tordon", both alone and in mixture with 2,4,5-T was as the potassium salt.

Although it is not yet possible to determine the final percentage of kill obtained from these treatments, an indication of the probable effectiveness of "Tordon" both alone and in mixture with phenoxy compounds can be deduced despite the fact that the treatments were applied only last spring. Observations recorded are shown in Table 2.

The unsatisfactory results obtained with 2,4,5-T ester is typical of its performance against South Island broom. The amine salt at even twice this rate also failed to give acceptable control. It is obvious that, after only six months, the activity of "Tordon" against broom is far greater than 2,4,5-T ester or amine. The most significant difference between these compounds would appear to be in the percentage of stem kill obtained in the relatively short period since treatment. The emergence of the mixture of "Tordon" and 2,4-D as the best treatment, to date, is most interesting. The obvious cost efficiency of this mixture compared with "Tordon" alone or "Tordon" plus 2,4,5-T would make this a preferred treatment on a cost basis. The mixture of "Tordon" and 2,4,5-T has so far given results very similar to those obtained with the "Tordon" plus 2,4-D mixture. A feature of all treatments containing "Tordon" is the unusual degree of disintegration of the broom. After six months, only main stems and branches remain, lighter tissue having fallen to the ground. Similar observations have been reported overseas on other species, and this characteristic is regarded as significantly beneficial where land is being cleared for grazing.

INKWEED (*Phytolacca octandra*)

Inkweed growing in a relatively frost-free environment near New Plymouth was treated by means of a mistblower unit on August 15, 1963. The inkweed was about to commence spring growth and was in the green fruit stage. Treatments and results are shown in Table 3.

TABLE 3: EFFECT ON INKWEED

Treatment (lb/acre)	Rating	
	8 weeks	28 weeks
2,4-D (amine) 4.0	4.5	0.0
"Tordon" (K) 0.7	7.5	9.7
"Tordon" (K) 1.4	7.7	10.0
"Tordon" (K) 0.35+2,4-D (amine) 2.0	5.0	7.7
Dicamba (amine) 4.0	5.5	10.0

0=No effect. 10=Complete kill.

The amine salt of 2,4-D gave good initial top kill but complete recovery eventually took place. "Tordon" alone at both rates gave near perfect control and after 7 months even the largest inkweed bushes had completely disintegrated. "Tordon" plus 2,4-D amine was slightly less effective but it should be appreciated that this was virtually an out-of-season application and that 2,4-D would not normally be recommended during a period of such limited growth

activity. Dicamba at three to six times the rate of "Tordon" also gave complete control, although slower in initial reaction.

Trials laid down in January and February, 1964, have confirmed the effectiveness of "Tordon" and "Tordon" mixtures against inkweed but insufficient time has elapsed to justify drawing absolute conclusions. Because of the known activity of 2,4-D against this weed, efforts have been concentrated on evaluating mixtures of "Tordon" and 2,4-D in an attempt to reduce the cost of treatment. Present indications are that, from both the cost and efficiency viewpoints, a treatment consisting of about 0.25 lb "Tordon" and 1.0 lb 2,4-D amine per 100 gal of water offers most promise. Applied as a wetting spray during active growth from full leaf until early fruiting, this mixture appears at present capable of giving very acceptable control.

BLACKBERRY (*Rubus fruticosus* complex)

In certain parts of Australia and New Zealand, particularly Victoria and on the East Coast of the North Island, respectively, considerable difficulty is experienced in controlling blackberry with esters of 2,4,5-T. A trial was laid down in Hawke's Bay on October 16, 1963. The blackberry was in fresh active leaf growth prior to bud formation which was earlier than would normally be recommended for 2,4,5-T ester treatment. A summary of treatments and results is shown in Table 4.

TABLE 4: EFFECT ON BLACKBERRY

Treatment (lb/100 gal)	Estimated lb/acre of actual blackberry	Ratings: 6 months	
		Top Kill	Regrowth Suppression
2,4,5-T (amine) 2.0	9.0	8	2
2,4,5-T (butoxyethanol ester) 1.0	4.5	8	4
Amitrole-thiocyanate 4.0	18.0	5	8
"Tordon" (K) 0.7	3.15	9	8
"Tordon" (K) 0.35+			
2,4,5-T (amine) 1.0	1.58+		
	4.5	9	9

0 = No effect. 10 = Maximum effect.

After six months, strong regrowth is evident on both 2,4,5-T treatments. Although some slight regrowth is present from the amitrole-thiocyanate treatment, this is chlorotic and grossly proliferated and will possibly fail to survive. A small amount of new growth is also present on both the "Tordon" alone treatments and the mixture of "Tordon" and 2,4,5-T and, although this exhibits residual "Tordon" symptoms, this is unlikely to prevent some eventual recovery.

Substantially the same results have been obtained with "Tordon" and "Tordon" plus 2,4,5-T mixtures in Australia, where 2,4,5-T ester applied alone in excess of 2.5 lb per 100 gal has not given acceptable control.

It would appear at this stage that, while "Tordon" is more active than 2,4,5-T on blackberry, complete eradication of this weed may not be possible with a single application made in mid-spring. It would also appear that a mixture of "Tordon" and 2,4,5-T is equally active as straight "Tordon" applied at twice the rate employed in the mixture. This is significant from the cost viewpoint.

SWEET BRIER (*Rosa rubiginosa*)

"Tordon", both alone and in mixture, is being evaluated against this very difficult-to-kill weed. Because of its known propensity to recover from phenoxyacetic herbicides following a complete top kill, no firm conclusions are drawn from these trials which were only commenced in the spring of 1963. However, results to date indicate that "Tordon" is very active against sweet brier and is the only compound so far evaluated which will completely suppress regrowth from large (200 stem) bushes in the first growing season following application.

Mixtures of "Tordon" at lower rates plus 2,4,5-T appear slightly less active against this difficult multiple-stemmed form of sweet brier. Small bushes up to 5 ft in height appear more susceptible to mixtures of "Tordon" and 2,4,5-T and the latter component could well be beneficial in obtaining more rapid top kill. A rather surprisingly successful result was obtained with a mistblower application of a mixture of "Tordon" and 2,4-D on an infestation of young brier and this more economic combination is certainly worthy of further investigation.

A granular formulation of "Tordon" having a 7.2% active ingredient content on an attapulgate clay has been evaluated and shows real promise against sweet brier. In contrast to fenuron which is non-selective and results in bare ground in the treated area, "Tordon" granules appear quite selective on grasses except when applied at massive local concentrations. It appears that a granular formulation of "Tordon" may control sweet brier in younger infestations, and when evenly applied around the drip-line of the bush, could prove completely selective to grasses. The most effective time of application suggested is in late winter to early spring before bud burst and when there is likely to be sufficient moisture to wash the "Tordon" into the root zone.

CALIFORNIAN THISTLE (*Cirsium arvense*)

Californian thistle growing in established pasture is notoriously difficult to control with phenoxy compounds. In trials conducted in South Taranaki, "Tordon" proved more active than phenoxy compounds when applied to Californian thistle in vigorous growth prior to and during early flowering.

In one trial, treatments were applied on October 30. A brief summary of effective treatments and results is shown in Table 5.

TABLE 5: EFFECT ON CALIFORNIAN THISTLE

Treatments (lb/acre)	Ratings	
	9 wks.	18 wks.
2,4-D (amine) 1.0	6.9	6.3
"Tordon" 0.18 + 2,4-D 0.7 (both amine)	6.6	4.9
"Tordon" 0.35 + 2,4-D 1.3 (both amine)	7.8	7.7
"Tordon" (K) 0.35	8.7	7.3
"Tordon" (K) 0.7	9.1	8.3
"Tordon" (K) 1.4	9.3	9.2

0 = No control. 10 = Complete eradication.

It appears that all treatments gave the maximum degree of top kill at about 9 weeks as fresh regrowths were evident after 18 weeks. This accounts for the lower ratings at that time. No treatments have given complete control but regrowths from "Tordon" alone at the 0.7 lb and 1.4 lb per acre rates showed marked symptoms of residual "Tordon". A second trial laid down in December confirmed these results and also showed "Tordon" at rates from 0.35 lb and higher to be considerably more active than MCPA, MCPB and dicamba at 2 lb per acre.

The toxicity of "Tordon" towards white clover and other pasture legumes was clearly demonstrated in these trials. After more than 3 months, white and red clover was absent from all treatments where "Tordon" was applied at rates in excess of 0.18 lb per acre. The usefulness of "Tordon" for the control of Californian thistle in pastures is undoubtedly reduced by its clover toxicity. Spot treatment appears the only practical means of applying this potent herbicide. The soil persistence of "Tordon" when applied to pastures at rates sufficient for the control of Californian thistle is obviously an important subject for future investigation.

The effectiveness of "Tordon" in conjunction with crop competition is discussed by Mason (1964). Usage in these circumstances may be more practical than treatment in established pasture.

DOCKS

(*Rumex* spp.)

"Tordon" alone and in mixture with 2,4-D has shown to be more active than any other herbicide evaluated previously on mature broadleaf docks (*Rumex obtusifolius*). Evidence obtained from one replicated trial in North Taranaki showed "Tordon" alone to be approximately four times as effective as dicamba on an equivalent dosage basis. "Tordon" at 0.35 lb per acre in mixture with 2,4-D amine at 1.3 lb per acre appeared capable of giving almost complete control of mature broadleaf docks. At this rate, however, clover damage was extremely severe.

Several trials in Australia have shown 2 or 3 oz of "Tordon" per acre to be adequate for controlling dock seedlings.

As with Californian thistle, treatment of this weed in permanent pasture appears practicable only as a spot application. Unfortunately, docks germinate readily from seed and even complete eradication of the population present at treatment may provide only temporary relief from this aggressive weed. It is a matter for conjecture whether this possibly short-term control is adequate compensation for the loss of the clover component of the sward.

CONCLUSIONS

Results obtained to date on broom, inkweed, sweet brier, Californian thistles and docks have shown "Tordon" to be more active than presently accepted herbicides. Because these weeds are all perennials, final conclusions cannot be drawn until all possibility of recovery is eliminated after the spring of 1964. However, interim results on the weed species discussed show this new compound to be a most promising addition to the field.

It is theorized that the phenoxyacetic compound causes a more rapid initial kill of the terminal growth system of the weed, leaving the residual action of the "Tordon" to act slowly on the lower lateral, basal or underground buds which are often not adequately controlled by "phenoxys" alone. Because of this, it appears possible to employ sub-lethal dosages of each component to obtain a kill.

The toxicity of "Tordon" to legumes precludes its use as a broadcast treatment, and spot application appears the most likely technique for the employment of "Tordon" on pasture. The high persistent activity of "Tordon" against many perennial and woody species suggests it may have widespread application on many New Zealand problem weeds when supplemented by present standard herbicides.

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