PERSISTENCE OF 3,6-DICHLOROPICOLINIC ACID AND DICAMBA RESIDUES IN THE SOIL

A. RAHMAN, B.E. MANSON AND P. SANDERS

*Ruakura Soil and Plant Research Station
MAF, Hamilton*

SUMMARY

The residual activity of 3,6-dichloropicolinic acid (3,6-DCPA) and dicamba was investigated in eight field trials laid down on permanent or short-term pastures in different parts of the country. Soil samples were collected at weekly intervals from 0-3 cm depth and bioassayed in the glasshouse using subterranean clover (*Trifolium subterraneum*) and peas (*Pisum sativum*) as test species. The time required for 3,6-DCPA residues to fall to safe levels which would allow clover establishment varied from 4-5 weeks for 100 g/ha rate, 6-7 weeks for 200 g/ha and 7-8 weeks for the 400 g/ha rate. The times for dicamba were 4-5 weeks for 300 and 400 g/ha rates and 6-7 weeks for the 800 g/ha rate. Soil temperature, soil texture and rainfall all affected the persistence of both herbicides in the soil.

INTRODUCTION

The herbicide 3,6-DCPA (Dowco 290) is a structural relative of picloram producing auxin type responses in dicotyledonous plants. Its persistence in soil is short relative to picloram and at low rates it can be used as a selective herbicide (Haagsma 1975; Naish 1975; Rutherford and Lobb 1979). Recent work indicates that this chemical may also be useful as an additive to non-residual herbicides for control of white clover (*Trifolium repens*) in minimum tillage situations (Moore 1979). Dicamba has also been used as an additive to paraquat and more recently to glyphosate mainly for control of white clover prior to drilling of pastures and crops into uncultivated ground (Cox 1977; Leonard and Hart 1977).

One of the main requirements for minimum tillage situations is that the herbicide should effectively control clovers with little risk to the crop to be sown. When establishing legume species such as lucerne (*Medicago sativa*), clovers and peas following the application of dicamba or 3,6-DCPA, sufficient time must be allowed before planting so that the herbicide residues will not reduce plant establishment.

The objective of the present study was to determine the residual activity of 3,6-DCPA and dicamba under different soil and climatic conditions to establish the time after spraying when legumes can be planted in the treated soil.

MATERIALS AND METHODS

Field trials were laid down on permanent or short term pastures at eight trial sites in different parts of the country. The locations and some soil properties of the trial sites determined by procedures described elsewhere (Rahman 1977) are listed in Table 1. The rainfall data and soil temperatures for the duration of trials are given in Table 2.

Dicamba at 300, 400 and 800 g/ha and 3,6-DCPA at 100, 200 and 400 g/ha were applied between late September and late October, 1980 in a spray volume of 200-300 litres/ha at a pressure of 200 kPa. Individual plots were 7-10 m long and 2-2.5 m wide and treatments were arranged in a randomised block design with four replications.

Soil samples for bioassay of herbicide activity were obtained from each plot at weekly intervals from 0-3 cm depth. All samples were bioassayed in the glasshouse using

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TABLE 1: Location and some soil properties of the trial sites.

Site No.	Location	Soil type	Sand (%)	Clay (%)	Organic C (%)	pH
1	Hamilton	Hamilton clay loam	31	33	4.9	5.6
2	Hamilton	Horotiu sandy loam	63	15	9.1	5.7
3	Rotorua	Taupo sandy silt	65	8	6.5	5.4
4	Feilding	Marton silt loam	44	26	4.4	6.0
5	Rangiora	Wakanui silt loam	51	21	3.4	5.9
6	Christchurch	Waimakariri sandy loam	68	11	3.6	5.4
7	Springston	Temuka silt loam	59	17	3.0	5.8
8	Ngapara	Timaru silt loam	43	20	4.6	5.1

TABLE 2: Rainfall and temperature records of trial sites.

Site No.	Spraying date	Rainfall (mm) in weeks				Mean soil temp. (°C)*	
		1	2-3	4-5	6-7	1st month	2nd month
1	26.9	12	16	35	61	14.4	15.3
2	26.9	12	16	35	61	14.4	15.3
3	14.10	21	43	32	45	12.9	13.8
4	6.10	9	46	71	20	12.7	13.4
5	20.10	0	38	20	27	13.2	14.4
6	29.9	3	8	3	45	12.1	12.2
7	29.9	4	8	2	56	12.4	12.7
8	30.10	12	66	24	4	10.6	12.8

* At 10 cm depth.

techniques described by Rahman and Cox (1975). The test species were subterranean clover and peas and a visual rating system as described by MacDiarmid (1975) was used for assessing the effects. A series of standards for both herbicides was established in the glasshouse by placing a 3 cm layer of treated soil on the top of each pot. The treated soil was prepared by spraying the surface of soil placed in a wooden flat 3 cm deep and mixing it throughout. Pots were watered as required and plants were assessed when 2 to 3 trifoliate leaves had developed.

RESULTS AND DISCUSSION

Bioassay ratings for the standards established with subterranean clover and peas using the Horotiu sandy loam soil (Site 2) are presented in Table 3. White clover was found to be slightly more susceptible to both herbicides but was not as well suited as a bioassay species because of its slower foliage growth.

Any samples which showed a bioassay rating for subterranean clover of up to 3.0 (cupping of spade leaf and etiolation of petiole, no effect on trifoliate leaves) was considered to have herbicide levels low enough to permit the establishment of white clover in that soil. Based on this assumption the time after which 3,6-DCPA residues fell below phytotoxic levels varied between 4-5 weeks for the 100 g/ha rate, 6-7 weeks for 200 g/ha rate and 7-8 weeks for 400 g/ha rate (Table 4). The times for dicamba varied between 4-5 weeks for both the 300 g/ha and 400 g/ha rates and 6-7 weeks for the 800 g/ha rate (Table 5). Peas were more tolerant to both herbicides and residue levels fell below phytotoxic levels 1-3 weeks sooner than for clovers depending on the rate. However, response trends for the peas bioassay followed a pattern similar to that of clovers.

The above results show that 3,6-DCPA had much longer persistence than dicamba and that the residual activity of both herbicides varied between different trial sites. An

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TABLE 3: Bioassay ratings* for standards established in the glasshouse using soil from site 2.

Rate (g/ha)	3,6-DCPA		dicamba	
	subterranean clover	peas	subterranean clover	peas
50	2.3	1.5	0	0
100	5.5	4.3	1.8	0
150	7.8	7.0	2.5	0.5
200	9.3	8.1	3.8	1.3
400			6.3	4.0
600			7.5	6.1
800			8.5	7.3
1000			9.3	8.8
± S.E. (P<0.05)	0.26	0.31	0.33	0.25

*0-10 scale with 0 being no damage (for details see MacDiarmid 1975). Rates of 3,6-DCPA of 400 g/ha and above killed both species.

TABLE 4: Residual activity of 3,6-DCPA as determined by bioassay ratings of subterranean clover.

Site* No.	Weeks after application								
	2	3	4	4	5	6	5	6	7
	100 g/ha			200 g/ha			400 g/ha		
1	6.0	4.3	2.8	6.5	4.8	2.3	6.5	4.3	1.8
2	4.5	3.5	1.3	5.3	4.3	1.5	5.5	4.0	1.0
3	7.3	5.0	4.0+	6.5	5.5	3.0	7.5	6.5	4.5+
4	5.5	4.5	2.5	6.0	4.0	2.5	6.8	4.8	2.8
5	8.0	7.3	4.8+	7.3	6.0	4.5+	7.5	6.0	4.8+
8	8.5	7.0	4.5+	7.0	6.0	4.0+	7.0	5.8	4.0+
CV%	16.1	24.8	21.3	15.3	27.6	19.8	18.2	16.4	22.7

* 3,6-DCPA treatments not included in sites 6 and 7.

+ Phytotoxic residues in these cases fell below a rating of 3 in the following week.

examination of the soil type and climatic data for trial sites in Tables 1 and 2 shows a strong relationship of these factors with the residual activity. Statistical analyses of data pooled over all the rates of application revealed that herbicide persistence was highly related to soil temperature ($r = -0.77^{**}$) followed by clay content of the soil ($r = -0.56^*$) and rainfall ($r = -0.47^*$). The residual activity of both herbicides was lost faster under high soil temperatures and in heavy soils (silt loams and clay loams) than under cooler conditions and in the light textured soils.

As mentioned earlier, only the samples showing a bioassay rating for subterranean clover of up to 3.0 were considered 'safe' enough for the re-establishment of susceptible species. MacDiarmid (1975) considered ratings of "less than 4" as safe in the case of picloram bioassays. Thus if the assumption on the rating limit is changed, or if less susceptible species, e.g. peas are to be planted in the treated soil, a site could be safe to oversow somewhat earlier than suggested here.

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TABLE 5: Residual activity of dicamba as determined by bioassay ratings of subterranean clover.

Site* No.	Weeks after application								
	2	3	4	2	3	4	4	5	6
	300g/ha			400g/ha			800g/ha		
1	5.0	4.0	1.5	6.5	5.3	3.0	4.0	3.5	1.0
2	5.0	3.5	0.5	6.0	4.5	2.8	5.0	3.0	0
3	6.3	5.0	2.8	7.0	5.5	3.8 +	6.5	5.0	2.8
4	5.0	4.3	2.0	6.5	5.0	3.0	6.8	4.5	2.3
5	6.5	4.8	4.0 +	7.3	6.0	4.5 +	7.3	6.3	4.0 +
6	6.0	5.3	3.5 +	7.5	6.3	4.5 +	Not included		
7	5.5	4.5	2.8	7.0	5.5	4.0 +	Not included		
8	6.0	4.5	2.5	7.3	6.0	4.5 +	6.8	5.3	3.8 +
CV %	18.2	22.9	24.8	26.8	21.3	15.5	19.3	14.8	22.1

*The rate used in sites 6 and 7 was 450 g/ha. Also the highest rate used at these two sites was only 600 g/ha.

+ Phytotoxic residues fell below a rating of 3 in the following week.

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