TOLERANCE OF CLARY SAGE, CORIANDER AND CARAWAY TO HERBICIDES APPLIED PRE- AND POST-EMERGENCE

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SUMMARY

Clary sage (*Salvia sclarea*), coriander (*Coriandrum sativum*) and caraway (*Carum carvi*) were evaluated for their tolerance to soil-active herbicides. Linuron, chlorbromuron and prometryne applied pre-emergence had little effect on plant numbers in all crops. When applied early post emergence coriander and caraway showed good tolerance to these herbicides but the materials caused moderate to severe leaf scorch on sage and a number of smaller plants were killed. Combinations of diquat with simazine, diuron or terbuthylazine applied 7 months after sowing of sage were more damaging to the plants than paraquat mixed with the same herbicides. Weeds were well controlled by all herbicides at all spraying dates with the exception of prometryne applied pre-emergence and metribuzin post-emergence, both of which failed to control germinating broad-leaved dock. Linuron and chlorbromuron gave best control of docks and a wide range of annual weeds.

Keywords: clary sage, coriander, caraway, plant numbers, vigour, weed control, soil active herbicides

INTRODUCTION

Clary sage, coriander and caraway are umbelliferous plants originating in the Mediterranean region with uses in the food, pharmaceutical and cosmetic industries.

In 1988-89 these herbs were planted with a number of new crops to be evaluated under New Zealand conditions. Trials were carried out at eight sites in Otago and Southland where single sprayings of herbicides including linuron and prometryne were applied either before or after crop emergence. From this series of trials it was found that failure to control weeds resulted in poor establishment or total crop loss particularly of clary sage. This herb was most vulnerable to weed competition while the second pair of leaves was developing. Where weeds were controlled, and after the emergence of the third pair of leaves, subsequent sage growth was rapid (Mitchell unpublished).

James *et al.* (1991) reported that in spring sown herb field trials conducted in the Waikato, linuron at 1 kg/ha damaged coriander plants as both pre- and post-emergence treatments. The plants subsequently recovered with no apparent long term effect. Hilik and Moskalenko (1979) recommended post-emergence linuron following trifluralin PPSI in coriander crops. In his Review of Literature, R G Rennie includes linuron and prometryne for possible use in coriander seed crops in New Zealand. Pinzaru (1983) also lists both herbicides for use in caraway.

This paper reports the results of further trials undertaken at Invermay to evaluate the tolerance of the three herbs to herbicides applied pre-emergence and post-emergence, and again for clary sage only, when the crop was well established.

METHODS

In separate trials at Invermay Agricultural Centre coriander and caraway were sown on 6.12.89 and clary sage on 14.12.89 using a cone seeder. The soil type was a Wingatui recent alluvial silt loam with an organic C content of 3.7%. Treatments were in randomised block designs with no unsprayed or hand weeded control included because it was considered that using herbicides was the only practical means of weed

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control. All herbicides were applied with a modified Oxford sprayer at 190 kPa in 300 litres/ha of water.

Clary sage

There were four replications of each treatment with a plot size of 20 x 1.5 m for the pre-emergence and early post-emergence applications (10 treatments - Table 1). Plot length was reduced to 10 m for final spraying on 31.7.90 (20 treatments - Table 2).

The pre-emergence treatments were applied 4 days after sowing to a moist seed bed. The same herbicides were used post-emergence 41 days after sowing, when sage plants had developed one or two pairs of leaves and varied between 2 and 15 cm diameter.

Herbicides (Table 2) applied on 31.07.90 were randomly placed on the earlier sprayed plots. An unsprayed treatment was included. The 7 month old sage plants averaged 30-50 cm in diameter and 10-20 cm in height covering 85% of available ground space. A trace of new crown growth was visible with some frosting of older leaves. A fertiliser mixture equal to 63 kg P, 25 kg K and 25 kg N per hectare was hand spread over the trial area on 2.8.90.

Sage plant counts were taken from randomly selected 8 x 0.5 m lengths of drill row in each plot approximately 1 month after both the pre- and early post-emergence sprayings (Table 1). Sage vigour was visually assessed on 2.2.90, 18.5.90, 17.8.90 and finally on 9.11.90 on a scale of 1 to 10 where 1 = poor and 10 = excellent plant vigour. The 2.2.90 figures indicate the degree of plant damage following the early post-emergence spraying. Subsequent vigour assessments were based on plant growth, colour and general plot appearance.

Coriander and caraway

Plot size in each of these trials was 10 x 1.5 m (8 drill rows) with three replications. Pre-emergence herbicides (Table 3) were applied to a weed free, fine moist seed bed 2 days after sowing. Early post-emergence treatments were applied on 12.1.90 to coriander plots which were not treated pre-emergence or where prometryne had failed to eliminate broad-leaved dock (*Rumex obtusifolius*). The remaining post-emergence treatments were applied on 23.1.90. On this date caraway averaged 5 cm in height with 90% of plants at or just beyond the two leaf stage, the remainder being smaller. Coriander plants varied between 2 and 10 cm in height and carried two to 10 leaves.

Haloxyfop (Gallant) at 5 ml/litre was spot sprayed on volunteer grasses on 9.2.90 and asulam at 20 ml/litre spot sprayed on large regrowth docks on 22.2.90 using a Solo knapsack sprayer in both instances.

Data from all three trials were subject to an analysis of variance.

RESULTS AND DISCUSSION

Tolerance of clary sage

Crop emergence was even and plant numbers were similar in all treatments following the pre-emergence spraying (Table 1). No visual crop damage was noted. James *et al.* (1991) reported visual plant damage in a field trial following the pre-emergence application of linuron and prometryne. Nagy *et al.* (1980) safely applied chlorbromuron and prometryne pre-emergence to clary sage. Generally plant numbers were lower following the post-emergence application on 24.1.90. Most plants suffered moderate to severe leaf scorch and some plants with only one pair of leaves and less than 3 cm in diameter were killed. Significant differences in sage vigour were recorded 9 days after this herbicide application (Table 1). In a glasshouse trial James (1991) noted similar crop damage from a range of herbicides applied early post-emergence. Crop damage was also recorded from post-emergence sprayings in field trials, but plants recovered well. Highest vigour ratings were in treatments where linuron was applied on plots which had been sprayed pre-emergence with prometryne. The reason for this is not clear but it is possible that the higher weed cover present in this treatment partly protected the crop from direct herbicide contact. No significant differences between plant numbers were recorded on 21.2.90. Damaged plants recovered rapidly

and 6 weeks after spraying the largest plants measured 60 cm across, with up to ten extended leaves. The crop averaged 65% ground cover in the post-applied linuron plots, 62% in chlorbromuron plots and was significantly lower, being 44% in the prometryne plots (data not presented). By mid May ground cover of sage ranged from 80 to 90%.

TABLE 1: Sage plant numbers one month after pre- and early post-emergence sprayings and sage vigour, scored on a scale of 1-10 (1 = poor, 10 = very vigorous) after the post-emergence spraying.

Treatment (kg ai/ha)		Plant numbers		Plant vigour	
Pre-emergence	Post-emergence	per 4 m of row		(scale 1-10)	
18.12.89	24.1.90	23.1.90	21.2.90	2.2.90	18.5.90
linuron 1.0	+ linuron 0.5	36	38	6.5	7.8
linuron 1.0	+ linuron 1.0	40	30	5.0	8.0
linuron 1.0	+ prometryne 0.5	36	28	4.0	7.0
linuron 1.0	+ prometryne 1.0	43	34	4.3	7.5
linuron 1.0	+ chlorbromuron 0.5	36	33	6.3	7.8
linuron 1.0	+ chlorbromuron 1.0	42	34	4.3	8.3
prometryne 1.0	+ linuron 0.5	38	38	7.8	6.5
prometryne 1.0	+ linuron 1.0	35	33	7.3	6.8
chlorbromuron 1.0	+ chlorbromuron 1.0	42	36	4.5	8.3
chlorbromuron 1.5	+ chlorbromuron 1.0	35	28	5.5	8.0
LSD (P = <0.05)		9	10	1.5	1.6

linuron (Linuron 50), prometryne (Gesagard 50 WP), chlorbromuron (Maloran)

Diquat applied alone or in combination in July 1990 caused more severe leaf damage, resulting in lower vigour scores than the paraquat equivalents (Table 2). This trend was still evident 3 months later. Paraquat treatments reduced crop vigour when compared to the untreated plots (Table 2) but plants had recovered and were more similar to untreated plots at the 9.11.90 assessment. The crop also showed good tolerance to linuron, chlorbromuron and prometryne. Plants in oxadiazon and oxyfluorfen treatments showed only slight initial damage but later growth was suppressed in comparison to linuron, chlorbromuron, prometryne and the treatments incorporating paraquat (Table 2). No phytotoxic symptoms of herbicide uptake were observed in treatments where simazine, diuron or terbuthylazine were applied. Gul'ko *et al.* (1981) recommended the use of diuron at 2 kg/ha in the first year when clary sage was at the rosette stage. Also the use of diquat 1.5 kg/ha or prometryne 2 kg/ha during early regrowth in the second year, both of which gave effective weed control and increased seed yields. In a pilot trial at Invermay, diquat alone and combined with diuron or simazine scorched the leaves of large sage plants more severely than paraquat, linuron or chlorbromuron following a late winter application (Mitchell unpublished). Although spring growth of clary sage was delayed by some herbicides, plants in all treatments grew normally to the flowering stage. It should be borne in mind however, that herbicide/crop interaction can vary according to soil type.

Tolerance of coriander and caraway

Metribuzin applied pre-emergence to caraway substantially reduced plant numbers; therefore this treatment was excluded from the analysis of plant number. There were no significant differences (P<0.05) between any other herbicide treatments applied pre-emergence in either crop when seedlings were counted after emergence (coriander 8.1.90 and caraway 22.1.90). Initially coriander plants appeared less vigorous where atrazine had been applied but plants quickly recovered. Short lived symptoms of leaf tip burn were observed on both coriander and caraway following the post-emergence spraying of linuron, chlorbromuron and prometryne but subsequent

plant growth was not visibly affected. Metribuzin applied post-emergence caused moderate leaf scorch and delayed development of both crops.

TABLE 2: Sage vigour scored on a scale of 1-10 (1 = poor, 10 = very vigorous) following the application of herbicides to 7 month old plants on 31.7.90.

Herbicide and rate (kg ai/ha)	Sage vigour	
	17.08.90	9.11.90
diquat 0.6	3.4	4.5
+ simazine 1.0	3.9	6.3
+ simazine 1.5	4.5	5.0
+ diuron 1.0	4.6	4.8
+ diuron 1.5	4.4	6.0
+ terbutylazine 1.0	3.6	5.0
+ terbutylazine 1.5	3.6	3.5
paraquat 0.6	5.3	7.8
+ simazine 1.0	5.9	8.5
+ simazine 1.5	5.6	7.0
+ diuron 1.0	7.1	7.8
+ diuron 1.5	6.9	9.0
+ terbutylazine 1.0	6.4	7.5
+ terbutylazine 1.5	6.1	8.8
linuron 1.5	8.4	8.5
prometryne 1.5	8.1	8.3
chlorbromuron 1.5	8.4	8.3
oxadiazon 1.6	7.9	6.3
oxyfluorfen 0.72	6.9	6.0
untreated	8.6	9.5
LSD (P = < 0.05)	0.9	2.0

diquat (Reglone), simazine (Gesatop 500 FW), diuron (Karmex), terbutylazine (Gardoprim 500 FW), paraquat (Gramoxone), oxadiazon (Foresite), oxyfluorfen (Goal)

Plant numbers were similar in all treatments in both crops at the final count on 20.2.90 except where prometryne 1.5 kg/ha had been applied as a single pre-emergence spray to coriander. In this treatment plants were subjected to vigorous competition from broad-leaved dock and survival was reduced relative to some of the other treatments (Table 3). Caraway numbers on 20.2.90 indicate that once established, plants can survive in treatments where weed control is poor. However, plants in these weedy plots appeared less vigorous than those in less weedy plots, with plants in the prometryne 1.5 kg/ha and both metribuzin treatments being worst affected.

High numbers of coriander plants establishing in all treatments resulted in a dense crop of around 75 cm high at flowering (2.3.90). Early frosts prevented seed set and no harvest was possible. Caraway, being a biennial, remained in a vegetative state through the growing season.

Weed control

A wide range of germinating annual weeds present in the trial plots which included shepherds purse (*Capsella bursa-pastoris*), fathen (*Chenopodium album*), wireweed (*Polygonum aviculare*), willow weed (*P. persicaria*), bindweed (*P. convolvulus*) and spurrey (*Spergula arvensis*) were well controlled by most herbicides, when applied pre-emergence. Broad-leaved dock was the most troublesome weed in all crops. Combined sprayings of both linuron and chlorbromuron and atrazine plus linuron achieved best control of this weed (Table 3).

TABLE 3: Counts of coriander and caraway plants after the pre- and post-emergence sprayings (mean of 2 m/plot) and percent total cover of dock and annual weeds at the final assessment

Herbicides (kg ai/ha)		Coriander			Caraway		
Pre-emergence	Post-emergence	Plant numbers		% weed	Plant numbers		% weed cover
8.12.89	12.1.90	8.1.90	20.2.90	cover	22.1.90	20.2.90	13.3.90
	*23.1.90			15.2.90			Dock Annuals
linuron 1.0	+ *linuron 0.5	71	58	0.2	14.0	13.0	2 12
linuron 1.0	+ *linuron 1.0	49	69	0.2	12.3	13.0	0.5 5
linuron 1.5	-	53	61	2	10.3	12.0	13 5
prometryne 1.0	+ prometryne 0.5	57	49	4	14.3	11.3	28 7
prometryne 1.0	+ prometryne 1.0	73	58	0.2	18.7	11.3	32 10
prometryne 1.5	-	56	46	66	18.7	14.3	72 17
chlorbromuron 1.0	+ *chlorbromuron 0.5	51	69	1	11.0	11.0	7 5
chlorbromuron 1.0	+ *chlorbromuron 1.0	58	56	1	16.7	11.7	1 7
chlorbromuron 1.5	-	62	59	11	11.3	12.3	33 8
atrazine 1.0	+ *linuron 1.0	59	68	0.1	-	-	- -
metribuzin 0.3	-	-	-	-	1.7	1.7	33 17
-	metribuzin 0.3	57	53	20	12.7	12.7	48 28
	chloroxuron 2.0	70	69	10	-	-	- -
LSD (P<0.05)		17	20	-	6.2	5.2	28 9

linuron (Linuron 50), prometryne (Gesagard 50 WP), chlorbromuron (Maloran), atrazine (Atrazine 80), metribuzin (Sencor DF), chloroxuron (Tenoran 50 WP)

In sage plots with the exception of prometryne, early post-emergence treatments kept weed levels to below 5% cover when the winter treatments were applied on 31.07.90. The only weed to survive the 31.07.90 spraying was dock which survived in the prometryne pre-emergence plots.

Information on possible herbicide contamination in the resultant oils was not obtained.

CONCLUSIONS

Clary sage emerged and grew successfully when herbicides were applied both pre- and post-emergence. Visually, crop damage was more severe following the early post-emergence spraying but plant numbers remained high enough to ensure a very good crop. Linuron would be the preferred material, as sage grew satisfactorily and weeds were well controlled at all three times of application. Chlorbromuron also performed well, but is not available commercially in New Zealand. If early weed control is necessary after the crop has emerged, spraying with linuron should be delayed, if possible, until sage plants have developed three pairs of leaves.

Coriander and caraway can tolerate concentrations of soil acting herbicides at rates high enough to control a wide range of weeds. Early weed control is essential from crop emergence and through the establishment phase. Coriander grows rapidly and a post emergence spray may not always be necessary, whereas caraway being a biennial develops slowly and in Otago a post-emergence spraying may be needed.

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