WILD GARLIC, *ALLIUM VINEALE* CONTROL: HERBICIDES, APPLICATION AND ENVIRONMENTAL FACTORS

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Summary. Research showed that dicamba at rates of 2 and 4 kg a.i./ha and metsulfuron, 4.2, 6 and 9 g a.i./ha, can reduce plant numbers in wild garlic, *Allium vineale*, infestations by over 90% in the season after treatment. 2,4-D ester (4 kg a.i./ha) occasionaly gave similar control, but was generally less effective and less reliable. Oils added to the spray mix improved the efficacy of treatments in glasshouse experiments. Variations in the growth and development of wild garlic, and in treatment efficacy, were measured from year to year. These were attributed to seasonal conditions, most probably moisture availability. Implications for the control of infestations are discussed.

INTRODUCTION

Wild garlic is a serious problem to grazing and cereal industries. Infestations have proved to be persistent and difficult to control as cultivation and herbicides rarely give satisfactory or reliable results. Infestations can be maintained by dormant hardshell bulbs (3, 5, 8, 11), the staggered emergence of plants (8, 9), and the survival of plants treated at non-susceptible stages of development (3, 5, 8, 9, 12). The control of wild garlic by herbicides is limited by:

(i) the waxy leaf surfaces which reduces retention and uptake (8, 12);
(ii) poor translocation (2);
(iii) the physiological activity of plants (5).

This paper reports the results of research which examined the effect of adjuvants, stage of plant development, and rainfall on the response of wild garlic to herbicides.

METHODS

Herbicide comparisons were made in field trials carried out at sites in central and north-western Victoria in 1983, 1984, and 1985. The treatments: dicamba (2 and 4 kg/ha); 2,4-D ester (4 kg/ha); metsulfuron (4.2, 6 and 9 g/ha); and chlorsulfuron; (20 g a.i./ha); were applied to replicated plots, using a 2 m, hand-held boom. Soil samples were taken during the growing season (March to December), and plant numbers, their stage of development, and bulb counts were taken from these. Plants were assigned to one of the following growth stages: dormant bulbs, sprouted bulbs, pre and post bulb exhaustion, base swelling, bulb development and scape production. Treatments were assessed by plant counts in the growing season the year after treatment.

The effect of additives on spray retention and herbicide efficacy was studied in the glasshouse and spray cabinet, using potted plants (5 single plants per treatment). The additives and rates used were: surfactants; Triton B 1965^R (0.125% v/v); Tween 20^R (0.125% v/v); oils; Sun Spray 6E^R (0.20% v/v); Winter Oil^R (0.20% v/v); and potassium carbonate (3.75% v/v). Potassium carbonate was included because of its commercial use to increase water movement through the waxy cuticle of grapes (1) and lucerne (13) to accelerate their rate of drying. Spray retention was measured by the fluorimetric assessment of fluorescein, added at a rate of 0.05 g/L to the spray mix.

Herbicide efficacy was compared by visual damage ratings, made at weekly intervals after treatment. A single herbicide was used to compare the additives, (3 kg/ha 2,4-D). The partial rate was used so that complete plant death, which would mask the comparison of the additives, was avoided. Translocation was assessed on the basis of symptoms of herbicide damage to parts of the plant that did not receive the spray directly, e.g. the inner leaves and below ground parts, including bulbs.

RESULTS AND DISCUSSION

Plant growth and development. Large seasonal variations were observed in the proportion of hardshell bulbs remaining dormant, and in the time of emergence of plants (Table 1).

Table 1. The proportion (% of plant numbers) of dormant bulbs, sprouted bulbs, and emerged plants in wild garlic populations in August of 1983, 1984 and 1985. (average of all field sites)

	1983	1984	1985
Dormant bulbs	2	19	1
Sprouted bulbs	8	17	3
Emerged plants	90	64	96

In general, however, the time of new bulb production, scape production and plant senescence occurred at similar times every year. There was no separation of plants into autumn and spring emerging groups as reported from overseas (8, 9). Bulb dormancy was low (about 2% of total bulb numbers) in 1983 and 1985 in samples taken from pastures and crops. In 1984, 10-40% of the hardshell bulbs remained dormant, the level varying between different sites. Most plants had emerged by May in 1983, by July in 1985 and not until August in 1984. The pattern of dormancy and emergence followed the rainfall patterns for those years; early and continuing rain in 1983 late rain and dry soil conditions in 1984 and delayed rains in 1985 with some areas remaining dry.

Herbicide trials. Trials to compare time of application showed that maximum control was achieved when infestations were treated after the old bulbs were exhausted (approximately 4 weeks after plant emergence) and before the new bulbs had fully developed. The dates defining this period varied from June in 1983, July in 1985, to September in 1984. Most treatments were applied close to the time considered to be optimal on the basis of observations of plant development, with usually a two month period between early and late treatments. There was little variation in the level of control for dicamba applied at various times, while differences of 10-15%, and up to 50%, were recorded between plots treated with 2,4-D ester or metsulfuron, at different times at the same site. The average level of control in each year for plots treated at the optimal time, are given below (Table 2). In 1985, herbicides were applied in wheat crops at two sites. Site 1 experienced uniform, moist conditions, while site 2 remained dry until after the plots had been sprayed. Metsulfuron (4.2 g/ha) gave a 90% reduction in plant numbers, and prevented scape production at site 1, but gave little plant control, and only a 68% reduction in scape numbers in the crop at site 2. Chlorsulfuron (20 g/ha) did not reduce plant numbers at either site, and gave only a 46 and 41% reduction of scape numbers.

Table 2. Average level of control (% reduction in plant numbers) for the herbicides applied in 1983, 1984 and 1985

Herbicide	Rate	1983	1984	1985
Dicamba	4 kg/ha	100	89	93
Dicamba	2 kg/ha	-	80	93
Metsulfuron	9 g/ha	-	68	93
2,4-D ester	4 kg/ha	82	77	91

The effect of spray additives. The effects of the additives on the retention and effectiveness of 2,4-D are given below (Table 3).

Table 3. The effect of additives on the retention and efficacy of 2,4-D applied at a rate of 3 kg/ha

Additive	Rate (% v/v)	Spray retention[a] (ul/10 cm^2)	Efficacy rating[b] (av. 5 plants)
Nil	-	4.82 a	7.8
Triton B 1965[R]	0.125	5.33 ab	7.8
Winter Oil[R]	0.20	5.67 abc	9.0
Sun Spray 6E[R]	0.20	6.05 bc	9.4
Tween 20[R]	0.125	6.08 bc	8.0
Potassium carbonate	3.75	6.46 c	9.6

[a]Retention values followed by the same letter are not significantly different using Duncan's Multiple Range Test (P = 0.05).
[b]Rating details: 7, older leaves necrotic, younger leaf green; 8, older leaves collapsing, younger leaf tip yellow; 9, older leaves collapsing, younger leaves chlorotic; 10, plant dead, new bulbs dessicated.

Only Sun Spray 6E[R], Tween 20[R] and potassium carbonate significantly increased the retention of 2,4-D, with potassium carbonate being the most effective. However, there was little correlation between the amount of spray retained on the leaves and the level of visual damage. For example, Tween 20[R] was effective in increasing spray retention, but did not improve the efficacy of 2,4-D, whereas Winter Oil[R] did not increase retention, but did improve efficacy.

Translocation. Plants treated with dicamba generally had soft bases as well as the typical symptoms of bulb distortion described by Davis *et al.* (4). Plants surviving on plots treated with 2,4-D often showed top damage, but no symptoms on the underground parts.

Effective control (greater than 90% reduction) of wild garlic infestations can be achieved with dicamba (2 and 4 kg/ha), metsulfuron (4.2 g/ha in crop, 6 and 9 g/ha in pastures). Results with 2,4-D ester (4, kg/ha), while sometimes as good, were generally less reliable. A major advantage of metsulfuron is that it provides a means of effective control of infestations in wheat crops. Control by chlorsulfuron was much poorer in these trials than reported from work in North America (7), but even there it was found to be less active than metsulfuron.

The factors listed in the introduction as causing limitations in the control of wild garlic were all found to influence the success of treatments, and their impact has been partially quantified. The two major factors, the time of application and seasonal conditions, were found to interact. Infestations must be treated after the old bulb is exhausted, and before the new bulbs have fully formed. This allows a period of about 6 to 8 weeks for effective treatment, but the dates of this period can vary from year to year. This seasonal variation appears to be related to rainfall conditions, a pattern also noted in America (9). Similar observations have been made on another bulbous plant, soursob, *Oxalis pescaprae* (6). In addition, the proportion of hardshell bulbs that remain dormant varies with seasonal conditions. In the driest year, 1984, an average of 20% of the hardshell bulbs remained dormant, with higher levels at some sites. These values were close to the reduced level of control recorded in that year.

While precise causes of seasonal influences on the control of wild garlic may be difficult to determine, their importance is demonstrated by these, and overseas results (9). It is suggested that the local conditions under which maximum control of wild garlic is achieved are determined, and that treatments are applied at optimal times.

The benefits of oils to the efficacy of 2,4-D ester on wild garlic is consistent with observations that they improve the uptake of herbicides through waxy surfaces (10, 14). The results suggest that additives could improve the efficacy of herbicides in the field, provided an appropriate type is used. Translocation may explain differences in the effectiveness of different herbicides e.g. 2,4-D ester and dicamba in these trials, or be partially responsible for the reductions in efficacy of herbicides in drier years. It is concluded that the biology of the plant and seasonal conditons combine to cause the difficulty experienced in controlling infestations of wild garlic, but that an understanding of these will enable acceptable results to be achieved.

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