SEASONAL UPTAKE AND TRANSLOCATION OF METSULFURON IN GORSE (*ULEX EUROPAEUS*)

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SUMMARY

Metsulfuron, with the addition of Silwet L-77, was applied at regular intervals throughout a year to mature gorse (*Ulex europaeus*) growing in the field. Radiochemical determinations of uptake and translocation of the herbicide did not show any clear seasonal trends: 53-77% of applied herbicide was absorbed into the mature foliage; translocation was 6-18% of absorbed a.i., and 3-12% of applied a.i. Uptake into mature foliage was strongly correlated with temperature. These results are compared and contrasted with the behaviour of 2,4,5-T and glyphosate in gorse.

Keywords: metsulfuron, uptake, translocation, gorse, Silwet L-77

INTRODUCTION

Previous results (Gaskin and Zabkiewicz 1988), with [¹⁴C]metsulfuron applied to gorse (*Ulex europaeus*) grown under varying controlled environmental conditions, showed that uptake could be improved significantly by the addition of Silwet L-77. Furthermore, they indicated that the magnitude of the uptake may be dependent on the seasonal effects or plant growth stage. In the current research, [¹⁴C]metsulfuron, plus Silwet L-77, was applied at regular intervals throughout a year to gorse growing outdoors and the uptake and translocation of the herbicide measured radiochemically. The results are considered in relation to environmental factors and compared with trends for herbicidal behaviour established previously for accepted gorse herbicides viz. 2,4,5-T and glyphosate.

MATERIALS AND METHODS

Clonal gorse cuttings were set and grown in pots for 12 months then planted out at metre spacings in the Forest Research Institute nursery at Rotorua. After a further 9 months, when the plants were approx. 1 m tall, the trial began.

Commencing in September 1988, treatments were applied at 4 to 6 week intervals, over a period of 12 months. A clear plastic canopy was positioned over the plants during each treatment period to prevent rain washing off the applied herbicide. Meteorological information was recorded for the site during each treatment period and for the Rotorua area throughout the experiment.

Metsulfuron (Escort) was formulated at 200 g product/300 litres water plus 0.3% Silwet L-77 (Pulse). [¹⁴C]metsulfuron methyl was added (5.4 µCi/ml) to the solution before application of the treatment. Droplets of the solution were applied to each of five consecutive spines (2 x 0.5 µl/spine) located on the stem, at least 10 cm from its apex. Treatments were replicated on five plants. Ten droplets were dispensed into each of five scintillation vials to accurately determine the applied dose and also onto glass slides located on-site to monitor any losses from degradation or volatilisation. Recoveries from these slides were greater than 95% (mean 98%).

After 48 h the treated spines and associated stem sections were excised from each plant and washed twice to remove any unabsorbed herbicide. The first wash (30 s) was with 30 ml aqueous Tween 80 (0.05%) and duplicate aliquots (5 ml) of these washes were added to equal volumes of scintillant solution (Packard Insta-Gel) and the samples assayed in a liquid scintillation counter (Packard 4430). The second wash (10 s) in methylene chloride (20 ml) was evaporated to dryness at room temperature before

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addition of scintillant solution (ACS II; Amersham) and radioassay. The radioactivity within the treated tissues was determined using a biological oxidiser (Harvey OX 300) and scintillation counting.

The results were tested by analysis of variance, some of the means requiring log transformation, and the means compared by the LSD test. The STATISTIX II programme was used for regression analysis. All regressions were significant at the 95% probability level unless otherwise indicated.

RESULTS AND DISCUSSION

Throughout the experimental period the weather was typical for the region and the growth pattern and development of the gorse foliage were considered representative (Table 1).

The uptake of [¹⁴C]metsulfuron into gorse foliage was generally high (52-77%) and similar to that reported previously i.e. 43-76% (Gaskin and Zabkiewicz 1988). The longest period of consistently high uptake occurred in newly mature foliage (Dec-Feb) while the plant was still actively producing new growth (flushing). This corresponded with the highest temperatures recorded at the time of herbicide application (0930 h) and the highest daily mean temperatures during the 48 h treatment periods (Table 1).

TABLE 1: Percentage uptake and translocation of [¹⁴C]metsulfuron in gorse and meteorological conditions during the trial period.

Date	1988				1989							
	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Growth stage*	M	M	F	NM	NM	M	M	—	M	—	M	M
Uptake (%)	75ab	66bc	52e	65cd	77a	75ab	72abc	64cd	—	55e	—	53e
Translocation (% Absorbed)	12abc	17a	3d	15a	10bc	16a	13ab	8bc	—	11ab	—	18a
Translocation (% Applied)	7abc	11ab	1e	10ab	7bcd	12a	9abc	5cd	—	6abc	—	9abc
Temp (°C) (0930 h)	17	17	18	22	20	19	13	—	11	—	4	7
†Temp (°C) (daily mean)	12	14	15	17	18	17	17	14	11	9	7	9
RH (%) (0930 h)	80	60	60	90	50	55	63	—	60	—	80	60
†Rainfall (mm) (monthly mean)	71	99	146	202	213	52	71	55	162	182	101	121

*M = mature foliage; F = flushing foliage; NM = newly mature foliage

† Rotorua meteorological data

Mean values in rows showing common postscripts are not significantly different at the 5% level (LSD test)

Uptake of metsulfuron into mature foliage decreased significantly (53-57%) during the winter months (May-Aug), but rose (66-75%) in the spring (Sept-Oct). However, uptake into new flushing foliage present on the plant at this time (Oct) was less (52%). The correlation between the uptake of herbicide into mature foliage and the temperature at time of application was very strong ($R^2=0.87$ $P=0.0002$); uptake increased with temperature as has been reported in other work (Caseley 1987).

The translocation of metsulfuron out of treated mature foliage, as a proportion of that absorbed into the plant, varied from 6-18%, with the low in August. There was no correlation with any of the environmental factors measured. Very little translocation occurred out of the soft, newly-flushed foliage in October, possibly indicating excessive phytotoxicity of the spray solution (Gaskin and Zabkiewicz 1988).

The translocation of metsulfuron from mature foliage, as a proportion of total herbicide applied, was over the range 3-12% with the low again in August. This calculation takes into account both the absorption and movement of absorbed [¹⁴C]metsulfuron within the plant. The results are most strongly influenced by the amount of translocation of absorbed herbicide ($R^2=0.82$) and again there was no correlation with measured environmental effects. Translocation of applied a.i. out of

the new foliage (Oct) was greatly reduced, confirming the need for application to mature foliage to obtain optimum field effectiveness.

Prior to 1985, 2,4,5-T was the dominant herbicide for gorse control. This chemical was well absorbed by the plant (Table 2), due either to molecular structure or product formulation. However, translocation was poor, so that thorough plant coverage was essential for good results. The addition of oil adjuvants to 2,4,5-T enhanced uptake, but proportionately this was only a small increase. Conversely, glyphosate and metsulfuron have good systemic activity but were not well absorbed by gorse (Zabkiewicz *et al* 1985; Gaskin and Zabkiewicz 1988). However, the addition of the non-ionic surfactant Silwet L-77 to either herbicide could substantially increase uptake (Table 2) and permitted the effective use of these products for gorse control. Their mobility within the gorse plant could also provide enhanced control of coppice regrowth.

The uptake and translocation characteristics of previous and current gorse herbicides, 2,4,5-T glyphosate and metsulfuron, are compared in Table 2.

TABLE 2: Comparison of uptake and translocation characteristics* of 2,4,5-T, glyphosate and metsulfuron with and without (±) adjuvant.

	% Uptake		% Translocation				Reference
	(–)	(+)	Absorbed		Applied		
			(–)	(+)	(–)	(+)	
2,4,5-T	76	89	<5	<5	[<4]	[<5]	(1)
	76	na	1.2	na	0.9	na	(2)
Glyphosate	7	70	43	20	[3]	[8]	(3)
	30	63	[9]	[18]	[3]	[11]	(4)
Metsulfuron	4	83	82	26	[<4]	[20]	(5)
	na	77	na	18	na	12	(6)

*The results quoted are maximum values obtained for each herbicide. They take no account of adjuvant class or active concentrations. Figures in square brackets indicate values not previously published and are derived from the authors data.

na = not available.

References: (1) Zabkiewicz and Gaskin 1982 (2) Zabkiewicz and Gaskin 1979
 (3) Zabkiewicz and Gaskin 1989 (4) Zabkiewicz *et al* 1985
 (5) Gaskin and Zabkiewicz 1988 (6) Current work

The differences between these three herbicides, in uptake and translocation, are also significant in relation to field effectiveness. The use of 2,4,5-T was advocated during the November-December period, i.e. flushing, for best result (Balneaves and Zabkiewicz 1981; Zabkiewicz and Balneaves 1984). In contrast, later work with glyphosate plus Silwet L-77 showed that the requisite gorse stem desiccation could be obtained (at 12 to 24 weeks after application) by spraying at almost any time of the year (Balneaves 1986). However, optimal results were obtained with applications during August to October i.e. just after spring flowering and ahead of new growth. Metsulfuron may also be applied all year round to give consistent gorse control (Cornwell, pers. comm.).

All-year-round efficacies with aerial or low volume applications of glyphosate and metsulfuron are a direct result of enhancing the spray formulation, such that uptake of the herbicides is consistently high and the intrinsic mobility of the chemicals in the plant can be exploited.

CONCLUSIONS

Metsulfuron, when applied with Silwet L-77 to mature gorse foliage, can be expected to give similar levels of control at most times of the year. For optimal results, it may be necessary to apply sprays when flushing foliage does not form a significant part of the canopy.

These trends are in contrast to the determined field efficacy for 2,4,5-T, which gave greatest control of gorse if applied during periods of maximum new growth, but they are similar to trends obtained with glyphosate, which also may be used virtually all year round, giving optimum efficacy when applied to mature foliage.

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