EFFECT OF SILWET L-77 ON UPTAKE AND TRANSLOCATION OF METSULFURON IN GORSE

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SUMMARY

The herbicide metsulfuron was applied to gorse at three field rates together with varying concentrations (0.1-1%) of Silwet L-77. Greatest absorption was from solutions which gave best wetting, but these solutions were also more phytotoxic and reduced translocation of the absorbed herbicide. Best results were with a Silwet L-77 addition of 0.3% or above. A 10-fold difference in herbicide concentration did not affect uptake or translocation patterns, but plant growth stage had a very significant effect.

INTRODUCTION

Due to the foreseen unavailability of 2,4,5-T a programme to evaluate alternative herbicides for the control of gorse *(Ulex europaeus)* has been underway for some years at the Forest Research Institute. This work has also led to the evaluation of a wide range of nonionic surfactants and the identification of those which could substantially enhance field effectiveness of herbicides applied to scrubweeds (Balneaves 1985a; Zabkiewicz *et al* 1985). To date the best surfactant has been Silwet L-77, now available commercially.

Metsulfuron is a potential herbicide for the control of mature gorse, provided Silwet L-77 is added (Balneaves 1985b; Davenhill and Preest 1986). This paper reports the effect of Silwet L-77 on the wetting, uptake, translocation and phytotoxicity of metsulfuron spray formulations in mature gorse at two growth stages.

MATERIALS AND METHODS

Mature, hardened (autumn growth stage) gorse cuttings were conditioned for 5 weeks prior to treatment at 15°/10°C day/night, 70% RH, 8 h photoperiod, 300-340 μmoles/m^2/s. Plants were 5 months old and 50-75 cm tall.

Metsulfuron (Escort) was formulated at two rates, 100 and 200 g/300 litres water, in combination with 0, 0.1%, 0.3%, 0.5% or 1% Silwet L-77 (Pulse). ^{14}C-metsulfuron-methyl was added (10 μCi/ml) and the solutions were applied as droplets (2 $\times$ 0.5 μl) to each of five individual spines on each of four plants. The treated spines followed consecutively on the main stem and were at least 15 cm from the apical tip.

After 48 h treated spines and associated stem sections were excised from each plant and washed twice to remove unabsorbed herbicide. The first wash (30 s) was with 50 ml aqueous Tween 80 (0.05%). Duplicate aliquots (5 ml) of this wash were added to an equal volume of scintillant cocktail (Packard Insta-Gel) and the samples assayed in a Packard Model 4430 liquid scintillation counter. The second wash (10 s) in methylene chloride was evaporated to dryness at room temperature before addition of scintillant solution (5.5 g Permablend I plus 150 ml methanol/1 toluene) and radioassay.

The treated sections and remainder of the plants (including roots) were freeze-dried and weighed, then finely ground in a Wiley mill. Triplicate subsamples of tissue (approximately 10 mg) were combusted on a Micromat BF 5010 oxidiser and subsequently radioassayed. The total radioactivity within the tissue was calculated by scaling up to total tissue dry weight.

Further gorse plants were treated at a "late winter/very early spring" growth stage with two rates of metsulfuron. These plants had new flower and foliage buds beginning to appear and were conditioned for 1 week prior to treatment under similar conditions to those previously described, but at lower temperatures (10°/5°C) to simulate appropriate seasonal conditions. A selected treatment from the first trial (100 g/300 litres plus 0.3% Silwet L-77) was repeated along with a reduced rate (20 g/300 litres plus 0.3% Silwet L-77). ^{14}C-metsulfuron comprised the entire active indredient in the latter treatment.

The contact angles (CA) of all treatment solutions were determined on films of gorse wax (Zabkiewicz *et al* 1985). Electrolyte leakage from gorse foliage immersed in treatment solutions was determined as an indicator of the phytotoxicity of the formulations to the foliage (Gaskin and Kirkwood 1986). The conductivity was measured after 48 h of immersion, the treatments were then boiled, cooled and remeasured. Electrolyte leakage from tissue after 48 h was expressed as a percentage of total leakage after boiling. Each treatment was replicated six times.

RESULTS AND DISCUSSION

Recoveries of ^{14}C-herbicide were within 78-90% of that applied. Results are summarised in Table 1. The uptake of ^{14}C-metsulfuron in the absence of added surfactant was low (3-5%). Doubling the concentration of the herbicide had no significant effect on relative (%) uptake but in real terms this meant twice as much chemical was being absorbed. Uptake of the herbicide was much greater (22—61%) with the addition of surfactant and the effect of increasing the surfactant concentration was highly significant ($P<0.05$). Greatest uptake were from treatments containing 0.3% or more Silwet L-77.

TABLE 1: Uptake, translocation, wetting and phytotoxicity of metsulfuron ± Silwet L-77 on mature gorse foliage at two growth stages.

Metsulfuron + Silwet L-77 (% v/v)	Uptake of ^{14}C-herbicide (% of applied)	Translocation of ^{14}C-herbicide (% of absorbed)	Contact angle (θ°)	Electrolyte leakage (% of Total)
"Autumn" gorse				
100 g ai/300 litres	3.3 e	55.8b	92.3	8.2a
+0.1%	22.4 d	17.0 c	<10	86.5 bc
+0.3%	42.8 c	6.7 c	TW	94.0 cd
+0.5%	54.3 ab	13.7 c	TW	93.2 cd
+1.0%	50.3 bc	16.9 c	TW	79.9 b
200 g ai/300 litres	4.7 e	81.7 a	91.1	9.6 a
+0.1%	26.8 d	11.1 c	<10	88.4 bc
+0.3%	50.9 abc	9.6 c	TW	99.7 d
+0.5%	49.3 bc	10.2 c	TW	92.4 cd
+1.0%	61.0 a	13.7 c	TW	89.5 c
Water	-	-	97.6	9.1 a
"Late winter" gorse				
100 g ai/300 litres +0.3%	76.4 a	25.5 a	TW	-
20 g ai/300 litres +0.3%	82.7 a	17.3 a	TW	-

TW = Total Wetting

Column means sharing common postscripts within tables are not significantly different at the 5% level (LSD test).

CONCLUSIONS

Uptake of metsulfuron into mature gorse can be improved significantly by the addition of Silwet L-77 surfactant but conversely, translocation of the herbicide is reduced. However, in high volume applications overall efficacy can be expected to be improved. Increased uptake and translocation was obtained when the herbicide was applied with surfactant to gorse in late winter rather than autumn. Variation in application rate of the herbicide (from 20-200 g ai) did not affect the proportion of uptake or relative transport.

Translocation of absorbed ^{14}C-metsulfuron out of the spines treated with herbicide alone was high (56% and 82%), but was significantly reduced by the addition of surfactant (down to 7-17%). There was no statistically significant difference between any of the surfactant concentrations.

The solutions of herbicide alone were incapable of wetting the wax of mature gorse foliage (CA>90°) and this was a probable reason for poor foliar uptake. Measurements of electrolyte leakage demonstrated that these solutions also caused little leakage (8-10%). This indicated that these treatments were having no greater phytotoxic effect than water alone (9%). Conversely, all surfactant formulations wet the wax extremely well. These could be seen to penetrate rapidly into the foliage and caused much greater electrolyte leakage (80-100%).

Treatments with high conductivity values (i.e. greater phytotoxicity) resulted in low translocation away from the site of application, possibly due to disruption of phloem transport systems (Gaskin and Murray 1988; Hull *et al* 1982). It appeared that the plant could effectively transport low concentrations of the herbicide (as absorbed from the treatments without surfactant), but with the higher doses taken up from the surfactant treatments relative translocation was reduced more than 3-fold. However this would not reduce efficacy of these treatments in field applications where good spray coverage of plants was achieved. This is because of the concurrent marked increase in herbicide uptake (8 to 16-fold), which is responsible for significantly more translocation of the total *applied* active ingredient. While excellent control of mature gorse can be achieved with high volume handgun applications of metsulfuron alone (Popay *et al* 1985), recent field trials have demonstrated that similar results can be achieved with a 40% reduction in active ingredient when Silwet L-77 is added to the spray formulation (Du Pont *pers. com.*).

Applications to "late winter" gorse foliage showed no significant difference in uptake and translocation between the two rates of metsulfuron. However, uptake and translocation of the 100 g ai treatment were better at this stage of plant development than for "autumn" gorse. Late winter plants are hardier and thus the rate of herbicide uptake and overall cell loading may have been reduced, resulting in less initial phytotoxicity. Less initial cell damage may result in less disruption of translocation, maintenance of a diffusion gradient across the cuticle and ultimately improved absorption. As plants enter a stage of active growth, photosynthate movement is expected to be greater compared with that of "autumn" plants and symplast transport of the herbicide would be correspondingly enhanced. Seasonal observations of field efficacy endorsed these results (DuPont *pers. com.).*

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