A COMPARISON BETWEEN TWO COMMERCIAL ORGANOSILICONE SURFACTANTS; THEIR EFFECT ON THE UPTAKE AND TRANSLOCATION OF GLYPHOSATE IN GORSE (*ULEX EUROPAEUS*)

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SUMMARY

A comparison between the effects of two commercially available organosilicone surfactants on the uptake and translocation of ^{14}C -glyphosate in gorse is presented. Both surfactants enhanced the absorption of a.i. into mature gorse foliage and increased translocation of the herbicide. There were no differences in effectiveness between the two surfactants, but surfactant concentration was a significant factor in determining efficacy of the a.i. Physical and chemical characterisation indicated no substantial differences between the two products.

Keywords: glyphosate, surfactants, uptake, translocation, gorse

INTRODUCTION

Glyphosate is a foliage-applied, systemic herbicide which is used to control many brushwood weeds (Grossbard and Atkinson 1985). On many such species the efficacy of the herbicide can be substantially improved by the addition of suitable surfactants. Non-ionic, organosilicone adjuvants have proven particularly effective for this purpose (Balneaves 1985; Stevens *et al* 1988). Until recently, the only organosilicone surfactant available for use with agrochemicals has been Pulse (Monsanto Company, USA), but 1990 saw the market release of Freeway (Nufarm Limited) in Australia, specifically for addition to glyphosate herbicide to improve gorse (*Ulex europaeus*) and bracken (*Pteridium esculentum*) control.

This work compares the effect of two commercial organosilicone surfactants on the uptake and translocation of ^{14}C -glyphosate in gorse and on the physical properties of the spray formulation. The chemical composition of the two adjuvants is also compared.

MATERIALS AND METHODS

Gorse cuttings up to 0.5 m tall were conditioned in a controlled environment for 3 weeks prior to treatment at 20°/15°C day/night temperature, 70% RH and a 12 h photoperiod, with 0.5 h dawn and dusk ramp, at *ca* 500 $\mu\text{moles/m}^2/\text{s}$ photosynthetic irradiance. All plants were >12 months old and carried foliage from two previous seasons and <2 cm of flushing tissue.

Glyphosate (as Nufarm Glyphosate 360 at 20 ml/litre) was formulated alone or with the addition of either of the organosilicone surfactants, Pulse or Freeway, at 0.2 and 0.5% v/v. ^{14}C -glyphosate (Amersham, 98.3% pure), as the monoisopropylamine salt, was incorporated in the formulations. Each treatment solution was prepared and ultrasonically mixed immediately prior to application (2 x 0.5 μl) to five mature spines adjacent on the main stem, >10 cm from the apical tip. Treatments were replicated on each of five plants. The dose of ^{14}C -glyphosate applied was determined by regularly dispensing droplets onto small Parafilm targets (8 x 8 mm); these droplets were subsequently quantified by liquid scintillation counting (lsc).

Uptake was determined 48 h after treatment as described by Gaskin and Murray (1988) and defined as the percentage of applied ^{14}C not recovered in the surface washes. The radioactivity within the treated spines was determined using a biological oxidiser (Harvey OX300) and lsc. Translocation was calculated as the radioactivity which was

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not recovered by washing or oxidation of the treated tissue and expressed as a percentage of both ^{14}C -glyphosate absorbed and applied. Mean values and standard errors were obtained from analysis of variance; where significant effects were indicated by an F-test, means were compared using the LSD.

The wetting, spreading and drying rates of the formulations on reconstituted gorse wax were determined by the methods of Gaskin and Zabkiewicz (1989). Chemical characterisation of the two surfactants was achieved by NMR analysis. All NMR spectra were recorded on a Bruker AC-200 NMR spectrometer using a 10 mm broadband probe at 25 °C. Quantitative ^{13}C spectra were acquired using a modified inverse gated sequence to remove NOE effects. ^{29}Si spectra were acquired using an optimised DEPT sequence.

RESULTS AND DISCUSSION

The uptake of ^{14}C -glyphosate (Table 1) was enhanced by addition of either surfactant; there were no differences between the two but their concentration had a significant effect ($P < 0.001$) on penetration of a.i. into the foliage, with higher surfactant concentration (0.5% v/v) promoting increased uptake. Similar effects with higher surfactant concentrations have been previously reported with the addition of an organosilicone surfactant to glyphosate spray formulations applied to gorse (Zabkiewicz and Gaskin 1989) and bracken (Gaskin and Kirkwood 1989).

TABLE 1: Effect of organosilicone surfactant addition on uptake and translocation of glyphosate in gorse.

Treatment	Uptake	Translocation	
	($\text{— \% applied } ^{14}\text{C}$)	($\text{— \% absorbed } ^{14}\text{C}$)	
Glyphosate (2%)	11.8c	7.9b	68.3a
Glyphosate + 0.2% Pulse	20.1bc	9.5b	45.2b
Glyphosate + 0.5% Pulse	52.0a	26.2a	50.5b
Glyphosate + 0.2% Freeway	26.4b	12.6b	47.3b
Glyphosate + 0.5% Freeway	55.6a	27.5a	49.7b

Column means sharing common postscripts are not significantly different at $P = 0.05$ (LSD).

Translocation, as a percentage of absorbed ^{14}C , was reduced by a similar amount following the addition of either surfactant in comparison to the nil-surfactant treatment (Table 1). Translocation of glyphosate is often markedly reduced when the herbicide is applied with added surfactant and this is most frequently attributed to adjuvant phytotoxicity (McWhorter *et al* 1980; Sherrick *et al* 1986; Gaskin and Murray 1988). Translocation of “applied ^{14}C ” indicates the dose of herbicide moving out of the treated area; the higher rate of surfactant significantly ($P < 0.001$) increased translocation in comparison to the nil-surfactant treatment. Again there were no differences between the two adjuvants.

The physical properties (Table 2) also indicated great similarity between the two products. Both increased the wetting, spreading and drying rate of the herbicide proportionally with increased concentration. While Freeway surfactant at 0.5% promoted enhanced spreading and faster drying of the spray formulation than Pulse at an equivalent rate, such differences were not translated into greater uptake or translocation of the herbicide.

Comparison of NMR spectra likewise revealed little difference between the two samples with the exception of possible variation in average ethylene oxide chain length by one or two units. Gas-liquid and high-performance liquid chromatographic analyses have confirmed these findings (J.A. Zabkiewicz, unpublished data).

The results presented here indicate little difference between the two organosilicone surfactant products examined. Both would be expected to similarly enhance the efficacy

of glyphosate in controlling mature gorse when used at suitable rates of addition. Recent field trial results confirm this expectation (J.M. Balneaves, pers. comm.).

TABLE 2: Physical properties of treatment formulations on reconstituted gorse wax.

Treatment	Contact angle (°)	Spread area (mm ²)	Drying rate (% wt/min)
Glyphosate (2%)	78a	2.0d	6.1d
Glyphosate + 0.2% Pulse	39b	4.7c	7.5bc
Glyphosate + 0.5% Pulse	0c	6.3b	7.9b
Glyphosate + 0.2% Freeway	40b	4.8c	7.0c
Glyphosate + 0.5% Freeway	0c	7.7a	8.6a

Column means sharing common postscripts are not significantly different at $P=0.05$ (LSD).

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REFERENCES

- Balneaves, J.M., 1985. Effect of added surfactant on the performance of scrubweed herbicides. *Proc. 38th N.Z. Weed and Pest Control Conf.*: 98-101.
- Gaskin, R.E. and Murray, B., 1988. Surfactant effects on activity of glyphosate and haloxyfop in pampas grass. *Proc. 41st N.Z. Weed and Pest Control Conf.*: 153-155.
- Gaskin, R.E. and Kirkwood, R.C., 1989. The effect of certain non-ionic surfactants on the uptake and translocation of herbicides in bracken (*Pteridium aquilinum* (L.) (Kuhn)). *In: Adjuvants and Agrochemicals*, Vol. 1, CRC Press: Pp 129-139.
- Gaskin, R.E. and Zabkiewicz, J.A., 1989. The effect of surfactants on the uptake and translocation of glyphosate in Yorkshire fog. *Proc. 42nd N.Z. Weed and Pest Control Conf.*: 128-131.
- Grossbard, E. and Atkinson, D., 1985. *The Herbicide Glyphosate*. Butterworths, London. 490 pp.
- McWhorter, C.G., Jordan, T.N. and Wills, G.D., 1980. Translocation of ¹⁴C-glyphosate in soybeans (*Glycine max*) and Johnson grass (*Sorghum halepense*). *Weed Science* 28: 113-118.
- Sherrick, S.L., Harvey, A.H. and Hess, F.D., 1986. Effects of adjuvants and environment during plant development on glyphosate absorption and translocation in field bindweed (*Convolvulus arvensis*). *Weed Science* 34: 811-816.
- Stevens, P.J.G., Gaskin, R.E. and Zabkiewicz, J.A., 1988. Silwet L-77: A new development in spray adjuvants. *Proc. 41st N.Z. Weed and Pest Control Conf.*: 141-145.
- Zabkiewicz, J.A. and Gaskin, R.E., 1989. Effect of adjuvants on uptake and translocation of glyphosate in gorse (*Ulex europaeus* L.). *In: Adjuvants and Agrochemicals*, Vol. 1, CRC Press: 141-149.