EFFECT OF SURFACTANT CONCENTRATION AND SPRAY VOLUME ON RETENTION OF ORGANOSILICONE SPRAYS ON WHEAT

R.E. GASKIN and R.J. MURRAY

NZ Forest Research Institute Ltd, Private Bag 3020, Rotorua

ABSTRACT

The retention of organosilicone surfactant sprays (0-0.8% v/v) on wheat was determined, using a calibrated track sprayer, over a range of spray volumes representative of ground-based arable applications (37-280 litres/ha). Volume of spray retained on foliage generally increased with carrier volume and surfactant concentration. Spray run-off was not evident with any treatment. The importance of the interaction between concentration of organosilicone and spray volume was highlighted. Spray was captured most efficiently at low spray volumes and 0.2% surfactant. It is expected that organosilicone surfactant addition to pesticide sprays on difficult-to-wet arable species would be beneficial over a wide range of application volumes.

Keywords: organosilicone, surfactant concentration, retention, spray volume, wheat

INTRODUCTION

Many publications report on the effects of spray adjuvants on the retention of sprays on plants. Surfactants affect retention to a greater extent on water-repellent species than on more readily-wetted species (Holloway 1994; de Ruiter *et al.* 1990; Anderson and Hall 1987), where frequently, they do not enhance retention compared to water alone (Grayson *et al.* 1996; Holloway 1993). Organosilicone surfactants are known to increase adhesion (wetting) and spreading of pesticide sprays on foliage due to their high surface activity (Stevens *et al.* 1993; Zabkiewicz *et al.* 1988). They can either improve or reduce the retention of sprays, dependent on their concentration and the target plant/leaf characteristics (Holloway 1994; Stevens *et al.* 1994; Holloway 1993).

The importance of the interaction between organosilicone concentration and application volume on spray efficacy has been highlighted with respect to high-volume, airblast applications onto tree fruit, where run-off may reduce efficacy (Stevens *et al.* 1994). Some efficacy data has also been generated on cereals (Stevens *et al.* 1995), but there are no reports on how organosilicone concentration and spray delivery volume may influence retention on such difficult-to-wet species. Accordingly, this systematic study examined retention by wheat of sprays containing an organosilicone, over a sixteen-fold concentration range and in four volumes representative of ground-based applications to cereals.

METHODS

Plants

Wheat plants (*Triticum aestivum*, L. cv. Otane) were propagated from seed and grown to growth stage 15 (Zadoks; 3-4 weeks) in individual pots (12 cm²) containing a proprietary potting mix (Bloom, Yates), under normal glasshouse conditions (temp 15-25°C; 12 h photoperiod of daylight), with irrigation daily as required.

Surfactant sprays

Silwet 408 surfactant (Witco Corp. Organosilicones Group, NY) was diluted in water at concentrations 0, 0.05, 0.1, 0.2, 0.4 and 0.8% (v/v). All solutions contained CuSO₄ (4 g/litre), which had no effect on the spreading or dynamic surface tension of the surfactant (D. Murphy pers. comm.).

Proc. 50th N.Z. Plant Protection Conf. 1997: 139-142

Surfactant treatments were applied (10 replicate plants in separate pots) using a moving belt track sprayer (Ray *et al.* 1996), at four application rates (37, 56, 127 and 280 litres/ha). A flat fan nozzle (TeeJet 8001; Spraying Systems NZ) was operated at 275 kPa, mounted 50 cm above the average plant height. Spray operating conditions were kept constant for each treatment so that any differences in retention could be attributed only to variation in the volume of spray applied. Spray volumes were achieved by varying the speed at which the plants passed beneath the nozzle. Application rates were determined by spraying over non-reflecting reference targets (filter papers; 4 replicates per treatment) positioned at pot height and evenly interspersed between plant replicates in each treatment.

Spray retention determinations

Plants were cut off at ground level after sprays had dried and foliage was oven-dried in paper bags at 70°C. Dry weights (ODW) of all plants were determined prior to ashing (4 h at 480°C) and quantifying retained spray (ie. copper) by atomic absorption (AA). The surface areas of individual plants were calculated from the correlation of ODW and surface areas of untreated plants (20 replicates), such that:

$$\text{cm}^2 = 3.29 + 0.122 \text{ ODW (mg)} \quad R^2 = 0.87 \quad P < 0.0001$$

Retention was expressed per unit weight ($\mu\text{l/g ODW}$), per area ($\mu\text{g/cm}^2$), and as a percentage of maximum possible spray deposition (Anderson *et al.* 1987; Grayson *et al.* 1996), where:

$$\text{retention (\%)} = \frac{(\mu\text{g CuSO}_4 / \text{cm}^2 \text{ foliage}) * 100}{(\mu\text{g CuSO}_4 / \text{cm}^2 \text{ reference target})}$$

Statistical analyses

The experiment was analysed as a factorial design and treatments were compared using analysis of variance and least significant difference (LSD) tests. Variance stabilising transformations were made where necessary prior to analysis.

RESULTS AND DISCUSSION

The retention of water on difficult-to-wet wheat foliage was poor and did not increase proportionally with increasing spray volume (Table 1). Addition of organosilicone surfactant increased the volume of spray retained, more so as carrier volume increased ($P < 0.001$). This effect of surfactants is well documented on water-repellent species (Grayson *et al.* 1996; van Toor *et al.* 1994; Anderson *et al.* 1987), in contrast to easily wetted species where surfactant addition tends to promote spray run-off (Grayson *et al.* 1996; Holloway 1994). A linear relationship between retention and spray volume was observed at all surfactant concentrations (0.05–0.8%), indicating that spray run-off did not occur at application rates ≤ 280 litres/ha. A similar effect has been reported for this class of surfactant at 0.2% when applied in up to 750 litres/ha to difficult-to-wet pea plants (Stevens 1993).

TABLE 1: Retention of sprays ($\mu\text{l/g ODW}$) on wheat foliage with varying surfactant concentration and spray volume.

Surfactant concentration (%)	Spray volume (litres/ha)			
	37	56	127	280
0	45	60	80	156
0.05	83	121	235	517
0.1	93	121	200	485
0.2	106	136	272	504
0.4	99	168	317	664
0.8	114	160	317	804

LSD ($P_{0.05}$) = 61

Retention (%) was determined on leaf area basis rather than plant plan areas for practical reasons. Sprays were fully captured and retained on wheat at low application volumes (≤ 56 litres/ha) and higher surfactant concentrations ($\bullet 0.2\%$) (Table 2). This was in contrast to water alone, which was retained moderately (*ca.* 35%) at the lowest application volume and poorly ($<20\%$) at volumes higher than 56 litres/ha. This volume effect is well documented. In his comprehensive review on the effect of carrier volume on herbicide performance, Knoche (1994) highlighted that decreasing volume enhanced droplet retention on difficult-to-wet plants.

The organosilicone sprays exhibited a similar trend to water alone in that *increased* spray volume *decreased* % retention ($P < 0.001$), particularly up to 127 litres/ha (Table 2). As loss to run-off was not a factor, deposition of spray solution must have been reduced. The reasons for less efficient capture at high spray volumes is unknown but, as spreading of organosilicone solutions on wheat foliage increases with increasing concentration (data not presented), reflection of droplets from pre-wetted surfaces is probably involved.

TABLE 2: Percentage retention of sprays (as % of maximum possible deposition) on wheat foliage with varying surfactant concentration and spray volume.

Surfactant concentration (%)	Spray volume (litres/ha)			
	37	56	127	280
0	35	32	18	15
0.05	78	67	58	51
0.1	81	68	61	63
0.2	95	87	75	68
0.4	103	94	78	76
0.8	103	95	82	83

LSD ($P_{0.05}$) = 13

Overall, % retention on wheat was enhanced with increasing surfactant concentration up to at least 0.2% (Table 2). Spray deposition, and hence efficacy, on wheat should be improved with the addition of organosilicone surfactant, and the use of reduced spray volumes will be particularly advantageous. While the danger of runoff from sprays containing high concentrations of organosilicones applied to horticultural tree crops has been highlighted (Stevens *et al.* 1994), the likelihood of this occurring with the lower volumes used on cereal crops is small. However, it is important to optimise both concentration of organosilicone surfactant and spray volume to maximise retention of pesticide sprays on the crop.

CONCLUSION

An organosilicone surfactant increased retention of spray volume on wheat. Spray run-off was not evident at concentrations $\leq 0.8\%$ v/v and with application volumes up to 280 litres/ha. Capture efficiency of sprays was greater at lower spray volumes and with higher surfactant concentrations ($\bullet 0.2\%$). Organosilicone surfactants are expected to enhance the retention of pesticide sprays on difficult-to-wet arable species over a wide range of spray application volumes.

ACKNOWLEDGEMENTS

Thanks to John Ray and Paul Gunn for assistance with the tracksprayer and AA spectrophotometer, respectively. This research was funded by Witco Corporation USA, and the Foundation for Research, Science and Technology.

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