

EFFECT OF SIMULATED RAINFALL AND ADJUVANTS ON THE PHYTOTOXICITY OF SULFONYLUREA HERBICIDES

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Summary

Glasshouse experiments were conducted with 11 sulfonylurea herbicides to investigate the effect of simulated rainfall applied 0.5, 1 and 2 hours after treatment and the influence of various adjuvants on their phytotoxicity to white mustard (*Sinapis alba* L.). Results show that phytotoxicity of all the herbicides was reduced by simulated rainfall applied 30 minutes after treatment. The adjuvants Ethokem and Pulse both significantly enhanced the activity of most of the herbicides while crop oil and Citowett were less effective. Both Pulse and Citowett were effective in minimizing the effect of rainfall soon after application. These results indicate that careful selection of adjuvant to suit either the conditions (possibility of rain) or to enhance activity could increase both the usefulness and efficacy of the sulfonylurea herbicides.

Introduction

The effectiveness of most foliar applied herbicides is reduced if rain falls soon after application. Herbicide penetration and surface retention also depend on the type and formulation of herbicide, carriers, diluents and adjuvants. Many researchers have reported that rainfall has adverse effects on the efficacy of post-emergence herbicides and have demonstrated the use of adjuvants to reduce the rainfree period required and to increase phytotoxicity (6).

The sulfonylurea herbicides are a relatively new family of compounds that are being developed for a variety of uses in crops and pastures. They are rapidly absorbed by plant foliage and once inside the plant are quickly translocated throughout the plant (1). Despite this rapid uptake there are reports of rainfall affecting their performance. Nalewaja and Adamczewski (5) and Kudsk *et al* (4) demonstrated reduced activity of thiameturon from simulated rainfall soon after application. On the other hand Buchanan *et al* (2) showed that the activity of ethametsulfuron on wild mustard (*Sinapis arvensis* L.) was not affected by simulated rainfall. It appears that there is a variation in the effect of rainfall on the activity of different sulfonylurea herbicides and formulations. As certain adjuvants are known to increase the efficacy of these herbicides (1) a series of experiments was conducted to study the effect of several adjuvants on the phytotoxicity and rainfastness of 11 sulfonylurea herbicides.

Materials and methods

The experiments were conducted in a glasshouse between February and May 1991. White mustard (*Sinapis alba* L.) was used as the test species for all the herbicides. Twelve seeds were planted per pot and thinned to eight plants after emergence. The soil used for the experiments was a Horotiu sandy loam with 8.9% organic C and a pH of 5.6. Plants were treated three weeks after planting when they had six true leaves and were about 50 mm high.

Treatments were replicated four times and pots were arranged in a randomised block design after treatment. Each experiment included one herbicide at two or three rates, with and without adjuvants and with simulated rain applied at 0.5, 1 and 2 hours after treatment and without rain.

The herbicides (Table 1) were the standard dry flowable type formulation supplied by the manufacturers. The adjuvants tested were a white emulsifiable crop oil (BP Crop Oil), an emulsifiable vegetable oil (Codacide Oil), an organo-silicone co-polymer surfactant Silwet-M (Pulse), a cationic wetting agent polyethanoxyalkylamine (Ethokem) and the non-ionic surfactants, alkylaryl polyglycoether (Citowett) and alkylaryl polyether alcohol (Triton X-45). Citowett, Pulse and Triton X-45 were used at a concentration of 0.2% of the spray solution, Codacide oil and Ethokem were used at 1 L ha⁻¹ and crop oil at 2 L ha⁻¹. The herbicide/adjuvant combinations were premixed according to label instructions and applied with a moving belt CO₂ powered sprayer fitted with an 8003 even spray nozzle to deliver 300 L ha⁻¹ at 200 kPa. Simulated rainfall of 10 mm was applied to the plants through an overhead glasshouse irrigation system over a 20 minute period.

For the duration of each experiment pots were sub-irrigated every 2-4 days as required to maintain the soil between 80 and 100% of field capacity. Day temperatures in the glasshouse were between 22 and 30°C, with night temperatures dropping to 16°C. No additional lighting was provided. Herbicide response was evaluated by regular visual damage assessments and by harvesting, drying and weighing top growth of surviving plants 3 weeks after treatment.

Results and discussion

The influence of simulated rainfall at different intervals after application of treatments is shown in Table 1. The data presented are from the highest rates tested as these were affected by the rain more than the lower rates which were less phytotoxic. The effect, however, was similar at all rates in that rainfall within 30 minutes of application of the herbicides significantly reduced their phytotoxicity to white mustard. Rainfall 2 hours after application reduced the activity of nicosulfuron only. These data confirm that the sulfonylureas are rapidly absorbed by plants but that their activity could be reduced by rain soon after application. A critical rainfree period of 1 to 2 hours appears to be sufficient time for most of the sulfonylurea herbicides tested to exhibit maximum phytotoxicity to white mustard plants. For plants in the field situation, other factors such as drought stress, dust, etc., may further modify the rainfree period required for each herbicide.

The effect of various adjuvants on the phytotoxicity of the herbicides is shown in Table 2. Triton X-45 and Codacide oil had only a small effect on the activity so were not tested in the final experiments and their results are not presented here. Of the other adjuvants, Citowett, possibly the most widely recommended additive with sulfonylureas, was the least effective in these experiments as it provided a significant increase in the activity of only three chemicals viz, metsulfuron, cinosulfuron and DPX-E9636. The most effective adjuvant was the cationic wetting agent Ethokem, which significantly increased the

Table 1. Effect of simulated rainfall on the foliar activity of some sulfonylurea herbicides without adjuvants on white mustard.

Herbicide	Rate g ha ⁻¹	Dry shoot wt* (% of untreated control)				SEM
		Hours before rainfall				
		0.5	1	2	no rain	
Chlorimuron	2.0	58	62	45	48	2.7
Chlorsulfuron	1.0	48	44	38	32	2.2
Cinosulfuron	1.0	43	33	28	29	3.4
DPX-E9636	1.0	80	65	49	41	2.6
Metsulfuron	0.25	103	75	65	46	8.9
Nicosulfuron	2.0	90	96	83	64	5.5
Primisulfuron	2.0	81	59	45	27	6.5
Sulfometuron	0.25	36	36	24	26	2.8
Thifensulfuron	1.0	91	82	71	65	3.1
Triasulfuron	0.25	102	88	79	70	7.6
Tribenuron	2.0	68	58	56	50	3.9

* Measured 3 weeks after application of treatments.

phytotoxicity of all 11 herbicides and was significantly better than the other adjuvants used for nicosulfuron, cinosulfuron and DPX-E9636. Ethokem also markedly enhanced the appearance of chlorotic symptoms in the plant. Crop oil significantly increased the phytotoxicity of eight herbicides while Pulse significantly increased the phytotoxicity of all except chlorimuron. When tested alone, the adjuvants had no effect on plant growth and yield although Ethokem caused some slight burning which appeared within 24 hours of application.

The adjuvants used in these experiments also affected the critical rainfree period. The effect was the same for all 11 herbicides. Both Pulse and Citowett proved very effective, as rainfall 30 minutes after herbicide application had no effect on phytotoxicity. However, with Ethokem and crop oil, rainfall significantly reduced phytotoxicity when applied 30 minutes after treatment, while the effect of rain 1 and 2 hours after application was significant only in some cases. The level of activity from Ethokem and crop oil with rain after 30 minutes was in most instances still equal to that of the herbicide alone without rain. The effect of rain on the adjuvants could relate to the drying time of the spray solution on the plants. In the glasshouse at 23°C in overcast conditions, the time required for the sprays to dry was 60, 40, 30, 6 and 6 minutes for the herbicide alone and in combination with Ethokem, Crop oil, Citowett and Pulse respectively. Pulse is also known to directly increase the penetration of the spray into the leaves via the stomata which is also likely to improve the rainfastness of the spray (3).

As the physiology of herbicide uptake varies between plant species, the relevance of these results will only be borne out by field testing on the target plants. However, data presented here suggest that careful selection of adjuvant either to suit the

conditions (possibility of rain) or to enhance activity could increase both the usefulness and efficacy of the sulfonylurea herbicides.

Table 2. Effect of adjuvants on the foliar activity of some sulfonylurea herbicides without rain on white mustard.

Herbicide	Rate g ha ⁻¹	Dry shoot wt* (% of untreated control)					
		Adjuvant					
		None	Pulse	Citowett	Ethokem	Crop oil	SEM
Chlorimuron	2.0	50	37	54	34	41	5.0
Chlorsulfuron	1.0	32	16	22	11	16	4.5
Cinosulfuron	1.0	29	17	21	12	17	1.6
DPX-E9636	1.0	41	23	23	7	25	3.6
Metsulfuron	0.25	46	6	11	6	19	5.4
Nicosulfuron	2.0	64	31	44	12	39	6.5
Primisulfuron	2.0	27	0	15	0	8	5.5
Sulfometuron	0.25	26	18	21	19	22	2.3
Thifensulfuron	1.0	65	49	65	52	58	3.3
Triasulfuron	0.25	70	36	54	25	41	5.8
Tribenuron	2.0	48	31	46	21	40	4.1

* Measured 3 weeks after application of treatments.

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