EFFECT OF SIMULATED RAINFALL AND ADJUVANTS ON THE ACTIVITY OF SOME GRASS HERBICIDES

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SUMMARY

The effect of rainfall and various adjuvants on the activity of sethoxydim, quizalofop and clethodim was investigated in the glasshouse using maize (*Zea mays*) as a test species. Simulated rainfall (10 mm over 20 minutes) reduced the phytotoxicity of all three herbicides when applied 0.5 and 1 h after treatment but not at 2 h. With sethoxydim and clethodim the addition of crop oil enhanced herbicide efficacy and reduced the effect of rainfall after treatment. For quizalofop, crop oil, Silwet-M and Citowett all gave increased herbicidal activity and reduced the effect of rain but the results with Citowett were far superior.

INTRODUCTION

Numerous studies have reported that rainfall can greatly affect the efficacy of post-emergence herbicides. In reviewing the influence of environmental factors on herbicide toxicity to plants, Muzik (1976) concluded that the effectiveness of most foliar-applied herbicides is reduced if rain falls soon after application. Selective grass herbicides require foliar uptake and act through disruption and decay of meristematic tissues. As they are readily absorbed by the plant foliage and travel quickly to the site of action (Velovitch 1982; Bryson 1988), this should lessen the chance of rainfall interfering with their effectiveness.

Herbicide penetration, surface retention, and washoff depend on the type of herbicide, carriers, diluents and adjuvants, in addition to plant type and environmental factors. Surfactants and other spray adjuvants increase the retention of spray on foliage which reduces the length of the critical period needed between spray application and the onset of rain (Balneaves and Fredric 1988; Bishop and Field 1987; Blowes *et al* 1987).

The objectives of this research were to study the effect of simulated rainfall applied at different intervals after spraying on the activity of some recently developed selective grass weedkillers, applied alone or with an adjuvant.

MATERIALS AND METHODS

Maize (cv. Pioneer 3709) was used as the test species for three glasshouse experiments conducted between November, 1988 and March, 1989. Six seeds were planted in 12-cm diameter plastic pots and plants were thinned to four seedlings per pot after emergence. The soil used for all experiments was a Horotiu sandy loam. Treatments were replicated four times and pots were arranged in a split-plot randomised block design after treatment.

In each experiment post-emergence applications of three herbicides were made 2 weeks after planting, when the plants had reached a height of 10 ± 2 cm (3-4 leaves). A moving belt CO_2 powered sprayer, fitted with an 8003 even spray nozzle, delivering 300 litres/ha at 200 kPa was used for applying treatments. The herbicides used were sethoxydim (Alloxol S), quizalofop (Zero), and clethodim (Select). Each herbicide was used at three rates selected from preliminary glasshouse tests (for 10 to 90% plant damage) to evaluate the effects of simulated rainfall.

The adjuvants used were a white emulsifiable crop oil (BP crop oil), a non-ionic wetting agent alkylarylpolyglycol ether (Citowett) and an organo-silicone co-polymer surfactant, Silwet-M (Pulse). Their usage rates were 0.67%, 0.15% and 0.10% of the spray solution respectively.

Simulated rainfall was applied to the pots at a constant rate of 10 mm over 20 minutes through an overhead glasshouse irrigation system at 0.5, 1 or 2 hours after

spraying herbicide treatments. Conditions at the time of application were; 22-23 °C and overcast, 30 °C and cloudy and 29-30 °C and sunny for the three experiments respectively.

For the duration of each experiment pots were sub-irrigated every 2-4 days as required, to maintain the soil near field capacity. Day temperatures in the glasshouse were between 22 and 30 °C, with night temperatures dropping to 16 °C. No artificial light was provided. Herbicide response was evaluated by regular visual damage scores, and by harvesting top growth and recording dry matter weight of surviving maize plants 4-5 weeks after planting.

RESULTS AND DISCUSSION

The influence of rainfall at different intervals after application of treatments and the effect of various adjuvants is shown in Tables 1-3. The results for each herbicide in the three experiments were similar, and therefore the data presented are averages from all three. The dry matter production data reported here were well supported by visual assessments of damage to maize plants. The effect of the simulated rainfall varied considerably with rate of application and type of adjuvant, with the largest reductions in phytotoxicity (higher dry matter production) being recorded at the low and middle rates of herbicide. At the high rate, despite the interference of the post-spray rainfall, sufficient chemical was probably absorbed by the plant foliage to be phytotoxic to maize seedlings. However in the absence of adjuvants and with no rainfall, only the highest rate of herbicide significantly reduced growth of maize plants.

With all three herbicides simulated rainfall at 0.5 and 1 h after treatment reduced their efficacy but rain after 2 h had no effect. The result for sethoxydim was similar to that determined by Rahman (1985) who also showed that the performance of sethoxydim, fenthiaprop-ethyl and haloxyfop, was affected by rain up to 1 h after application. Glasshouse work by Bryson (1988) which included all three herbicides reported here also suggests that in most cases at least a 1 h rain-free period was required after application to control Johnson grass (*Sorghum halepense*) effectively.

The effect of suitable adjuvants was twofold: it increased the actvity of the herbicide and gave a measure of protection from rain. For sethoxydim and clethodim the most effective adjuvant was crop oil which doubled the activity of these herbicides and also reduced the critical no-rainfall period from 2 h to 1 h. Citowett and Silwet-M were not beneficial as adjuvants for either herbicide. In the case of quizalofop the most

TABLE 1: Effect of rainfall at different intervals after spraying on the phytotoxicity of sethoxydim plus various adjuvants.

Additive	Herbicide rate (g ai/ha)	Dry shoot weight of maize (% of untreated)*			
		No rainfall	Rain (hours after spraying)		
			0.5	1	2
Water only	22	96	96	95	96
	45	84	92	88	87
	60	71	95	88	78
Crop oil 0.67%	22	59	81	64	64
	45	42	65	50	43
	60	32	51	36	34
Citowett 0.15%	22	88	86	89	91
	45	73	79	72	72
	60	62	81	65	63
Silwet-M 0.10%	22	91	102	88	89
	45	74	81	75	68
	60	61	69	62	60

* LSD ($P<0.05$) = 13, applies to differences between both rows and columns.

TABLE 2: Effect of rainfall at different intervals after spraying on the phytotoxicity of quizalofop plus various adjuvants.

Additive	Herbicide rate (g ai/ha)	Dry shoot weight of maize (% of untreated)*			
		No rainfall	Rain (hours after spraying)		
			0.5	1	2
Water only	4	94	90	97	95
	6	98	91	93	96
	10	67	84	86	64
Crop oil 0.67%	4	58	85	82	73
	6	29	55	14	32
	10	3	8	5	2
Citowett 0.15%	4	23	64	51	38
	6	7	34	16	18
	10	0	6	2	1
Silwet-M 0.10%	4	67	96	97	66
	6	17	80	47	36
	10	5	54	23	13

* LSD ($P < 0.05$) = 13, applies to differences between both rows and columns.

TABLE 3: Effect of rainfall at different intervals after spraying on the phytotoxicity of clethodim plus various adjuvants.

Additive	Herbicide rate (g ai/ha)	Dry shoot weight of maize (% of untreated)*			
		No rainfall	Rain (hours after spraying)		
			0.5	1	2
Water only	4	93	96	92	91
	6	94	97	93	96
	10	87	95	97	90
Crop oil 0.67%	4	87	96	89	87
	6	78	92	82	80
	10	56	79	49	60
Citowett 0.15%	4	92	84	89	89
	6	80	73	75	82
	10	68	62	51	57
Silwet-M 0.10%	4	87	97	98	89
	6	82	89	88	92
	10	79	84	84	71

* LSD ($P < 0.05$) = 13, applies to differences between both rows and columns.

effective adjuvant was Citowett, which greatly enhanced herbicidal activity and also further reduced the critical rain-free period compared to other adjuvants. The use of crop oil or Silwet-M with quizalofop resulted in increases in activity similar to those recorded for crop oil as an adjuvant to sethoxydim and clethodim.

An absence of rainfall immediately following application of post-emergence grass herbicides is critical to achieving optimum and cost-effective weed control. Knowledge of the rain-free interval required for effective activity would help growers co-ordinate herbicide application with the weather. The activity of the three grass herbicides was not seriously affected when 10 mm of simulated rain fell 2 h after application. The rapid absorption of these herbicides by the plant foliage is a very desirable attribute for their use as post-emergence treatments.

The results reported here show that the addition of crop oil increased the activity of sethoxydim, clethodim and quizalofop and improved protection from simulated rainfall. However Citowett was a better adjuvant to use with quizalofop, giving a greater increase in activity than either crop oil or Silwet-M. Citowett and Silwet-M had no effect on the activity of the other two herbicides. The period required for protection from rainfall for each of these herbicides was up to 2 h without an adjuvant, reduced to 1 h with a suitable adjuvant.

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