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The Effect of Simulated Rain on the Activity and Uptake of Imazapyr on *Mikania micrantha* H.B.K.

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ABSTRAK

Kesan hujan buatan keatas aktiviti dan pengambilan imazapyr telah dikaji pada Mikania micrantha *H.B.K.. Aktiviti imazapyr adalah meningkat dengan kadar yang bermakna pada kadar kepekatan imazapyr yang lebih tinggi dan isipadu semburan yang rendah. Imazapyr memerlukan sekurang-kurangnya enam jam antara penyemburan imazapyr dengan pendedahan pada hujan buatan untuk mendapat kawalan melebihi dari tahap 50%. Peningkatan isipadu dan kelebatan hujan buatan telah mengurangkan aktiviti racun imazapyr. Peratus kawalan yang paling rendah yang telah diperolehi pada 10 mm isipadu hujan buatan dan 50 mm sejam kelebatan hujan buatan. Pengambilan ^{14}C-imazapyr dicatat dengan peningkatan yang bermakna pada pokok yang telah didedahkan terlebih dahulu dengan hujan buatan sebelum didedahkan dengan ^{14}C-imazapyr.*

ABSTRACT

The effect of simulated rain on the activity and uptake of imazapyr was studied on Mikania micrantha *H.B.K. The activity of imazapyr was significantly increased both at high concentration of imazapyr and low volumes of spraying. Imazapyr required at least six hours between herbicide application and onset of simulated rain to obtain more than 50% control. Increasing the volume and intensity of simulated rain adversely affected the activity of imazapyr. Lowest percentage of control was obtained at 10 mm and 50 mm/h for volume and intensity of simulated rain respectively. Greater uptake of ^{14}C-imazapyr was recorded in plants pretreated with simulated rain than those without exposure to simulated rain. Twenty-four hours after treatment, uptake was 78.7% and 70.5% for those exposed to simulated rain and without simulated rain respectively.*

INTRODUCTION

Rainfall can drastically reduce the efficacy of herbicides. This is mainly due to removal of active ingredients from the foliage before a lethal dose can be absorbed by the plants (Bovey and Diaz-Colon 1969; Doran and Anderson 1975; Skuterud and Caseley 1980). Linscott and Hagin (1968) found that 93% loss of the dimethylamine salt of 2,4-D from foliage occurred when exposed to simulated rain of 5 cm. The reduction in efficacy of the herbicide depends on the quantity and intensity of rain, the elapsed period after application and the resistance of the pesticide to rainwash (McDowell 1987).

The objectives of this study were to investigate (a) the effects of rainfall on the uptake and distribution of ^{14}C-imazapyr, (b) the amount of rain and its intensity, and (c) the rain-free period required for effective control of *M. micrantha* after application of imazapyr.

MATERIALS AND METHODS

The rain simulator used for Experiments 1, 2 and 3 was similar to the one adopted by Taylor and Mathews (1984). A droplet spectrum resembling that of natural rain was delivered by four 1/4 G10 solid cone nozzles (Spraying System co., Illinois, U.S.A.), mounted 80 cm apart on a square metal frame. Two sets of thin aluminium V-shaped channels running at right angles to each other were used to intercept a portion of nozzle output. The V-shaped channels were fitted into the wooden frames with V-shaped notches leaving a gap of about 6 mm. The intensity of rainfall (volume/time unit) was adjusted by removing some of the V-channels.

Experiment 1. Effects of intervals of simulated rainfall on the control of M. micrantha by imazapyr at three rates

Plate 1. Layout of rain simulator

The amount of rainfall used in the activity studies was 30 mm at a rain intensity of 50 mm/h. Plants at the twelfth leaf stage were treated with 0.05, 0.1 and 0.3 kg a.i imazapyr/ha. A Maldrive laboratory pot sprayer was used to deliver a spray volume of 211 l/ha. At intervals of 1, 3, 6, 12, 24 and 72 hours after herbicide spraying, treated plants were exposed to simulated rain. Plants treated with imazapyr at the 3 rates and subsequently not exposed to simulated rain were considered as the control treatment. All assessments were recorded five weeks after spraying.

Experiment 2. Effects of interval of simulated rainfall and volume of application of imazapyr on the control of M. micrantha

The second experiment was conducted to determine the effect of spraying volume and exposure to simulated rain on imazapyr activity. Plants were sprayed with 0.3 kg a.i/ha of imazapyr at the spraying volumes of 20, 105 and 211 l/ha. At intervals of 1, 3, 6, 12 and 72 hours after spraying, treated plants were exposed to simulated rain at 30 mm from 50 mm/h intensity. The spinning disc (Micron Herbi 77, UK) was used to deliver 20 l/ha and the Maldrive laboratory pot sprayer for 105 and 211 l/ha. The percentage control was recorded five weeks after application of herbicide.

Experiment 3. Effect of amount of simulated rainfall on the control of M. micrantha

The third experiment was carried out to determine the effect of the amount and intensity of simulated rain. The amount of simulated rainfall used was 2, 5 and 10 mm through rain intensities of 10, 30 and 50 mm/h. Imazapyr was sprayed at 0.3 kg a.i/ha in a volume of 211 l/ha and treated plants were exposed to simulated rain at the respective amounts and intensities three hours after spraying. All assessments were recorded five weeks after spraying.

Experiments 1, 2 and 3 were arranged in completely randomized block design with six replicates and repeated twice. Data was subjected to variance analysis and means were compared with Least Significant Difference (LSD) test.

Experiment 4. Uptake and distribution studies

Plants at the fifth leaf stage were selected for this experiment. ^{14}C-imazapyr (specific activity: 44 uCi/mmol) solution was applied to the second youngest leaf. The application of radiolabelled solution and radioactivity determination was carried out using the technique described by Ipor and Price (1990). 1 ul of ^{14}C-radiolabelled solution was applied to each leaf using microsyringe applicator (Hamilton, USA) avoiding the midrib of the leaf. Plants were exposed for 30 minutes to simulated rain at 50 mm/h, one hour prior to ^{14}C-herbicide application. Those plants not exposed to simulated rain served as the control. The uptake periods were 1, 6 and 24 hours, and each leaf was divided into four portions: tip, treated area (middle portion), base leaf and petiole. The radioactivity of these different portions was determined by digesting with 'NCS' tissue solubilizer (Amersham, UK) and bleaching with benzoyl peroxide before adding scintillation fluid (Burell and Brunt 1981).

A randomized complete block design was used in this experiment with six replications and repeated twice. Data were subjected to analysis of variance and mean values were compared by using LSD test.

RESULTS

Experiment 1. Effects of intervals of simulated rainfall on the control of M. micrantha by imazapyr at three rates.

Fig. 1 shows the effect of different time intervals between application of different concentrations of imazapyr and simulated rain on control of *M.*

micrantha. Exposure to simulated rainfall one hour after treatment recorded the lowest effect of imazapyr on *M. micrantha.* The response increased with increase in time interval of exposure to simulated rainfall. The rate of response sharply increased during the first 12 hours after treatment with imazapyr. The results were significantly higher at 0.3 kg a.i/ha than at 0.1 and 0.05 kg a.i/ha between 12 and 72 hours of rain exposure. In addition, the increase of control (irrespective of dosage was marginal between these intervals.

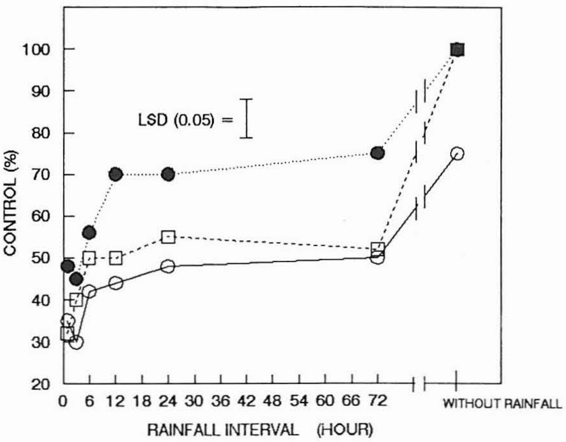

Fig 1: Effect of imazapyr application rates and rain intervals on the control of M. micrantha, *five weeks after spraying.* —⊖— *0.05 kg a.i/ha* -⊟- *0.1 kg a.i./ha* ··●·· *0.3kg a.i/ha*

Experiment 2. Effects of interval of simulated rainfall and volume of application of imazapyr on the control of M. micrantha

Fig. 2 shows the effect of time interval between application of imazapyr at different volumes and exposure to simulated rain on the control of *M. micrantha.* The phytotoxicity of imazapyr was significantly increased with increase in the time intervals of exposure to simulated rain. The plants which were sprayed at 211 1/ha showed significantly less response to imazapyr. Spraying with 20 1/ha showed greater response although this did not differ significantly from 105 1/ha. Complete control was recorded in the standard treatment regardless of the spraying volume.

Experiment 3. Effect of amount of simulated rainfall on the control of M. micrantha

The effect of amount and intensity of simulated rain on control of *M. micrantha* is shown in *Fig. 3.* Exposure to simulated rain after imazapyr application resulted in significant reduction in the

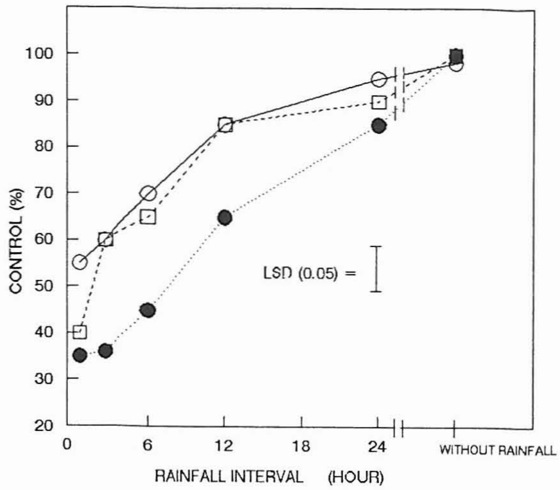

Fig 2: Effect of spraying volumes and rainfall intervals on the control of M. micrantha *by imazapyr at 0.3 kg a.i/ha, five weeks after spraying.* —⊖— *0.05 kg a.i/ha* -⊟- *0.1 kg a.i./ha* ··●·· *0.3kg a.i/ha*

phytotoxicity of imazapyr. Volumes of simulated rain showed a remarkable effect on control of *M. micrantha.* Plants exposed to 10 and 30 mm/h of simulated rain intensities were controlled significantly better than those exposed to 50 mm/h.

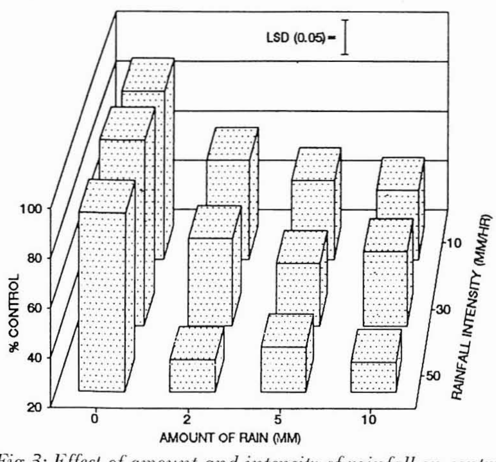

Fig 3: Effect of amount and intensity of rainfall on control of M. micrantha *by imazapyr at 0.3 kg a.i./ha, 5 weeks after spraying*

Experiment 4. Uptake and distribution studies

Exposing the plants to simulated rain significantly increased the uptake of ^{14}C-imazapyr in *M. micrantha* (Table 1). The uptake of ^{14}C-imazapyr in leaves which had been exposed to simulated rain was significantly higher than in those without rain exposure. Most of the recovered ^{14}C-imazapyr was found in the treated area. At 24 hours after treatment, a significantly greater amount of ^{14}C-imazapyr was recovered from the lower zone in leaves exposed to simulated rain than in those without rain exposure.

DISCUSSION

Rapid herbicide uptake and washing-off of surface deposits from leaf surface have practical implications for reducing the critical period between spraying and the onset of rainfall. The present study indicated that the translocated herbicide, imazapyr on *M. micrantha* required 24 hours between herbicide application and rainfall to obtain optimum control (*Fig. 2*). This rain-free period is essential to allow sufficient percentage of applied herbicide to be absorbed within the plants where it will no longer be readily susceptible to removal by rain. This was illustrated by the increased uptake of ^{14}C-labelled herbicide with increasing time after application (Table 1).

A significantly higher uptake of ^{14}C-imazapyr was recorded for *M. micrantha* after being exposed to simulated rain. Exposure to simulated rain may cause destruction and erosion of the epicuticular wax. Baker and Hunt (1986) found that droplets (250 to 400 um) travelling at a low or medium velocity (0.25 to 5 ms^{-1}), fractured the dendrites and tubes on leaves of *Brassica* spp, the tubes on *Eucalyptus globulus* and ribbons on the adaxial surfaces of *Pisum sativum* L. and *Fragaria ananassa* Duchesne. Damage to the leaf surface and erosion of epicuticular wax may result in an increase in wettability and increase in cuticular permeability. Improved cuticular permeability is possible because of re-wetting through exposure to simulated rain.

The volume of spraying, amount and intensity of rainfall were shown to be associated with a decrease in the effectiveness of herbicide. *Fig. 2* shows that reducing the spray volume of imazapyr appreciably increased the control of *M. micrantha.* Improved retention using low volume spraying has been attributed to the larger area of contact between the smaller droplet and the leaf cuticle. Pick *et al.* (1984) believed that the speed at which a compound penetrated the leaf surface probably determined its resistance to wash-off. When imazapyr is applied in low volume, some of the active ingredient may be carried rapidly into the leaf cuticle.

An increase in the amount and intensity of rainfall decreased the percentage control of imazapyr on *M. micrantha (Fig. 2).* In the present study, highest amount (10 mm) and intensity (50 mm/h) of rainfall were sufficient to remove the spray deposits from the leaf surfaces. Changing the rain intensity could affect the wash-off capability of a given amount of rain, since increased

TABLE 1
Effect of simulated rain on uptake and distribution of ^{14}C-imazapyr in *Mikania micrantha* leaves.

Time		Leaf section*					
		C.A.	T.Z.	U.Z.	L.Z.	P.	T.U.
(h)	Treatment	% of applied					
1	Without rain	40.3	37.6	1.2	1.3	1.5	40.6
	With rain	31.5	42.5	1.0	2.8	1.0	47.3
6	Without rain	27.0	40.5	4.4	4.5	6.4	55.8
	With rain	21.1	44.2	4.6	8.6	5.1	62.5
24	Without rain	10.6	49.1	5.8	8.5	7.1	70.5
	With rain	11.3	53.7	3.5	14.0	7.5	78.7
	LSD (5%) =	8.7	9.0	3.3	5.7	2.8	8.3

* C.A. = Cellulose acetate T.Z. = Treated zone
U.Z. = Upper zone L.Z. = Lower zone P. = Petiole
T.U. = Total Uptake

intensity is usually accompanied by a larger median droplet size (Best 1950); concomitant increase in terminal velocity perhaps increased the ability to remove herbicide from the plant. McDowell (1987) also found that the amount of rainfall affected the wash-off of fenvalerate from cotton plants to a greater extent than did rainfall intensity.

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