

THE CONTROL OF *PANICUM REPENS* (L.) BEAUV WITH GLYPHOSATE

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Established stands of *Panicum repens* (L.) Beauv were treated with glyphosate (N-phosphonomethyl glycine) at 4.48, 2.24, 1.12, 0.56 Kg/ha and dalapon (2, 2, dichloropropionic acid) at 11.2 Kg/ha. Both herbicides suppressed shoot growth and development of new rhizomes significantly at each rate of applications. Glyphosate at 4.48 and 2.24 Kg/ha completely suppressed shoot growth 4½ months after the first application. Two applications of glyphosate at 4.48 Kg/ha reduced the dry weight of new rhizomes to 0.1% nine months after the first application, while the reduction in weight of new rhizomes due to dalapon at 11.2 Kg/ha was 53% during the same period.

Panicum repens (L.) Beauv is one of the most noxious weeds in Sri Lanka, and has been described in detail by Trimen (1900) Senaratne (1956) and Bor (1960). It is commonly referred to as Couch Grass in Sri Lanka and Torpedo Grass in the United States. It has become a particularly troublesome weed in certain tea districts in Sri Lanka—Dimbula, Dickoya (1000-1400 m amsl) and certain parts of Uva (1000-2000 m amsl) and the mid country. It has an extensive rhizome system which contains a high level of carbohydrate reserves. The carbohydrate reserves in the rhizome provide the capacity for rapid regeneration of shoots and rhizomes from small fragments which can develop into a dense subterranean system within a short period. It has been shown that the weight of new rhizomes was 12 times the weight of planted rhizomes after 11 months of growth (Manipura & Somaratne 1974). The rhizomes bear a meristem at each node. Each rhizome terminates in a sharply pointed bud which can penetrate the soil easily. Rhizomes of *P. repens* are reported to a depth of 7 m (Bor 1960). Investigations done at the Tea Research Institute of Sri Lanka indicate that although there is extensive horizontal spread of rhizomes, downward penetration is limited, and is generally confined to the first 60 cm of the soil (Manipura & Somaratne, unpublished).

No satisfactory method of control has yet been developed. Depletion of carbohydrate reserves, by repeated defoliation with low doses of paraquat at two weekly intervals, killed the grass in pot experiments, but this method needs further testing under field conditions on established stands of *P. repens* (Manipura & Somaratne 1974). The control methods presently available have been described in detail by Manipura & Somaratne (1974).

The experiment that is reported here, examined the effect of glyphosate (isopropyl amine salt of N-phosphonomethyl glycine) as a foliar application on established stands of *P. repens*. Dalapon (2,2-dichloropropionic acid) was used for comparison.

MATERIALS AND METHODS

The experiment was carried out at the Tea Research Institute of Sri Lanka, Talawakele (1200 m amsl). Plots 3.05x3.05 m were separated by boundaries 30 cm wide on all sides. In order to prevent the spread of rhizomes from one plot to the next, each plot was lined with a double layer of 700 gauge polythene to a depth of 45 cm. The soil was a clay loam. Glyphosate at 0.56, 1.12, 2.24, 4.48 Kg/ha and dalapon at 11.2 Kg/ha were applied to the foliage in each of four plots (replicates) in randomized blocks. Each block had one control plot. Rhizomes of uniform thickness were dug out, and kept on moist blotting paper overnight to prevent desiccation. The rhizomes were planted in rows 30 cm apart at a depth of 10 cm. Rhizomes were placed end on end in the row. They were planted on 16 September 1972 and shoots had emerged in most plots by 5 October. Tea fertilizer mixture T 200 (Tolhurst 1961) at the rate of 49 Kg/ha and ammonium sulphate 24.5 Kg/ha were applied to the experimental area on 19 December 1972 and 6 April 1973 respectively.

The first application of herbicides was done on 21 May 1973. A pressurized sprayer delivered the herbicide in 562 L of water/ha. At the time of the first spraying the dry weight of rhizomes and shoots were 42.30 and 43.90 g/930 cm² respectively. Rhizomes had penetrated to a depth of 30 cm and the shoots were 30-40 cm in height. The second and third applications were given on 8 October 1973 and 30 January 1974 respectively. The last application of glyphosate at 4.48 Kg/ha was not applied as there were no live shoots. There was no rain within 10 hr of application on any of the dates of application.

Control of *P. repens* was evaluated by visual scoring at weekly intervals within the range 0-complete control, 10-no control, and by digging out the plants from the plots, 3, 6 and 9 months after the first application of herbicide. Each plot was divided into 25 squares. The outer squares were rejected to minimize edge effects, if any, and the nine squares at the centre were assessed. Three squares were selected at random for each assessment. A square quadrat of 930 cm², was placed at the centre of the selected square and the plants within it were carefully dug out, and washed free of soil. The plants from all three points were bulked together. The plant material was separated into shoots, live rhizomes and dead rhizomes and the dry weight of each category was determined after drying at 100 °C for 24 hr.

RESULTS

The effect of glyphosate and dalapon on the growth of shoots of *P. repens* is shown in Table 1. All chemical treatments depressed the dry weights of shoots (see also Figs 1-4). Glyphosate at 4.48 and 2.24 Kg/ha was significantly better than at 0.56 Kg/ha and dalapon at 11.2 Kg/ha in reducing shoot growth. The effect of dalapon at 11.2 Kg/ha was comparable with the lower rate of application of glyphosate. The foliage after glyphosate application showed chlorotic symptoms on the third day after application and within a week plants were completely scorched and withered. The degree of scorch was correlated with the dose of glyphosate applied. The initial activity was slow. The foliage was completely scorched and disintegrated with time as shown in Figs 2 & 3. The effect of herbicides on the control of *P. repens* with time is shown in Fig. 5. The degree of control of *P. repens* as assessed by visual scoring, at 4.48 and 2.24 Kg/ha was in the range 90-99% from the second week onwards, while at the lowest dose, control decreased from 70% to 35% from the 5th to the 20th week. The effect of dalapon on the shoot system was slow and gradual and by the 12th week the control was in the range of 70-75%, which decreased to 50% by the 20th week. Two applications of glyphosate at 4.48 and 2.24 Kg/ha killed all top growth by the 22nd and 28th week respectively whereas other treatments failed to completely kill the plants.

TABLE 1 — *Effect of glyphosate and dalapon on shoot of P. repens*

Herbicide	Dose (Kg/ha)	Time of assessment Months after first application	Dry weight of shoots (g) per 3 squares of 920 cm ² each Transformed to $\sqrt{\frac{n}{n+1}}$ Figures in parenthesis show re-transformed data					
			3		6		9	
Glyphosate	0.56		4.22	(16.80)	2.91	(7.46)	4.29	(17.40)
	1.12		2.90	(7.41)	2.08	(3.32)	1.94	(2.76)
	2.24		1.37	(0.87)	1.00	(0)	1.00	(0)
	4.48		1.06	(0.12)	1.00	(0)	1.00	(0)
Dalapon	11.20		4.60	(20.16)	2.67	(6.12)	4.27	(17.23)
Control			13.99	(194.72)	11.04	(120.88)	17.12	(292.09)
LSD (<i>P</i> =0.05)			1.67		1.62		2.74	

TABLE 2 — *The effect of glyphosate and dalapon on live rhizome growth of P. repens*

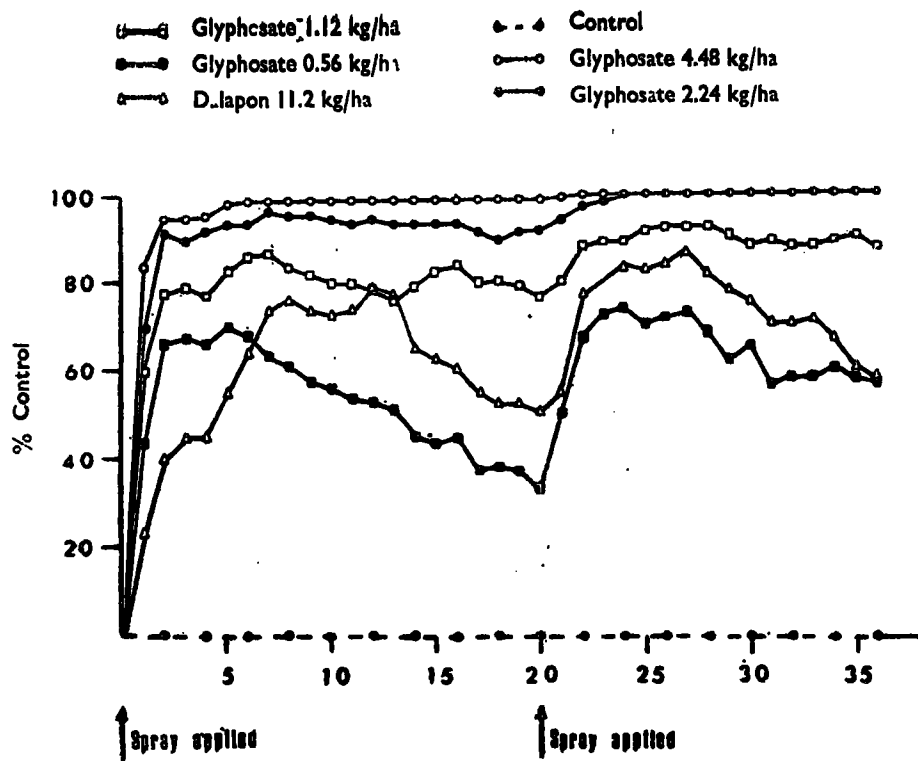
Herbicide	Dose (Kg/ha)	Time of assessment Months after first application	Dry weight of live rhizomes (g) per 3 squares of 920 cm ² each Transformed to $\sqrt{\frac{n}{n+1}}$ Figures in parenthesis show re-transformed data					
			3		6		9	
Glyphosate	0.56		6.83	(45.64)	7.17	(50.40)	7.33	(52.72)
	1.12		6.53	(41.64)	6.86	(46.05)	6.52	(41.51)
	2.24		3.50	(11.25)	3.63	(12.17)	3.84	(13.74)
	4.48		2.80	(6.84)	2.61	(5.81)	1.13	(0.27)
Dalapon	11.20		7.29	(52.14)	7.57	(56.30)	6.78	(44.96)
Control			10.39	(106.95)	10.09	(100.80)	14.83	(218.92)
LSD (<i>P</i> =0.05)			1.32		1.11		1.16	

TABLE 3 — *The effect of glyphosate and dalapon on rhizomes of P. repens*

Dry weight of dead rhizomes (g) per 3 squares of 920 cm² each
 Transformed to $\sqrt{\frac{n+1}{n}}$
 Figures in parenthesis show re-transformed data

Herbicide	Dose (Kg/ha)	Time of assessment Months after first application	3		6		9	
			Mean	(Re-transformed)	Mean	(Re-transformed)	Mean	(Re-transformed)
Glyphosate	0.56		3.19	(9.17)	3.16	(8.98)	4.07	(15.72)
	1.12		3.97	(14.73)	3.71	(12.76)	3.72	(12.83)
	2.24		4.40	(18.36)	5.02	(24.20)	3.52	(11.39)
	4.48		4.71	(21.18)	4.46	(18.89)	2.98	(7.88)
Dalapon	11.20		1.84	(2.38)	1.92	(2.68)	2.18	(3.75)
Control			2.01	(3.04)	1.85	(2.42)	1.72	(1.95)
LSD (<i>P</i> =0.05)			0.96		0.69		0.82	

* Most of the rhizomes were disintegrated



Time in weeks from first herbicide application
 FIG. 5—Effect of glyphosate and dalapon on tee control of *P. repens*

The effect of glyphosate and dalapon on the rhizomatous system is shown in Tables 2 and 3. Both herbicides reduced the production of new rhizomes. The reduction in dry weight of rhizomes was significantly better at 4.48 and 2.24 Kg/ha glyphosate than at 1.12 and 0.56 Kg/ha glyphosate or at 11.2 Kg/ha dalapon. The effect of glyphosate on the kill of rhizomes was significant at all doses whereas dalapon was effective only in reducing the dry weights of rhizomes. The disintegration of rhizomes was better at the two higher doses of glyphosate. In general there were more dead rhizomes in glyphosate-treated plots than in dalapon-treated plots. At the highest dose of glyphosate used in our experiments, there was a residue 0.27g/3 × 920 cm² of viable rhizomes still in the soil at the time of the last assessment—6 months after the 2nd application of the herbicide.

DISCUSSION

It is clear from the results presented (Tables 1 & 2) that the herbicides tested reduced the growth of shoots as well as new rhizomes at all levels tested. Glyphosate at 2.24 and 4.48 Kg/ha was effective and completely suppressed shoot growth. Earlier attempts were made to reduce shoot growth of *P. repens* by repeated defoliation by manual and chemical means. Fortnightly applications of paraquat caused the greatest reduction in growth and caused the death of whole plants five months after planting in pot experiments (Manipura & Somaratne 1974). In the present study glyphosate at 4.48 and 2.24 Kg/ha completely suppressed shoot growth, 4½ months after the first application in established stands of *P. repens*. The suppression of growth due to dalapon at 11.2 Kg/ha was in the range of 75-80% by the 12th week. This declined gradually to 50% by the 20th week. The decline in the rate of control was mainly due to the emergence of new shoots rather than the recovery of affected shoots.



Fig. 1—Control plot 9 months after the first herbicide application

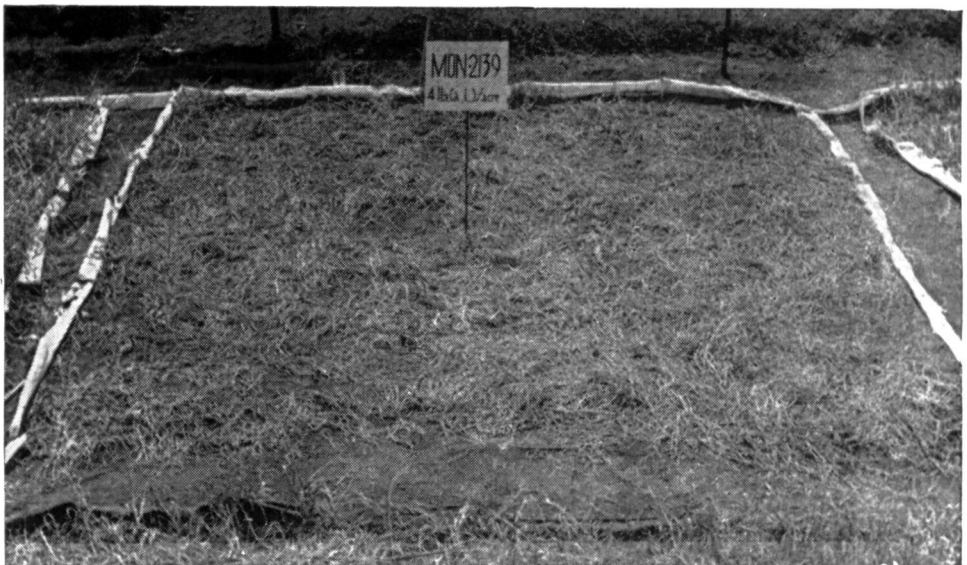


Fig. 2—Plot treated with glyphosate at 4.48 Kg/ha, 3 months after the first herbicide application



Fig. 3—Plot treated with glyphosate at 4.48 Kg/ha 9 months after the first herbicide application



Fig. 4—Plot treated with dalapon 11.2 Kg/ha 9 months after the first herbicide application

The response of rhizomes to chemical treatment was similar to that of the shoots, the greatest effect resulting from two applications of glyphosate at 4.48 Kg/ha. The rhizomes are the main storage organs of *P. repens* and other rhizomatous perennial grasses. Any attempt made to control such grasses should, therefore, be directed towards reducing the growth and development of new rhizomes. Suppression of rhizome development was achieved through repeated defoliation by Turner (1966; 1968) and Williams (1969) in *Agropyron repens* and Manipura and Somaratne (1974) in *P. repens*. This method also reduced the carbohydrate reserves in the rhizomes (Turner 1966; 1968; 1969; Manipura & Somaratne 1974). Schirman & Buchholtz (1966) reported that atrazine reduced carbohydrate reserves in *A. repens* to levels insufficient to support regrowth. Although no attempt was made to determine the mode of action of glyphosate on *P. repens* in the present study, it is evident from the results that it drastically reduced rhizome development and killed almost all the rhizomes at the highest dose used. When *P. repens* was repeatedly defoliated, although the dry weight of new rhizomes decreased when compared with the control, there was a slight increase in the dry weight of new rhizomes with time (Manipura & Somaratne 1974). After treatment with dalapon the dry weight of live rhizomes appeared to be static for 9 months whereas with glyphosate at the highest level there was a continued decrease in dry weight of rhizomes. It appears, that with glyphosate the development of rhizomes is, therefore, drastically affected. In the controls the dry weight of live rhizomes had increased by 75% within nine months while glyphosate at 4.48 Kg/ha reduced it to 0.1% and dalapon at 11.2 Kg/ha to 53% during the same period. At the lowest dose of glyphosate the reduction in the dry weight of live rhizomes was 56%. The kill of living the rhizomes killed at all levels of glyphosate tested was significantly greater than that caused by dalapon. The quantity of dead rhizomes dug out from dalapon-treated plots was almost the same as that from the control plots. It appears, therefore, that dalapon at the level tested in the present study was not effective in killing rhizomes. McIntyre (1962) reported a marked increase in translocation of dalapon into the roots when a treated leaf of *A. repens* was exposed to prolonged darkness and according to Sagar (1960) the rapidity with which dalapon migrates from xylem to phloem is dependent on the rate of transpiration, consequently a high transpiration rate will reduce the downward translocation of the compound. Lund-Hoie and Bylterud (1969) showed from tracer studies that the node from which the treated tiller had developed presented a barrier to the downward movement of dalapon in *A. repens*. Thus in *P. repens* as in *A. repens* downward movement of dalapon from the treated shoots to rhizomes may have been blocked at certain points or impeded due to high transpiration rates, because the period following the application of herbicides was dry and was, therefore, conducive for high transpiration rates. The reduction in the dry weight of new rhizomes in dalapon-treated plots was similar to that due to defoliation manually or with paraquat (Manipura & Somaratne 1964). It appears, therefore, that in the present experiment the main effect of dalapon was on the shoot system and the overall effect was similar to that due to defoliation.

Glyphosate apparently does not have any phytotoxic activity through the soil (Freisen 1972). Experiments conducted at the Tea Research Institute of Sri Lanka, Ratnapura (60 m amsl) indicates that glyphosate (1.12 Kg/ha in 562 L water/ha) did not produce any visually recognizable symptoms of phytotoxicity even when the spray was applied onto the foliage of young tea (Wettasinghe 1974). Furthermore *P. repens* does not form a uniform ground cover in most tea fields, but is scattered and confined to small areas in most tea estates. It appears, therefore, that glyphosate may prove to be a safe herbicide for the control of *P. repens* in tea fields.

ACKNOWLEDGEMENTS

The authors wish to thank the Monsanto Commercial Products Company for the supply of glyphosate used in the experiment and Mr S. T. Yatawatte for able assistance and for the statistical analysis of the data.

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In the press.

Accepted for publication—27th July 1974