Weed Control With Simazine in Planting Strips of Hevea brasiliensis and in Leguminous Cover Plants

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In tests with applications of Simazine as a pre-emergence herbicide in planting strips at rates of 5 and 10 lb per acre, a significant negative correlation between the clay content of the soil and the period of weed control was recorded. Compared with hand weeding, Simazine extended the period of control by a maximum of 3.2 weeks on a coastal clay soil, and by 9.0 weeks and more on a sandy inland soil. Simazine gave poorer control when sprayed between the drills of legume cover plant seedlings than when applied to planting strips, owing to the encroachment of weeds from the unsprayed drills.

Experiments comparing various chemicals as pre-emergence herbicides have been described in a previous paper (RIEPMA, 1962). It was found that on a sandy soil herbicides belonging to the triazine group of compounds showed considerable promise. Simazine, which was found to be less persistent in its effect than some of the other compounds, was the only member of this group of pre-emergence weed-killers commercially available in Malaya, and experiments were therefore carried out on various soil types during 1961 and 1962 with the object of determining the usefulness of this herbicide.

Simazine is proposed for use in rubber cultivation for two main purposes; the maintenance of weed-free conditions in the planting row, and the prevention of weed seed emergence in the inter-row areas until sown leguminous creeping cover plants have developed sufficiently to cover the soil surface and shade out colonising weed growth. In present estate practice the drills of young cover plants are weeded by hand, a procedure which can be expensive if weeds are abundant. This paper presents a report on work evaluating the effectiveness of Simazine when used for the above purposes; throughout these experiments hand weeding was used as the control with which Simazine was compared.

METHODS

The results described below were obtained in a series of trials involving a number of different herbicides, but for the purposes of this paper only the results for treatments with Simazine application are discussed. All applications were made using an Eclipse knapsack sprayer, and at a volume of 100 gal. per acre.

Weed Control in Leguminous Cover Plants

Six experiments, described in *Table 1*, were laid down in hand-weeded plots in inter-row areas where young leguminous cover plant seedlings had been sown in drills. In preliminary trials it had been found that the cover plants *Pueraria phaseoloides* and *Centrosema pubescens* are very susceptible to Simazine, being killed by pre- and post-emergence applications of 1 – 2 lb per acre of the chemical, and because of this the Simazine was sprayed only on the bare soil between the rows of young seedlings. In one experiment (No. 1) spraying was carried out before the legume seeds had germinated.

Weed Control in Planting Strips

Ten experiments were laid down in which Simazine was sprayed on to hand-weeded planting strips some 6 feet wide. Creeping plants that encroached on the strips were

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thrown back from time to time into the inter-row area, but even so one experiment had to be discarded eventually because of encroachment by *Paspalum conjugatum* and *Mikania scandens*. In this experiment encroachment from the side increased the proportion of ground covered by weeds from 2% to 80% in one month. Details of the nine remaining experiments are given in *Table 2*.

Recording. In both the above sets of experiments the percentage of ground covered by weeds was estimated visually at regular intervals after spraying. The data on percentage cover were converted to logarithms and graphed against time in weeks after spraying. Regression lines were calculated as described in a previous paper (RIEPMA, 1962), and estimation of the time in weeks after spraying at which hand-weeding would be necessary again (5% ground cover) were made (*Tables 3* and *4*).

Influence of Soil Characteristics on Effectiveness of Simazine

An attempt has been made to determine from the experiments in planting strips whether any relationship exists between soil characteristics and the effectiveness of Simazine. Only those experiments in which Simazine was applied at 5 or 10 lb per acre were included in this test, and to supplement the data results were included (*Table 5*) from three other previously reported experiments (RIEPMA, 1962) which involved similar pre-treatment hand-weeding and Simazine application. The experiments on the use of Simazine in legumes were not included in the study, since development of weeds from the unsprayed drills of legumes prevented a strict comparison.

RESULTS

Weed Control in Leguminous Cover Plants

Results from the six experiments concerned (Numbers 1 to 6) are given in *Figures 1* to *6* and *Table 3*. From *Table 3* it can be seen that at the 5% ground cover stage Simazine presents little advantage over control by hand-weeding: up to 2.7 weeks' extension of control on coastal clay soil, and ranging from 4.1 to 6.5 weeks on sandy and lateritic clay soils. The experiments are limited in number, but since levels of application ranged up to 12 lb per acre no great promise is indicated.

Weed Control in Planting Strips

Results of the nine experiments (Numbers 7 to 15) that were carried through to completion are given in *Figures 7–15*. The summarised data given in *Table 4* show that extension of control over hand-weeding was variable; 10 lb of Simazine per acre generally gave rather better control than did 5 lb per acre, and poorer control was obtained on the clay soils than on sands, loams and clay loams. With applications of 10 lb per acre a maximum extension of control of 3.2 weeks was recorded on a coastal clay soil, as compared with 9.0 weeks on a sandy inland soil.

Influence of Soil Characteristics on Effectiveness of Simazine

The data from those experiments carried out in planting strips which utilised treatments of 5 and 10 lb per acre of Simazine, and previously published data from a further three experiments, have been grouped in *Table 5*, together with data on the mechanical analysis of the soil types concerned. Calculation shows that there is a positive correlation between persistence of control and soil pH, and a negative correlation with the clay and silt fraction. No correlation with organic matter content is indicated.

DISCUSSION

The experiments reported above were carried out on sites where *Paspalum conjugatum* was the main weed species. Preliminary work had shown that seedlings of this grass will tolerate application of 2.5 lb per acre of Simazine, but since comparable tolerance by other weed seedlings, notably *Digitaria longiflora*, *Cyperus* spp, *Borreria latifolia* and *Axonopus compressus* was also observed, the results can be considered to be of general validity.

It seems unlikely that Simazine will be of much value in maintaining weed control in inter-row areas sown with legume cover plants. Because young legume seedlings cannot be sprayed with Simazine, weed seed germination along the cover plant drills can proceed unchecked and if creeping weed species develop they will soon encroach on the sprayed area; comparison of the results in *Tables 3* and *4* shows that in general, on the same soil type, weed control in legumes was rather less effective than in planting strips, probably owing to this development of weeds in the unsprayed drills.

The experiments carried out in planting strips have shown that on coastal clay soils little extension of weed control over that obtained by hand-weeding was given by Simazine applied at either 5 or 10 lb per acre and that extensions obtained on inland clays, loams and sands were rather better, with a maximum extension of 9.6 weeks obtained by an application of 7.5 lb per acre. These extensions are not so marked as those obtained on coarse sandy soil in previous work (RIEPMA, 1962) some results of which are given in *Table 5* (Experiments 24/61, 50/61 and 57/61), and from these and other results it appears that the lower the clay and silt fractions in the soil the better will be the control obtained.

The relationship between soil characteristics and the persistence of Simazine determined from the limited range of experiments described above should be regarded as tentative only. Both rates of application of Simazine showed the same dependence on soil characteristics, and since *Paspalum conjugatum* was the main weed in nearly all experiments, a uniform weed susceptibility was involved. However, for a comprehensive test a large number of soil types and rates of herbicide application would have to be used. In comprehensive tests of this type previously carried out, the activity of Simazine has been found to depend upon the organic matter content rather than on the clay and silt fraction and the soil pH value (UPCHURCH AND MASON, 1962). Naturally the interactions of Simazine with soil will be complex and a further factor to be considered will be the effect of soil type upon weed regeneration: the coastal clay soils involved in these experiments are more fertile and have a higher nitrogen status than soils of the inland clays and loams, and this is likely to have stimulated weed regeneration by comparison with the poorer soil types (RIEPMA, 1962).

Whatever the nature of the interactions between soil and Simazine, it appears that on coastal clay soils Simazine offers little advantage over hand-weeding. Simazine can be expected to provide greater persistence of control on the sandier types of soil, but on only one soil type, a coarse sandy loam of the Sungei Buloh series, did Simazine applications give an advantage of more than 10 weeks over hand-weeding.

ACKNOWLEDGEMENTS

I wish to acknowledge my appreciation of the careful spraying of the experiments by Mr A. V. S. Nathan, Mr P. Balakishnan and Mr M. K. Raveendran. Especially I thank the Managers of Bukit Cheraka, Connemara, Pilmoor, Selangor River, Sengkang Estates and of the R.R.I.M. Experiment Station for their invaluable co-operation in conducting these experiments.

Soils Division

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RIEPMA KZN, P. (1962) A comparison between the effectiveness of some pre-emergence herbicides applied in planting strips of *Hevea brasiliensis* on a sandy soil. *J. Rubb. Res. Inst. Malaya* **17**, 167.

UPCHURCH, R. P. AND MASON, D. D. (1962) The influence of soil organic matter on the phytotoxicity of herbicides. *Weeds* **10**, 9.

TABLE 1. DETAILS OF EXPERIMENTS IN INTER-ROW AREAS SOWN WITH LEGUMINOUS CREEPING COVER PLANTS

Experiment No. †	Simazine treatments, lb per acre	Replication	Design	Estate	Spraying date
1 (11/61)	4,8	5	Randomised blocks	Selangor River	19.10.61
2 (49/61)	8,12	4	Youden square	Selangor River	20.10.61
3 (56/61)	5,10	5	Youden square	Connemara	10.10.61
4 (62/61)	5,10	5	Youden square	R.R.I.M. Experiment Station	1.11.61
5 (63/61)	5	4	Youden square	R.R.I.M. Experiment Station	2.11.61
6 (65/61)	5	4	Latin square	R.R.I.M. Experiment Station	31.10.61

† R.R.I.M. experiment number given in parenthesis.

TABLE 2. DETAILS OF EXPERIMENTS IN PLANTING STRIPS

Experiment No. †	Simazine treatments, lb per acre	Replication	Design	Estate	Spraying dates
7 (51/61)	5,10	4	Youden square	Pilmoor	15.9.61
8 (52/61)	5,10	4	Youden square	Pilmoor	15.9.61
9 (53/61)	5,10	5	Youden square	Bukit Cheraka	26.9.61
10 (71/61)	5,10	4	Youden square	R.R.I.M. Experiment Station	15.12.61
11 (78/61)	7.5	3	Randomised blocks	Sengkang	6.11.61
12 (79/61)	7.5	3	Randomised blocks	Connemara	9.11.61
13 (6/62)	5,10	4	Youden square	Selangor River	1.2.62
14 (7/62)	5,10	4	Youden square	Selangor River	1.2.62
15 (9/62)	5,10	4	Youden square	Pilmoor	27.2.62

† R.R.I.M. experiment numbers given in parenthesis

TABLE 3. WEED CONTROL IN LEGUMES. PERIOD IN WEEKS BETWEEN APPLICATION AND REGENERATION OF WEEDS TO COVER 5% OF GROUND SURFACE

Soil texture	Coastal clay		Sand		Lateritic clay	
Experiment No.	1	2	4	5	6	3
Treatment	Pre-emergence†	Post-emergence†	Post-emergence†	Post-emergence†	Post-emergence†	Post-emergence†
Control	8.4	5.2	5.5	4.0	8.3	8.7
Simazine 4 lb per acre	8.0	—	—	—	—	—
Simazine 5 lb per acre	—	—	10.2	9.5	12.4	13.6
Simazine 8 lb per acre	9.7	7.9	—	—	—	—
Simazine 10 lb per acre	—	—	11.9	—	—	15.2
Simazine 12 lb per acre	—	7.5	—	—	—	—

† in relation to legume cover plants.

TABLE 4. WEED CONTROL IN PLANTING STRIPS. PERIOD IN WEEKS BETWEEN APPLICATION AND REGENERATION OF WEEDS TO COVER 5% OF GROUND SURFACE

Soil texture	Coarse sand	Loam	Coastal clay	Sand	Loam	Lateritic clay	Coastal clay	Coastal clay	Loam
Experiment No. / Treatment	7	8	9	10	11	12	13	14	15
Control	12.5	6. 4	14.4	3.8	7.0	3.1	5.8	6.8	3.9
Simazine 5 lb per acre	16.5	14.2	17.3	10.8	—	—	8.5	7.2	6.5
Simazine 7.5 lb per acre	—	—	—	—	12.9	12.7	—	—	—
Simazine 10 lb per acre	19.4	11.5	17.6	12.8	—	—	7.8	9.3	6.8

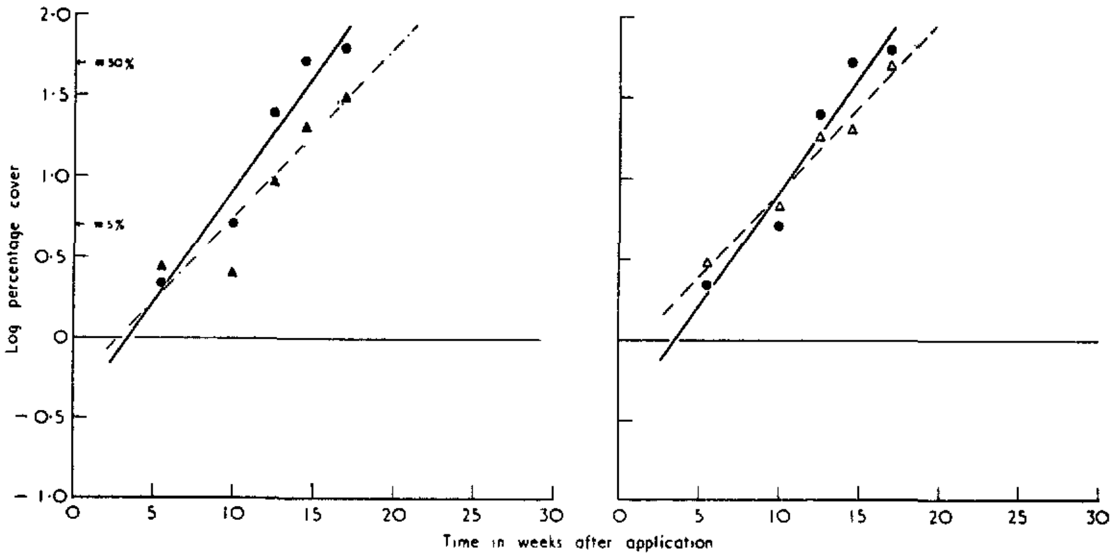
TABLE 5. THE EFFECT OF SOIL CHARACTERISTICS ON THE EFFECTIVENESS OF SIMAZINE IN RELATION TO THAT OF THE CONTROL TREATMENT (HAND WEEDING)

Experiment No.	Advantage in weeks of 5 lb Simazine over Control	Advantage in weeks of 10 lb Simazine over Control	Properties of Soils					
			Texture	Percentage clay	Percentage clay + silt	Percentage fine + coarse sand	Percentage organic carbon	pH
7	4.0	6.9	Coarse sand	8.01	11.25	85.94	1.02	5.40
8	7.8	5.1	Loam	31.33	35.60	58.56	0.94	4.84
9	2.9	3.2	Coast. clay	31.64	72.32	18.18	4.64	3.78
10	7.0	9.0	Sand	12.11	15.26	82.73	0.65	4.50
13	2.7	2.0	Coast. clay	36.37	66.34	31.61	1.61	4.22
14	0.4	2.5	Coast. clay	36.37	66.34	31.61	1.61	4.22
15	2.6	2.9	Loam	31.33	35.60	58.56	0.94	4.84
24/61†	11.5	15.7		10.27	14.93	76.96	2.04	5.90
50/61†	8.7	10.8		10.27	14.93	76.96	2.04	5.90
57/61†	9.3	12.1		10.27	14.93	76.96	2.04	5.90

Correlation coefficients of soil characteristics with effectiveness of Simazine

	5 lb per acre	*10 lb per acre*
Clay content	— 0.714*	— 0.861**
Clay + silt	— 0.738*	— 0.793**
Organic carbon	— 0.073	— 0.038
pH	+ 0.77**	+ 0.822***

† Data previously published (RIEPMA, 1962) * significant at 5% level ** significant at 1% level *** significant at 0.1% level

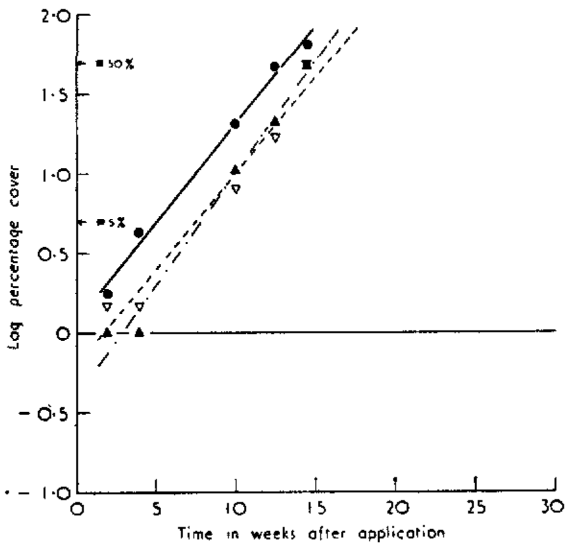


● ——— ● Control — $Y = (0{\cdot}1406 \pm 0{\cdot}0211)t - 0{\cdot}477 \pm 0{\cdot}265$

△ — — — △ Simazine 4 lb/ac between rows — $Y = (0{\cdot}1050 \pm 0{\cdot}0100)t - 0{\cdot}138 \pm 0{\cdot}126$

▲ — · — · — ▲ Simazine 8 lb/ac between rows — $Y = (0{\cdot}1019 \pm 0{\cdot}0247)t - 0{\cdot}289 \pm 0{\cdot}310$

Figure 1. Data for Experiment 1.

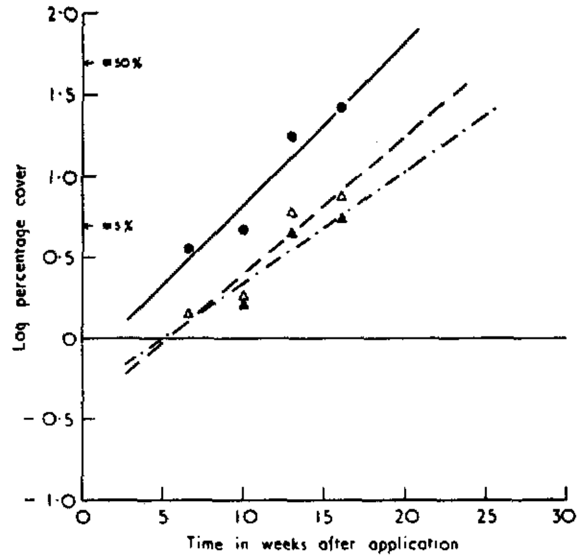


● ——— ● Control — $Y = (0{\cdot}1248 \pm 0{\cdot}0590)t + 0{\cdot}059 \pm 0{\cdot}0646$

▲ — — — ▲ Simazine 8 lb/ac between rows — $Y = (0{\cdot}1417 \pm 0{\cdot}0111)t - 0{\cdot}413 \pm 0{\cdot}109$

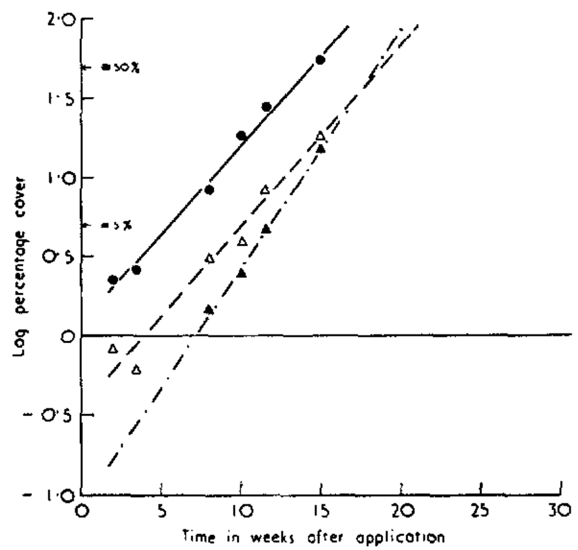
▽ - - - - - - ▽ Simazine 12 lb/ac between rows — $Y = (0{\cdot}1203 \pm 0{\cdot}0132)t - 0{\cdot}198 \pm 0{\cdot}132$

Figure 2. Data for Experiment 2.



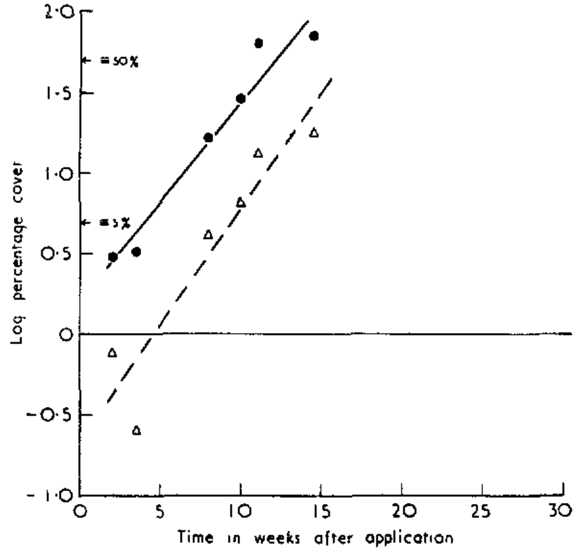
●———●	Control	$Y = (0{\cdot}1002 \pm 0{\cdot}0217)t - 0{\cdot}168 \pm 0{\cdot}259$
△— — —△	Simazine 5 lb/ac	$Y = (0{\cdot}0849 \pm 0{\cdot}0200)t - 0{\cdot}454 \pm 0{\cdot}239$
▲—·—·—▲	Simazine 10 lb/ac	$Y = (0{\cdot}0692 \pm 0{\cdot}0174)t - 0{\cdot}356 \pm 0{\cdot}207$

Figure 3. Data for Experiment 3.



●———●	Control	$Y = (0{\cdot}1140 \pm 0{\cdot}0170)t + 0{\cdot}069 \pm 0{\cdot}0509$
△— — —△	Simazine 5 lb/ac between rows	$Y = (0{\cdot}1141 \pm 0{\cdot}0110)t - 0{\cdot}466 \pm 0{\cdot}105$
▲—·—·—▲	Simazine 10 lb/ac between rows	$Y = (0{\cdot}1502 \pm 0{\cdot}0028)t - 1{\cdot}080 \pm 0{\cdot}0305$

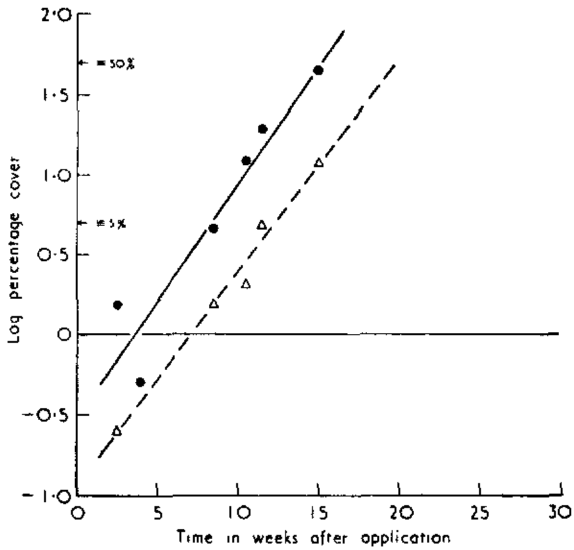
Figure 4. Data for Experiment 4.



●———● Control $Y = (0{\cdot}1251 \pm 0{\cdot}0148)t + 0{\cdot}197 \pm 0{\cdot}136$

△– – –△ Simazine 5 lb/ac between rows $Y = (0{\cdot}1439 \pm 0{\cdot}0276)t - 0{\cdot}668 \pm 0{\cdot}256$

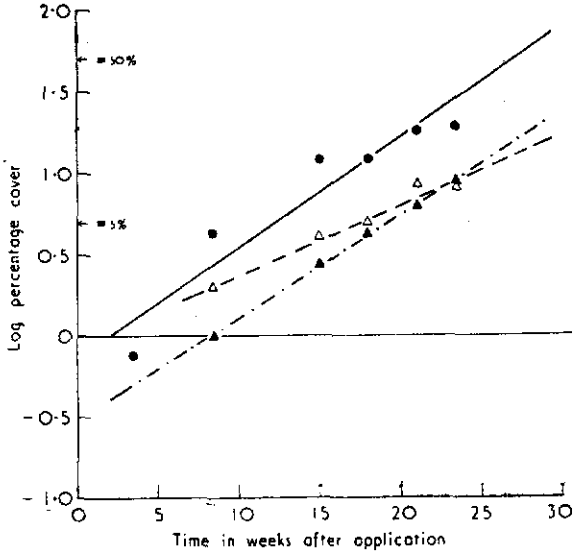
Figure 5. Data for Experiment 5.



●———● Control $Y = (0{\cdot}1458 \pm 0{\cdot}0245)t - 0{\cdot}509 \pm 0{\cdot}237$

△– – –△ Simazine 5 lb/ac between rows $Y = (0{\cdot}1342 \pm 0{\cdot}0107)t - 0{\cdot}964 \pm 0{\cdot}112$

Figure 6. Data for Experiment 6.

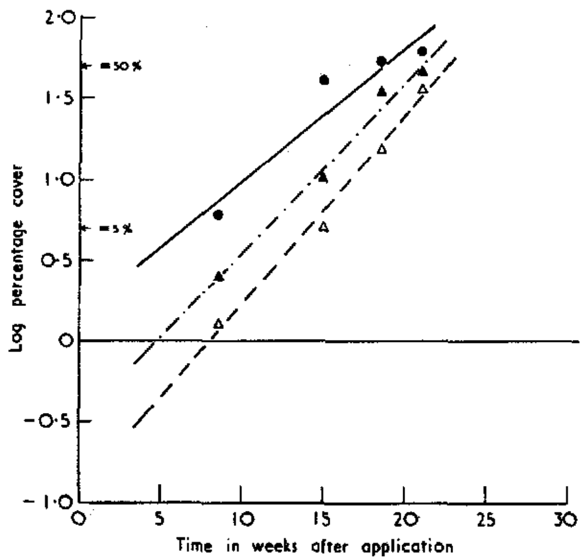


●———● Control $Y = (0{\cdot}0666 \pm 0{\cdot}0116)t - 0{\cdot}130 \pm 0{\cdot}190$

△— — —△ Simazine 5 lb/ac $Y = (0{\cdot}0436 \pm 0{\cdot}0044)t - 0{\cdot}060 \pm 0{\cdot}078$

▲—·—·—▲ Simazine 10 lb/ac $Y = (0{\cdot}0628 \pm 0{\cdot}0012)t - 0{\cdot}519 \pm 0{\cdot}022$

Figure 7. Data for Experiment 7.

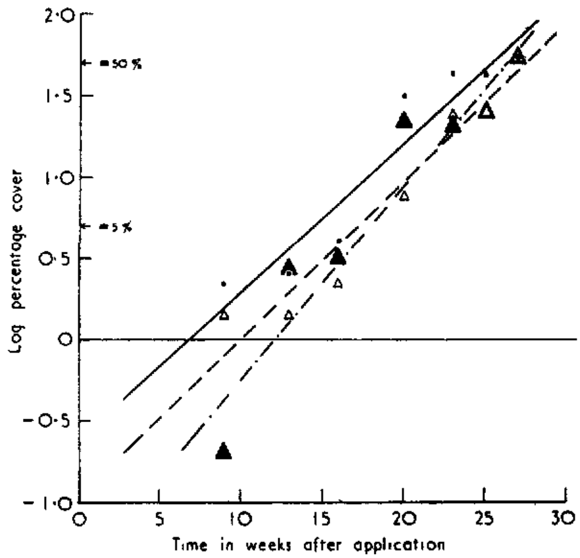


●———● Control $Y = (0{\cdot}0824 \pm 0{\cdot}0181)t + 0{\cdot}174 \pm 0{\cdot}297$

△— — —△ Simazine 5 lb/ac $Y = (0{\cdot}1148 \pm 0{\cdot}0092)t - 0{\cdot}928 \pm 0{\cdot}148$

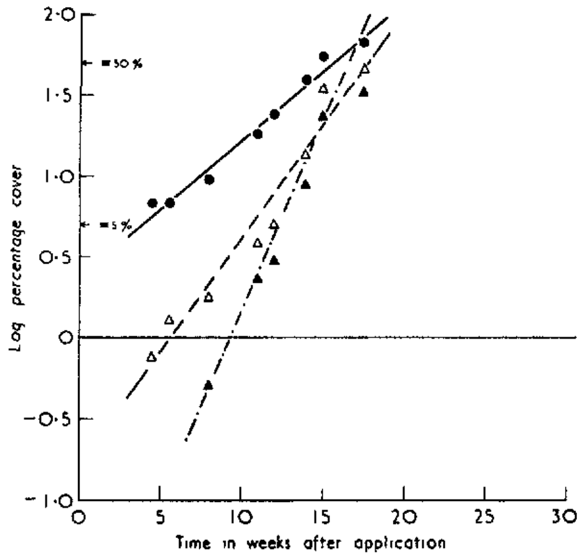
▲—·—·—▲ Simazine 10 lb/ac $Y = (0{\cdot}1048 \pm 0{\cdot}0089)t - 0{\cdot}503 \pm 0{\cdot}146$

Figure 8. Data for Experiment 8.



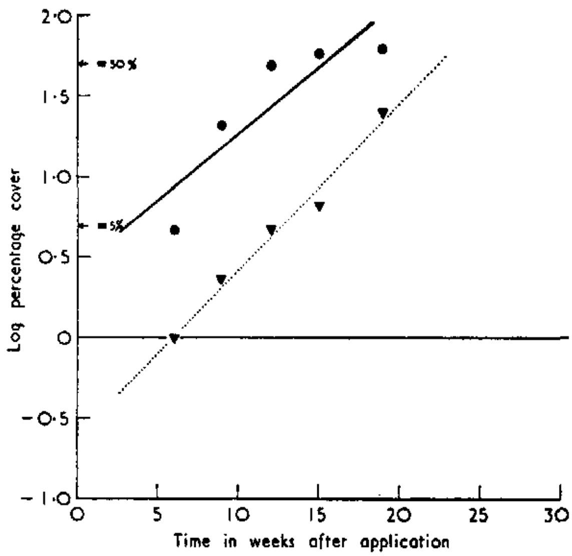
• ——— •	Control	$Y = (0{\cdot}0911 \pm 0{\cdot}0130)t - 0{\cdot}611 \pm 0{\cdot}259$
△ – – – △	Simazine 5 lb/ac	$Y = (0{\cdot}0969 \pm 0{\cdot}0109)t - 0{\cdot}979 \pm 0{\cdot}217$
▲ – · – ▲	Simazine 10 lb/ac	$Y = (0{\cdot}1213 \pm 0{\cdot}0175)t - 1{\cdot}437 \pm 0{\cdot}348$

Figure 9. Data for Experiment 9.



● ——— ●	Control	$Y = (0{\cdot}0852 \pm 0{\cdot}0151)t + 0{\cdot}374 \pm 0{\cdot}178$
△ – – – △	Simazine 5 lb/ac	$Y = (0{\cdot}1391 \pm 0{\cdot}0127)t - 0{\cdot}796 \pm 0{\cdot}150$
▲ – · – ▲	Simazine 10 lb/ac	$Y = (0{\cdot}2028 \pm 0{\cdot}0174)t - 1{\cdot}895 \pm 0{\cdot}232$

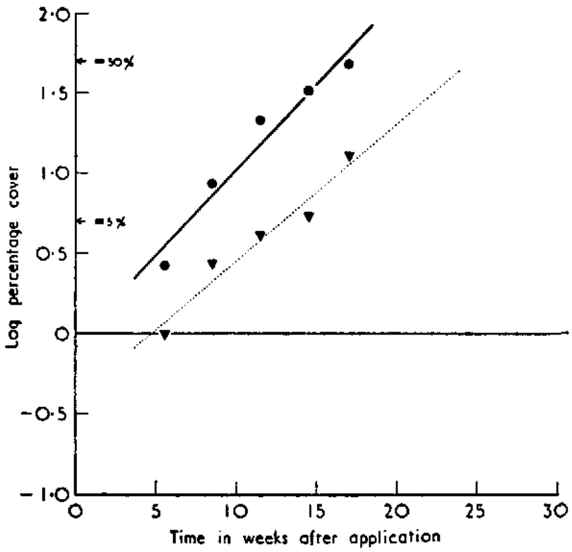
Figure 10. Data for Experiment 10.



● —— ● Control $Y = (0{\cdot}0820 \pm 0{\cdot}0261)t + 0{\cdot}444 \pm 0{\cdot}340$

▼ ······ ▼ Simazine 7·5 lb/ac $Y = (0{\cdot}1025 \pm 0{\cdot}0082)t - 0{\cdot}599 \pm 0{\cdot}107$

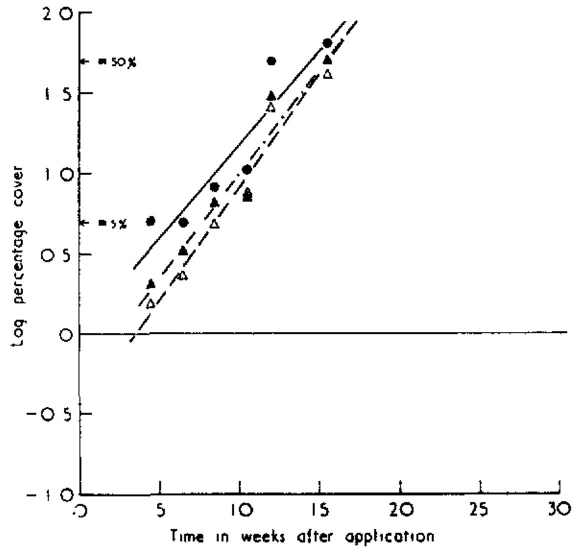
Figure 11. Data for Experiment 11.



● —— ● Control $Y = (0{\cdot}1071 \pm 0{\cdot}0127)t - 0{\cdot}046 \pm 0{\cdot}160$

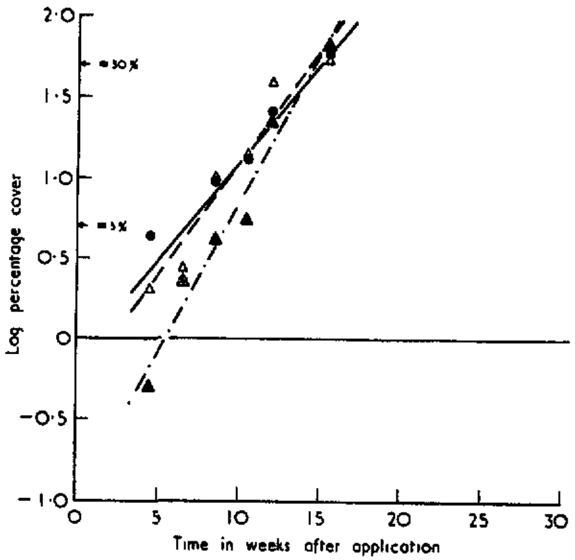
▼ ······ ▼ Simazine 7·5 lb/ac $Y = (0{\cdot}0362 \pm 0{\cdot}0105)t - 0{\cdot}412 \pm 0{\cdot}132$

Figure 12. Data for Experiment 12.



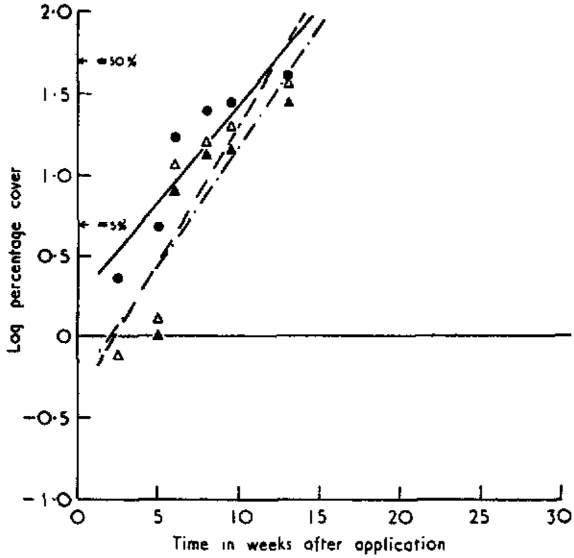
●———●	Control	$Y = (0{\cdot}1148 \pm 0{\cdot}0235)t + 0{\cdot}033 \pm 0{\cdot}248$
△– – –△	Simazine 5 lb/ac	$Y = (0{\cdot}1403 \pm 0{\cdot}0148)t - 0{\cdot}496 \pm 0{\cdot}156$
▲— ·—▲	Simazine 10 lb/ac	$Y = (0{\cdot}1321 \pm 0{\cdot}0177)t - 0{\cdot}326 \pm 0{\cdot}187$

Figure 13. Data for Experiment 13.



●———●	Control	$Y = (0{\cdot}1229 \pm 0{\cdot}0222)t - 0{\cdot}133 \pm 0{\cdot}234$
△– – –△	Simazine 5 lb/ac	$Y = (0{\cdot}1420 \pm 0{\cdot}0179)t - 0{\cdot}327 \pm 0{\cdot}190$
▲— · — ·—▲	Simazine 10 lb/ac	$Y = (0{\cdot}1854 \pm 0{\cdot}0178)t - 1{\cdot}015 \pm 0{\cdot}188$

Figure 14. Data for Experiment 14.



Control $Y = (0\cdot1208 \pm 0\cdot0283)t + 0\cdot229 \pm 0\cdot238$

Simazine 5 lb/ac $Y = (0\cdot1680 \pm 0\cdot0412)t - 0\cdot387 \pm 0\cdot346$

Simazine 10 lb/ac $Y = (0\cdot1459 \pm 0\cdot0480)t - 0\cdot292 \pm 0\cdot435$

Figure 15. Data for Experiment 15.