

## EFFECTS OF DALAPON AND GLYPHOSATE ON *IMPERATA CYLINDRICA* (L.) BEAUV. AT DIFFERENT GROWTH STAGES

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### RINGKASAN

Dalapon dan glyphosate kurang berkesan untuk mengawal *Imperata cylindrica* pada peringkat empat helai pucuk (S3) berbanding dengan peringkat pucuk tunggal (S1 atau S2). Pada peringkat empat helai pucuk, berat kering rizom tidak reput yang disampel 30 hari selepas penyemburan glyphosate (1 kg b.a./ha) didapati lebih rendah daripada berat kering rizom tidak reput yang diracuni dengan dalapon (8 kg b.a./ha).

### INTRODUCTION

*Imperata cylindrica* (L.) or lalang, a weed to 35 crops, is among the ten most important weeds in the world (HOLM, PLUCKNETT, PANCHO and HERBERGER, 1977). It is considered to be the worst perennial weed in Southeast Asia (EUSSEN and WIJARHARDIA, 1973). It is difficult to control mainly because of its extensive rhizome system which has numerous buds. Systemic herbicides like dalapon and glyphosate must be translocated from the point of application to the rhizome buds in order to suppress subsequent regrowth of shoots (LEE, 1983).

Little information is available in the literature on the relative susceptibility of this weed at various stages of growth to dalapon (2, 2 – dichloropropionic acid) and glyphosate (N – phosphonomethyl glycine). In Africa, IVENS (1973) observed that young shoots in the field were susceptible to both herbicides, and dalapon was more effective when applied to young shoots of 0.6 m height than those of 1.0–1.2 metres. His studies suggested that the weed is more difficult to control when it has become more established. In Malaysia, shoots at various stages of growth occur under field conditions, and it is of interest to find out their relative susceptibility to herbicides.

The main objective of this investigation was to evaluate the effects of dalapon and glyphosate applied on the weed at three growth stages. Observations were also carried out on the phytotoxicity of the herbicides to the shoots and rhizomes.

### MATERIALS AND METHODS

The experiment which was carried out in a glasshouse at MARDI, Jalan Kebun, Kelang, in 1981 consisted of nine treatment combinations, each replicated four times. The nine combinations comprised three stages of growth and three treatments. Table 1 shows the characteristics of the shoots at the three stages of growth used at the commencement of the experiment. Single shoots which sprouted from the tips of single rhizomes (40 cm in length) represented growth stages S1 and S2, the distinction between them was in terms of the

Table 1. Characteristics of the 3 growth stages of *Imperata cylindrica* at the commencement of the chemical treatment

Stage of growth	No. of shoots		Primary Shoots	
	Primary	Secondary and tertiary	No. of leaves	Height (cm)
S1	1	0	1	15–24
S2	1	0	4	32–48
S3	1	3	6–7	68–85

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number of leaves and plant height. Growth stage S1 had one leaf but S2 had four leaves. Growth stage S3 was characterized by a primary rhizome which culminated in a six or seven-leaf shoot and three secondary shoots; the latter were linked to the primary rhizome by interconnecting rhizomes.

The three treatments imposed were control, treated with tap water (T1), dalapon at 8 kg a.i./ha (T2) and glyphosate at 1 kg a.i./ha (T3).

### **Arrangement and Sampling of Plants**

Three batches of plants were established at three intervals and 12 plants at each stage of growth were finally selected for the experiment. The 36 plants in pots were arranged in four rows (replicates) and the nine treatment combinations were allocated randomly to the nine plants within each row. All 36 plants were sampled 30 days after treatment.

### **Application of Herbicides**

Dalapon (72.5% of 2,2, dichloropropionic acid sodium salt and 12.0% of 2,2, dichloropropionic acid magnesium salt) and glyphosate [360 g a.e. of the isopropylamine salt of N – (phosphonomethyl glycine)] were applied on 3 February 1981 using an 18-litre conventional knapsack sprayer (giving an output pressure of 0.9 kg/cm<sup>2</sup>). Tap water was used in the herbicide solution; the volume of spray was 880 litres/hectare. During application, the temperatures were between 30.5°C and 31.5°C while relative humidity ranged from 60% to 63 per cent.

### **Assessment of Treatment Effects**

Thirty days after foliar application, the phytotoxic symptoms of injury caused by both herbicides on the leaves and rhizomes were assessed. After this assessment, the green parts of the shoots and new green shoots that emerged were excised and oven-dried at 105°C for 24 hours. Similarly, the

undecayed regions of the rhizomes (which were characterized by their firmness and pale yellow/white colour) were also oven-dried, weighed and recorded.

### **Statistical Analysis**

Using the analysis of variance, the dry weights of undecayed shoots and rhizomes, and the total dry weights (undecayed shoots and rhizomes) were analysed.

## **RESULTS**

### **Effects of Herbicides on Shoots**

Application of dalapon at 8 kg a.i./ha resulted in a complete kill of one-leaf shoot (S1) and a partial kill of four-leaf shoot (S2). When dalapon was applied to shoots at the six to seven-leaf stage (S3), it killed the old leaves, and the tips and mid-regions of the younger leaves. In contrast, old leaves of the untreated control were green.

Glyphosate at 1 kg a.i./ha provided a 75% kill of shoots at the four-leaf and six to seven-leaf stages.

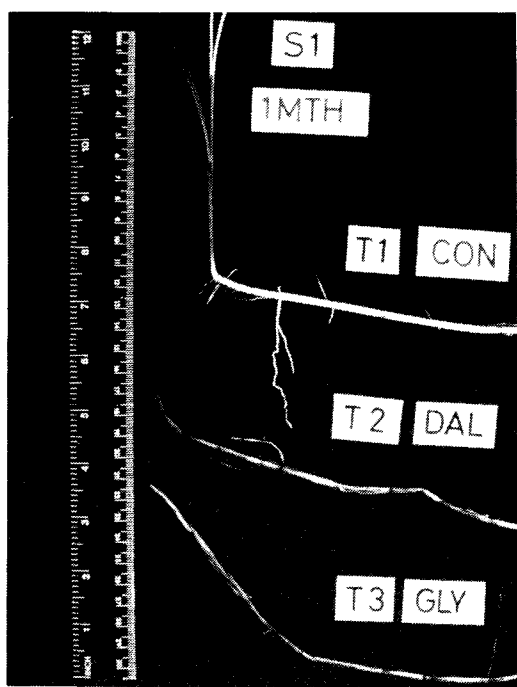
### **Effects on the Decay of Apices of Shoots and Rhizomes**

#### **Application to single shoots at 1-leaf stage**

One month after the commencement of the experiment, control plants which developed from single primary rhizomes, had three to five green leaves and one to three secondary rhizomes. In contrast, however, application of dalapon had resulted in the complete decay of three out of four primary rhizomes and glyphosate caused the complete decay of all the primary rhizomes (*Plate 1*).

#### **Application to single shoots at 4-leaf stage**

After one month, three to five secondary rhizomes had developed from each primary rhizome of untreated plants, and some of the secondary rhizomes were as



*Plate 1. Effect of dalapon and glyphosate on the decay of primary rhizomes 1 month after treating 1-leaf shoot .*

- T1 : Control plant had a 3-leaf shoot and a firm and whitish primary rhizome.
- T2 : Dalapon at 8 kg a.i./hectare. Primary shoot had decayed and was removed. Primary rhizome was soft and brown to black.
- T3 : Glyphosate at 1 kg a.i./hectare. Primary shoot had decayed and was removed. Primary rhizome was soft and brown to black.

long as 28.1 centimetres. Plants treated with dalapon showed a few decayed secondary buds and rhizomes but the remaining buds and rhizomes (up to 6.2 cm in length) appeared unaffected, *i.e.* firm and white. Only the distal regions of these primary rhizomes showed decay.

Two of the plants treated with glyphosate, however, showed complete decay of two of their primary rhizomes while the primary rhizomes of the other two plants were unaffected. The buds at the nodes, close to the shoot apices, of the unaffected primary rhizomes appeared healthy.

#### **Application at 4-shoot stage; the primary shoot with 6 – 7 leaves**

*Plates 2–4* show the effects of external decay by dalapon and glyphosate on shoot apices and rhizomes one month after treatment. Primary rhizomes of plants which were untreated or treated with dalapon were mainly unaffected by decay but those plants treated with glyphosate turned brown or black and were almost completely soft (*Plate 2*). The 4-cm region which included the base of the primary shoot and nodes proximal to them appeared black and disintegrated one month after the glyphosate application (*Plate 3*, near B).

All interconnecting secondary rhizomes of untreated plants did not show any decay. Those plants treated with dalapon showed some decay when assessed visually. In contrast, there was sign of advanced decay in the region near the shoot apices and partial decay on most parts of the secondary rhizomes after glyphosate application (*Plate 3*, D and C.).

Tertiary rhizomes of the control were completely firm and white (*Plate 4*, T1). There was little decay on tertiary rhizomes (2.4–4.1 cm) of plants treated with dalapon. Tertiary rhizomes of plants treated with glyphosate had decayed completely and longer (10.8–42.8 cm) rhizomes showed decay at the tips, with intermittent decay in the mid-regions, especially the nodes (*Plate 4*).

#### **Dry weight of undecayed shoots and rhizomes**

*Figure 1* shows the effects of dalapon and glyphosate on the dry weights of undecayed (green) shoots and rhizomes, and the total dry weight. The statistical analysis showed that the 'stage of growth x chemical treatments' interactions were significant at  $P = 0.01$  level. This means that the efficacy of herbicides in reducing the shoot dry weight, rhizome dry weight and the total dry weight was significantly dependent on the growth stage at the time of spraying.

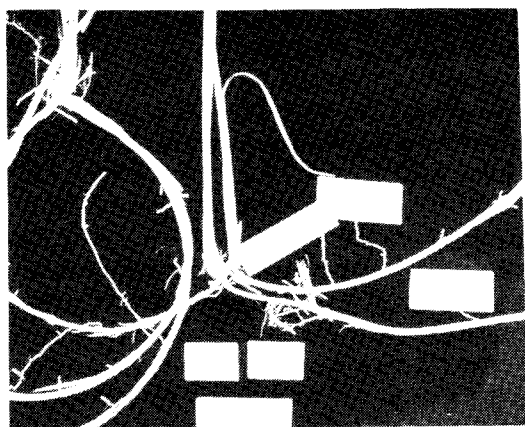


Plate 2. Shoot-rhizome system sampled 1 month after the foliar application of dalapon at 8 kg a.i./ha at the 4-shoot stage (intermittent decay of rhizomes was observed).

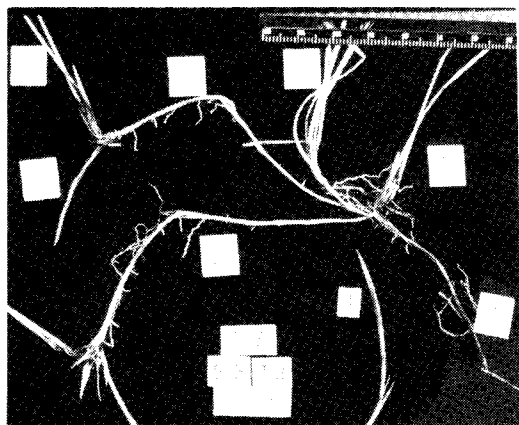


Plate 3. Shoot-rhizome system sampled 1 month after the foliar application of glyphosate at 1 kg a.i./ha at the 4-shoot stage.

- A – Primary rhizome (completely decayed).
- B – Primary shoot (completely necrotic; apices black and macerated)
- C,E,H – Secondary shoots (completely necrotic; apices black and macerated).
- D,G – Secondary rhizomes (intermittent decay).
- J – Tertiary rhizome (apical and mid-regions decayed).

Application of dalapon or glyphosate at the four-shoot stage resulted in a significant reduction in the dry weight of unaffected rhizomes when compared with the

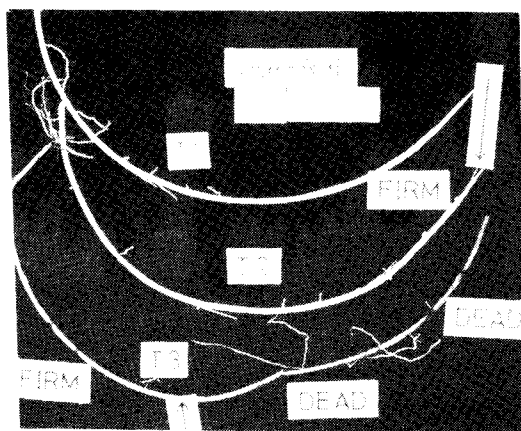


Plate 4. Tertiary rhizomes were detached from the intact rhizome system of the 4-shoot stage (S3) 1 month after treatment [Note the decay at the apical and mid-sections of rhizomes after glyphosate treatment (T3). The distal region was firm and white].

T1 : Control

T2 : Dalapon

untreated control. Dry weights of undecayed rhizomes sampled after glyphosate treatment were significantly lower than dry weights of those plants treated with dalapon at the four-shoot stage.

## DISCUSSION

The main finding of the experiment was that the efficacy of control by dalapon or glyphosate, in terms of the amounts of undecayed shoots and rhizomes recovered, was dependent on the growth stage of *I. cylindrica* at the time of treatment.

One of the reasons is that larger plants at the four-shoot stage (S3) may have a 'dilution effect' on dalapon. This explanation had been suggested by HULL (1969) for dalapon. Dalapon applied to plants of *Sorghum halepense* during advanced stages of growth showed less mobility and this was attributed to greater dilution within a larger rhizome system (HULL, 1969). Larger plants may also 'dilute' glyphosate for a similar reason.

Secondly, larger plants usually have more nodes and larger rhizomes. In this

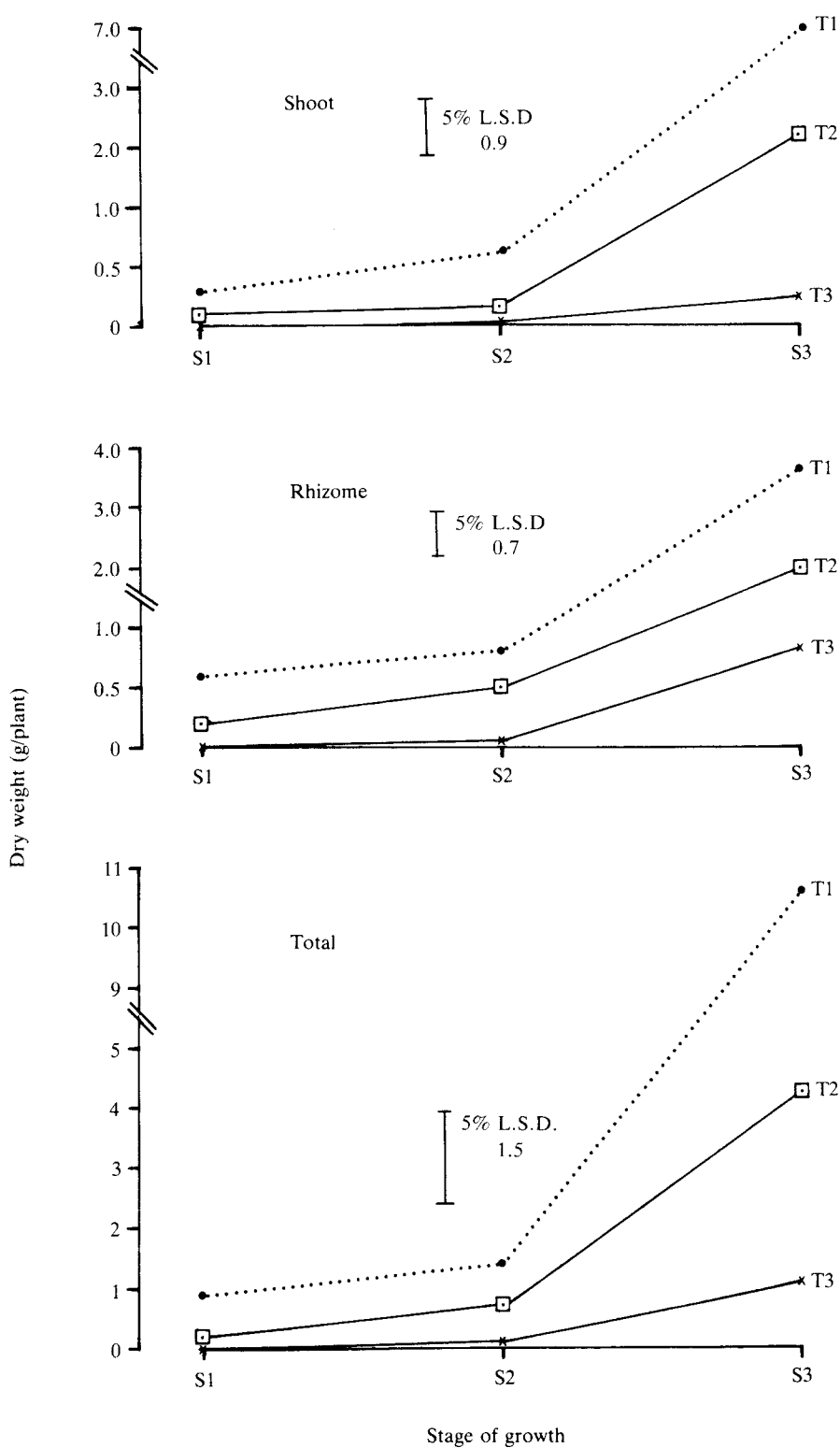


Figure 1. Effects of dalapon and glyphosate applied at 3 stages of growth on the dry weights of *Imperata cylindrica*.

experiment, the rhizome system at the four-shoot stage (S3) was more extensive than at the single shoot stages (S1 and S2). In *Agropyron repens*, CLAUS and BEHRENS (1976) found that bud mortality was lesser on rhizomes with greater number of nodes. It is possible since larger plants have a more extensive rhizome system, more dalapon or glyphosate is required for the kill of more buds (COUPLAND and CASELEY, 1981).

Finally, larger plants might detoxify glyphosate better and this was suggested by FERNANDEZ and BAYER (1977) for larger plants of *Cynodon dactylon*. In the case of dalapon, it was reported to be absorbed, translocated and accumulated as the original molecule and might remain essentially non-metabolized for longer periods (CRAFTS and FOY, 1959).

In this study, there was evidence to show the complete decay of three out of four primary rhizomes one month after the foliar application of dalapon to one-leaf shoots. This finding suggested that there was basipetal movement of the herbicide in a sufficient quantity to result in phytotoxicity to the rhizomes and shoot apices. In *C. dactylon*, apices of rhizomes were killed by foliar application of dalapon (MARODER, 1973).

Of special interest in this investigation is the basipetal movement of glyphosate or its metabolites or both into the rhizomes, and apices of rhizomes and shoots. The black colour and 'macerated' appearance at the apices of tertiary rhizomes and shoot apices were observed one month after application at the four-shoot stage (S3, Plate 4).

This finding appears to be consistent with reports on its accumulation in tips of rhizomes (CLAUS and BEHRENS, 1976) and shoot apices (SANDBERG, MEGGITT and PENNER, 1980) of other weeds.

The results of this experiment which pertained to the decay of rhizomes after the foliar applications of dalapon and glyphosate supported the findings in other field experiments which showed the decay of rhizomes of chemical treatments (LEE, 1983). The recovery of tipless axillary rhizomes after the application of glyphosate in the field is likely to be accounted by the decay of their tips as shown in this experiment.

The efficacy in the control of *I. cylindrica* by glyphosate is dependent on its growth stage at the time of spraying. In the field, several growth stages of *I. cylindrica* are present, and it is likely that the efficacy of control with dalapon or glyphosate will be reduced for the larger shoot-rhizome system compared with the smaller one. Nevertheless, repeated doses of herbicides can be proven useful for long-term control of larger shoot-rhizome systems in the field.

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#### ABSTRACT

Dalapon and glyphosate provided less effective control of *Imperata cylindrica* at the four-shoot stage (S3) than at the single shoot stage (S1 or S2). At the four-shoot stage, dry weights of undecayed rhizomes sampled 30 days after the foliar application of glyphosate at 1 kg a.i./ha were significantly lower than the dry weights of those plants treated with dalapon at 8 kg a.i./hectare.

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