GROWTH, BIOMASS ALLOCATION AND RESPONSE TO GLYPHOSATE OF *IMPERATA CYLINDRICA* GROWN UNDER DIFFERENT LIGHT CONDITIONS

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Summary. Lalang (*Imperata cylindrica*) was grown from seed in a greenhouse 0, 50 and 75% shade to determine the vegetative response, partitioning of biomass allocation and response to glyphosate treatment. Leaf area of *I. cylindrica* increased as shade level increased. Dry matter of shoots, roots and rhizomes declined as shade level increased. Shading significantly influenced the pattern of biomass allocation of *I. cylindrica* as was clearly shown by the different values of leaf to root weight ratio, leaf area, net assimilation rate and leaf area duration. Placement of plants originally from three shade levels to 0% shade or vice versa resulted in different patterns of biomass allocation and response to glyphosate treatment. The activity of glyphosate was significantly enhanced with increase in light intensity.

INTRODUCTION

Imperata cylindrica Raeuchel is an important perennial weed in Malaysia and many other countries in Southeast Asia. It is one of the ten worst weeds in the world and regularly infests many crops (5). It is aggressive and has an extensive rhizomatous system (11) and reproduces profically from both seeds and rhizomes (6). For many years control of this weed has been attempted using mechanical, cultural, chemical and combined methods, but little attention has been paid to the role of environment and its effects on plant growth rate, vigour and competitive ability. These studies were designed to determine growth, biomass allocation and response to glyphosate of *I. cylindrica* grown under different light conditions.

MATERIALS AND METHODS

Three shade levels (100% available sunlight, 50 and 75% shade) were used in this study. At 35 and 42 days after planting, four plants from each shade level were harvested. Leaf areas, height of the longest extended leaf and total plant dry weights (65°C oven-dried) were determined. At the 42-day harvest, the dry weights of leaves, stems and roots were also determined for growth analysis by a standard method (10).

The activity of glyphosate on *I. cylindrica* was determined by applying 1.0, 1.5 and 2.16 kg a.i/ha of glyphosate at 400 L/ha with knapsack sprayer. All experiments were arranged in a randomised complete block design with 5 replicates.

RESULTS AND DISCUSSION

Decreasing the light intensity tended to increase the plant height (Table 1). Plants at 0% shade produced significantly more leaves and tillers than those from 50 and 75% shade. Reduction of light intensity to a certain degree had resulted in increase stem elongation and leaf size of *Solidago virgaurea* (1), but further reduction of light significantly reduced the vegetative growth of the plants. This pattern of growth was also observed on *I. cylindrica* (9, 12).

Partitioning of plant biomass into leaves and rhizomes differed significantly among the plants from the three shade levels. At 75% shade, the plants partitioned more biomass into leaves and less into rhizomes than the other two light regimes (Table 2). However, the shoot to root weight ratios did not differ significantly between shade levels. Leaf area and leaf area ratio significantly increased with increase in shade. Both specific leaf area and leaf area ratio were greatest at 75% shade. Leaves produced under shade conditions were generally thinner then those produced in unshaded treatment (2). This concomitant increase in specific leaf area and leaf weight ratio indicated that the amount of leaf area per unit of plant weight was increased by shading. The dry matter production (DMP), net assimilation rate (NAR) and leaf area duration (LAD) at 50% shade were significantly higher than those from 0% and 75% shade (Table 3), and were lowest at 75% shade.

Table 1. The height, leaf and tiller number of *I. cylindrica* grown under different shade levels at tenth week of transplanting.

Shade level (%)	Height (cm)	No. of leaf	No. of tiller
0	64.8b	65.0a	29.3a
50	72.5a	37.5b	13.8b
75	71.8a	27.5c	9.5c

Within each column, values sharing the same letter are not significantly different at 5% level, according to Duncan's multiple range test.

Table 2. Effect of shading on vegetative growth, leaf area production and biomass allocation in *I. cylindrica*

Shade level (%)	LWR	SWR	RhWR	SLA	LAR
	(g/g)			(cm^2/g)	
0	0.398b	0.258a	0.117a	178.1b	70.9c
50	0.377b	0.265a	0.228a	288.4a	108.7b
75	0.514a	0.289a	0.129a	298.6a	153.4a

Within each column, values sharing the same letter are not significantly different at 5% level, accordin to Duncan's multiple range test.

Table 3. Effect of shading on dry-matter production (DMP), net assimilation rate (NAR) and leaf area duration (LAD) of *I. cylindrica* during the 35th to 42nd-day interval after transplanting

Shade level (%)	Height (cm)	No. of leaf	No. of tiller
0	3.8b	0.00111a	9619.9b
50	19.0a	0.00293a	12970.2a
75	2.9b	0.00051b	2448.6c

Within each column, values sharing the same letter are not significantly different at 5% level, according to Duncan's multiple range test.

Control of *I. cylindrica* by glyphosate was significantly improved with increasing light intensity (Fig. 1). Plants under 0% shade were completely killed at 1.5 and 2.16 kg a.i/ha 21 days after treatment, compared with only about 50% at 2.16 kg a.i/ha under 50 and 75% shade, 21 and 28 days after treatment respectively. Different growth patterns and physiological characteristics of plants can influence herbicide performance by affecting spray interception, retention, uptake and translocation of herbicide (7). Placement of the treated plants at 75% shade severely decreased the phytotoxicity of glyphosate on *I. cylindrica* (Fig. 1). At 0% shade, 100% control was recorded with 1.5 kg a.i/ha, but it required 2.16 kg a.i/ha at 50% shade, 35 days after treatment. The rate of the control reduced to only 53% with 2.16 kg a.i/ha at 75% shade during the same interval. Light intensity enhanced the onset of activity of imazapyr against *I. cylindrica* (8). Increased activity under high light intensity was mainly due to the increase of herbicide percentage distribution in plants.

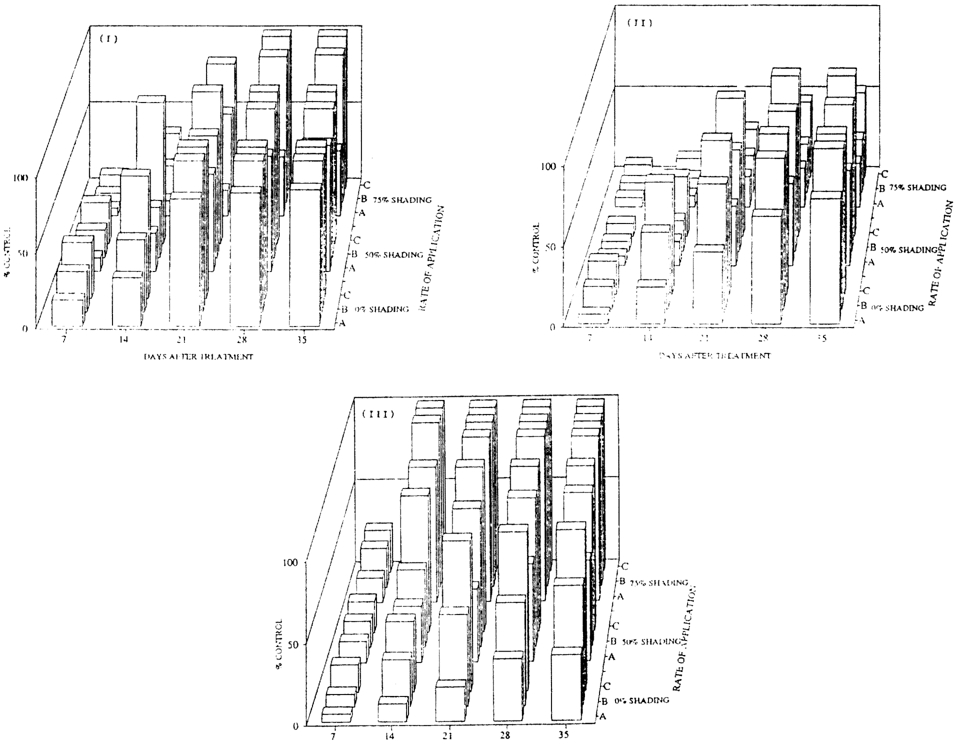

Figure 1. Effect of shading on control of *I. cylindrica* by glyphosate (I). Remained at three shade levels (II). Transferred from 0% shade to 3 shade levels (III). Transferred from three shade levels to 0% shade A = 1.0 kg a.i./ha; B = 1.5 kg a.i./ha; C = 2.16 kg a.i./ha.

Treated plants initially at 75% shade were completely killed even at the application rate of 1.0 kg a.i/ha, 21 days after treatment (Fig. 1). Complete control required 2.16 kg a.i/ha for plants initially grown under 50% shade. Plants grown at higher light intensities were slower to develop phytotoxic symptoms and damages was still minimal 35 days after treatment. Plants exposed to high light intensity experienced an increase in photosynthetic products which may have caused an increase in the translocation of herbicide immediately after spraying.

REFERENCES

1. Bjorkman, O. 1968. Physiol. Plant 21, 84-89.
2. Blackman, G.E. and Black, J.N. 1959. Ann. Bot. 23, 51-63.
3. Craft, A.S. and Crisps, C.E. 1971. Phloem translocation in plant. W.H. Freeman and Co., San Francisco.
4. Hammerton, J.L. 1968. Proc. 9th Brit. Weed Control Conf. pp 1088-1110.
5. Holm, L.G., Plucknett, D.L., Pancho, J.V. and Herberger, J.P. 1977. The World's Worst Weed: Distribution and Biology, University Press of Hawaii. pp 609.
6. Hubbard, C.E. 1944. *Imperata cylindrica.* Taxonomy, Distribution, Economic Significance, and Control. Imp. A Agric. Bur., Joint Publ. No. 7. Imp. Bur. Pastures and Forages Crops, Aberystwyth, Wales, Great Britain.
7. Ipor, I.B. 1989. PhD thesis, University of London.
8. Lapade, B.E., Manimtim, M.B. Calora, F.B. and Lalap, E.T. 1983. Ninth Asian Pacific Weed Science Society Conference. pp 428-435.
9. Moosavi-nia, H. and Dore, J. 1979. Weed Res. 19, 321-327.
10. Patterson, D.T. and Flint, E.P. 1983. Weed Sci. 31, 318-323.
11. Santiago, P. 1980. Biotrop Special Publication 5, 23-24.
12. Soerjani, M. 1970. Biotrop Bull., No. 1.
13. Weaver, M.L. and Nylund, R.E. 1965. Weeds 13, 110-113.