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Observations on Growth of *Eupatorium odoratum* L. and *Imperata cylindrica* (L.) Beauv. var. *Major*. under Different Light and Moisture Regimes

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The growth of *Eupatorium odoratum* L. and *Imperata cylindrica* (L.) Beauv. var. *major*. was adversely affected under shade and reduced soil moisture. In *E. odoratum*, shade not only affected growth but also allocation pattern in a way favouring belowground parts. A shift in allocation from above to belowground organs under moisture stress was noted in *I. cylindrica*. These results have been related to their success as early successional weeds of jhum fallows.

Key Words: Slash and burn agriculture, Jhum, Secondary succession, Allocation, Weed biology

Introduction

Eupatorium odoratum L. and *Imperata cylindrica* (L.) Beauv. var. *major*. are two perennial weeds of contrasting life strategies, growing abundantly in cultivated fields, wastelands and other exposed areas. These weeds are also important components of secondary successional communities developing soon after 'slash and burn' agriculture (Jhum) in the north-eastern hill region of India (Ramakrishnan et al. 1981). Both the species produce seeds in large numbers and in addition, *I. cylindrica* has extensive underground rhizome system. Seed germination, in both the species starts in May-June with the onset of monsoon after a period of active growth (June–October). In *E. odoratum* flowering starts while in *I. cylindrica* it commences only after dry winter month, i.e. in April. Maximum fruiting takes place in the month of January (for *E. odoratum)* and in April-May (for *I. cylindrica)*.

A few studies are available on their life cycle attributes (Kushwaha et al. 1981, Yadav & Tripathi 1981) and on growth characteristics (Edwards 1974a, b, 1977, Soerjani 1970). The present study was undertaken to investigate the growth behaviour of these two species as affected

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by different light and soil moisture regimes so as to understand the mechanism of their population regulation in nature.

Materials and Methods

Seeds of both the species, collected from Burnihat in Meghalaya (26° 02'N latitude and 91° 52'E longitude), were used for pot culture experiments. Four-week-old seedlings raised separately were transplanted into pots (one seedling per pot) of 20.8 cm diameter filled with 2 : 1 mixture of soil and organic manure. Before transplantation, the soil and manure were mixed thoroughly to avoid any error due to soil heterogeneity.

Two sets of experiments, one related to two levels of light intensity (experiment 1) and another for the three watering regimes (experiment 2) were designed. Two sets of sixteen pots each were subjected to full sun light and about 30% of full sun light (for 11 hr) respectively. The light intensity was reduced artificially by covering the four walls and the roof of the chamber with muslin cloth. The experiments with three watering regimes had three sets of sixteen pots each. One set was watered daily, another on alternate days and the third one at weekly intervals with 150 ml of water at a time. Under these regimes, the soil had 40%, 25% and 15% moisture levels respectively as determined just prior to application of moisture during the experiment.

The total leaf area was determined as the leaf area/weight ratio of the mature leaves for the different treatments. Leaf area ratio, net assimilation rate and relative growth rate were determined following the procedure outlined by Watson (1947) and Hammerton (1965). At the conclusion of the experiments (at the end of 4 months) dry weight yields of the aboveground and belowground parts of plants were determined after drying the plants in an oven at 80°C for 48 hr. The statistical analysis of the data was done using student 't' test. The probability level for all the tests of significance was 0.05.

Results

Experiment 1

In *E. odoratum*, plant height grown in sun was not significantly different from the shade grown plants whereas the sun-grown plants of *I. cylindrica* attained significantly more height than the shade-grown plants. Dry weight yields of aboveground and belowground, parts relative growth rate and net assimilation rate of sun grown plants of both the species were significantly higher than those grown in the shade. The dry weight ratio of the aboveground/belowground parts was

Table 1 *Growth characteristics of* E. odoratum *and* I. cylindrica *in sun and shade at the final harvest*

Parameters	*E. odoratum*			*I. cylindrica*		
	Sun	Shade	CD at 5% level	Sun	Shade	CD at 5% level
Plant height (cm)	186	167	22	143	61	20
Aboveground dry weight(g)	78.9	13.8	10.2	23.4	4.3	9.8
Belowground dry weight (g)	25.0	5.5	4.8	21.8	2.6	6.2
Aboveground/Belowground dry weight ratio	3.1	2.5	0.32	1.0	1.6	0.36
Ralative growth rate (g/cm²/week)	0.008	0.005	0.001	0.003	0.002	0.001
Leaf area ratio (cm²/g)	59.9	59.2	12.2	111.7	111.6	16.2

significantly higher for the sun grown plants of *E. odoratum* as compared to shade grown plants and the reverse was true for *I. cylindrica*.

Experiment 2

Plant height and dry weight yield of aboveground parts of the species declined significantly under treatment of weekly watering as compared to the other two regimes. Dry weight yield of belowground parts showed significant increase in the case of *I. cylindrica* with water stress whereas it showed a significant decline in *E. odoratum* under weekly watering regime. No significant difference was observed for relative growth rate, net assimilation rate and leaf area ratio under different watering regimes. A significant reduction in aboveground/belowground ratio was noted for *I. cylindrica* under weekly watering regime (table 2).

Discussion

The results indicate that shade had an adverse impact on the growth and development of the two species causing drastic reduction in dry weight yields. Such reduction in overall growth in these two weeds has also been observed by other workers (Bennet & Rao 1968, Cruttwell 1968, Eussen & Wirjahardja 1973). The higher aboveground/belowground biomass ratio in the light grown plants of *E. odoratum* and the reverse condition under shade are indicative of shift in photosynthate allocation strategies as an adaptation to light availability. Thus, in the open habitat a greater proportion of photosynthate is allocated to the aboveground parts leading to high seed production, while in the shady habitat the species resorts to perennation and reproduction through underground root and root sprouts. In *I. cylindrica*, on the other hand, the allocation of the biomass to the underground parts was more than in the sun suggesting more efficient vegetative propagation potential in the open than in the shade. It may be noted that this species is chiefly dependent upon vegetative multiplication rather than seed reproduction which occurs only under the influence of heavy disturbance (Ramakrishnan, unpublished).

Table 2 *Growth characteristics of* E. odoratum *and* I. cylindrica *at final harvest under three water regimes*

Parameters	*E. odoratum*				*I. cylindrica*			
	DW	ADW	WW	CD at 5% level	DW	ADW	WW	CD at 5% level
Plant height (cm)	197	188	90	28	150	140	80	15
Aboveground dry weight (g)	81.9	82.6	51.0	9.2	31.2	35.2	24.4	5.7
Belowground dry weight (g)	22.0	24.8	13.0	7.0	14.0	15.7	16.0	1.4
Aboveground/Belowground dry weight ratio	3.7	3.3	3.9	0.6	2.2	2.2	1.5	0.3
Relative growth rate (g/g/week)	0.489	0.489	0.489	0.01	0.316	0.315	0.268	0.08
Net assimilation rate (g/cm^2/week)	0.008	0.008	0.008	0.01	0.003	0.003	0.002	0.01
Leaf area ratio (cm^2/g)	111.5	111.6	111.6	12.9	59.5	60.0	60.0	8.9

DW, daily; *ADW*, alternate day and *WW*, weekly watering regimes

Edwards (1974a) found a significant correlation between precipitation and growth of *E. odoratum*. A similar observation between aboveground dry weight yield and moisture availability has been noted for this species. High rainfall occurring during the growth season of these two species may help in their colonization and rapid spread northeastern India. The decrease in aboveground/belowground ratio of *I. cylindrica* with decrease in moisture availability in the soil may be an adaptation not only for increasing water absorption surface but also to ensure survival under unfavourable conditions through increased allocation to perennating organs.

These species are important components of the community only during 5–6 years of fallow development after jhum (Ramakrishnan et al. 1981). Kushwaha et al. (1981) have suggested that the elimination of *E. odoratum*, from older fallows may be related to its sensitivity to shading. The growth behaviour of *E. odoratum* and *I. cylindrica* under low light regimes where the aboveground and belowground growth yield of both the species get markedly reduced and *I. cylindrica* tends to emphasize on better perennation strategy by allocating more to the belowground organs, in the open confirm this. Inspite of the high rainfall, during the monsoon period when seedling establishment/sprouting occur in these two species, shorter or longer duration of dry spells which are common during this period may adversely affect the growth of this species evident from the present study. However, the high allocation to belowground organs of *I. cylindrica* under water stress as seen from the results here suggests its better ability to survive stress conditions.

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