

PLASTICITY OF *CLIDEMIA HIRTA* UNDER COMPETITION AND NUTRIENT STRESS

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Introduction

Clidemia hirta (L.) Don (Malastomataceae) is an invasive shrub that occupies natural and semi-natural ecosystems in Sri Lanka. Due to the ecological and economical importance of invasive species many scientists are interested in predicting the conditions under which invasions are most likely to occur and study their resource use ability, dispersal, stress tolerance etc. (Funk *et al.*, 2008). This ecophysiological information of invasive plants will assist in designing management strategies in controlling these invasive species. The aim of this research was to investigate the plastic behavior of *Clidemia hirta* when exposed to intra-specific and inter specific competition, and nutrient stress.

Materials and Methods

To test these objectives, pot and field experiments were carried out at the Department of Botany, University of Peradeniya.

Intra-specific competition

Five liter plastic pots were filled with a mixture of garden soil to river sand in 1:1 ratio. Three and 5 *Clidemia* seedlings were planted in 5 pots each (hereafter named as Intra/low and Intra/high) to expose plants to different levels of intra-specific competition. After 11 weeks of growth, plants were harvested, oven dried and root dry weight (RDW), shoot dry weight

(SDW) and total dry weight (TDW) were measured while, the root: shoot ratio (RSR), root weight ratio (RWR) and relative growth rate (RGR) were estimated.

Inter-specific competition

Twelve plant beds (raised from the soil surface) were prepared and 6 *Clidemia* seedlings were transplanted in each bed and then the beds were allowed naturally to invade by *Eleutheranthera ruderalis* (Asteraceae), a non-invasive herb. After 4 weeks of growth, *Clidemia* plants were exposed to 3 levels of inter-specific competition by removing all *Eleutheranthera* plants (Inter/no), thinning *Eleutheranthera* seedlings to give 5 plants/100 cm² (Inter/low) and 10 plants/100 cm² (Inter/high). Mortality of *Clidemia* plants was measured and after 14 weeks they were harvested, oven dried and relevant measurements were determined.

Nutrient stress

Two liter pots were filled with a mixture of garden soil to river sand 1:3 ratio (by the low soil: sand ratio, a nutrient poor condition was made). Six seedlings of *C. hirta* were planted in each pot. Half the pots were treated once a week with 200 ml of water and 200ml of Albert solution (N+) and the rest with only 400 ml of water (N-). Plants were harvested after 14 weeks,

oven dried and measurements were taken.

Results and Discussion

Intra-specific competition

The average height of *C. hirta* plants in both high and low density treatments showed a similar growth up to the 4th week and the plants exposed to high intra-specific competition gradually increased their height compared to plants in low intra-specific competition. *Clidemia* plants tend to increase their height in order to overcome the shading effect that they have been exposed to due to high density conditions. They also seem to have taken some time to show their plastic responses once they have come across competition from other plants. RDW, SDW and RGR of Intra/high treatment were higher than Intra/low, but not significant ($P=0.335$, $P=0.073$ and $P=0.061$ respectively). The TDW was significantly higher ($P=0.048$) in plants exposed to Intra/high treatment than in Intra/low. RWR and RSR of Intra/low treatment was higher than Intra/high, but not significant ($P=0.166$ and $P=0.181$ respectively). The result suggests that biomass allocation patterns seem to have not affected. This is perhaps due to the fact that competition levels are not intense enough or plants need more time to respond. Slightly higher RWR also indicate that when plants exposed to higher intra-specific competition, they tend to allocate more biomass to above-ground parts relative to the below-ground parts.

Inter-specific competition

The percentage mortality of *C. hirta* in each treatment has been increased in the order inter/low < inter/high <

inter/no. *E. ruderalis* plants seem to have served as a nursing plant for emerging *Clidemia* seedlings. However, the higher inter-specific competition from *E. ruderalis* has reduced the survival of *C. hirta* indicating their lack of ability to withstand high inter-specific competition from *E. ruderalis* at least in its early seedling stage. Though the mortality rate was the highest under inter/no, the *Clidemia* plants that survived performed well when they were without any inter-specific competition. This indicates that *E. ruderalis* has a competitive effect over *C. hirta* at least during their initial growth stage. The *Clidemia* seedlings under Inter/no also showed significantly higher ($P=0.05$) root biomass compared to seedlings exposed to inter-specific competition. SDW, TDW, RSR, RWR and RGR showed no significant difference ($P=0.375$, $P=0.263$, $P=0.065$, $P=0.147$ and $P=0.263$ respectively).

Nutrient stress

C. hirta did not respond to nutrient addition positively. This is perhaps due to their inherent slow growth during the early phase of their life cycle. *Clidemia* seedlings supplied with no nutrients (-N) performed well with higher RGR (not significant) compared to seedlings receive nutrients (+N). The root:shoot and root weight ratios also showed significantly higher values ($P=0.011$ and $P<0.01$ respectively) in -N plants than +N. In nutrient poor environments, root morphology and root allocation are generally important for determining the outcome in their overall growth (Aerts, 1999). Slow growing plants tend to proliferate more roots and

hence become morphologically plastic when grown in nutrient poor habitats (Callaway *et al.*, 2003). SDW, RDW, TDW and RGR showed no significant differences ($P=0.329$, $P=0.911$, $P=0.426$ and $P=0.558$ respectively).

Conclusions

Clidemia hirta seems to be more plastic when exposed to intra- and inter-specific competition and also under poor soil nutrient conditions. This ability gives them an added advantage to invade nutrient poor habitats over other non invasive plants. *E. ruderalis* has a competitive effect over *C. hirta* at least during their early growth stage. However, low densities of *E. ruderalis* plants can also serve as a nurse plant for the survival of *Clidemia* seedlings during their initial stage.

References

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