Influence of Water Availability on the Growth and Morphology of Invasive Plant, *Mikania micrantha* Kunth

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Abstract: *Mikania micrantha* (Mile a minute weed) is a fast growing perennial vine native to Central and South America. It has been listed as one of the 100 most invasive plants in the world. This study focused on investigating the response of *M. micrantha* to the water availability under Sri Lankan climatic conditions. For achieving the objective, the quantity and frequency of water supplying was changed among different treatments. The frequency and quantity of water supplied did not influence *M. micrantha* growth and morphology significantly (P>0.05). Hence, it can be hypothesized that the species is less sensitive to the water availability in the soil and this may be one trait that facilitates the invasion of *M. micrantha*.

Keywords: Water availability, *Mikania micrantha*, Growth, Morphology, Biomass

1 INTRODUCTION

Biological invasions have been identified as one of the major environmental problems and one of the major threats to the biodiversity. Production of large seed set, rapid growth, high resource use efficiency, biotic and abiotic stress tolerance and allelopathy are some invading mechanisms identified in many invasive plant species (Zedler and Kercher, 2004). Ecosystem conditions may probably play a vast role in determining which trait will increase the chance of invading. Successful invasion and impacts of that invasion on a particular ecosystem depends on the environmental characteristics of the invaded ecosystem and the biotic interactions with that community (Vila and Weiner, 2004). When an alien plant is introduced to a new ecosystem, probably the first interaction is competing for limited resources in the ecosystem. Adaptive plasticity has been hypothesized as one of decisive traits that allow them to be invasive in newly colonized habitats (Zhang and Wen, 2009a). Changes in biomass partitioning patterns, relative growth rate, changes in specific leaf area, chlorophyll content and changes in reproduction patterns are some of the strategies encountered to adapt the abiotic environmental conditions available (Martina and von Ende, 2012; Zhang and Wen, 2009 a and b). Although some of the above responses are unavoidable results of environmental limitations, plastic responses generally help them to maintain function and fitness in broad range of environmental conditions (Mal and Doust, 2005).

*Mikania micrantha* (Mile a minute weed) is a fast growing perennial vine native to Central and South America (Zhen et al., 2011). It has been introduced and well established in most countries in Asia and Pacific region. Later, it has become a serious threat to the biodiversity of natural ecosystems in those countries (Macanawai et al., 2009). It has been listed as one of the 100 most invasive plants in the world (Zhen et al., 2011). *Mikania micrantha* has invaded in almost all ecosystem types and climatic regions in Sri Lanka. However, the influence of Sri Lankan environmental conditions on their spreading and growth has not yet been explored in detail. This study focused on investigating the growth and morphological responses of *M. micrantha* to the water availability under Sri Lankan climatic conditions. For achieving the objective, the quantity and frequency of water supplying was changed among different treatments.

2 MATERIALS AND METHODS

The study was conducted at a covered outdoor experimental facility located at the Faculty of Engineering, University of Ruhuna (6.08° N, 80.19° E). *M. micrantha* seeds were collected from a nearby site and planted for obtaining experimental plants. They (28 Nos.) were transplanted in experimental pots (Diameter – 15 cm, Height- 17 cm) (one in each pot) when their age was 2 months. The substrate was a top soil obtained from the university premises in an area covered by vegetation. After two weeks of
acclimatization, 6 plants were randomly allocated for each experiment condition. Four plants were used for initial measurements. The study was conducted for a period of 72 days. Plant height, fresh weight (FW), dry weight (DW), leaf number and shoot and root length were measured and recorded at the end of the experimental period.

2.1 Experimental conditions

The plants received the following treatments: 1) 100 ml of water once in two days ("100-2" treatment), 2) 200 ml of water once in two days ("200-2" treatment), 3) 100 ml of water once in four days ("100-4" treatment). 4) 200 ml of water once in four days ("200-4" treatment). The variation of the soil moisture content at each experimental condition was measured and presented as a percentage of the saturated moisture content of the soil. Soil moisture content was calculated as;

$$SMC(\%) = \frac{(W_2 - W_1)}{W_1} * 100.$$  

Where smc is soil moisture content, w2 is wet weight of the soil sample; w1 is dry weight of the soil sample.

2.2 Sampling and laboratory analysis

Plant harvesting was carried out at the end of the experimental period. The plants were gently washed, blotted dry and weighted for the total fresh weight (FW). The plant height and the root length were measured to the nearest millimetre. The area of each leaf in each plant was recorded manually. Then, the plants were divided into leaves, petioles and roots. Fresh weight of each component was measured separately and allowed to be dry in an oven at 70°C for 72 hours. The dry weight (DW) of each part was measured separately.

2.3 Statistical analysis

All of the data are presented as the mean ± SD. The Kolmogrov-Smirnov test and Levene’s test were performed on the data sets prior to the statistical analysis to verify the assumptions of normal distribution and homogeneity of variances. Differences among the various groups were analysed using one way ANOVA to check for significance with post-hoc Tukey’s test. For all of these analyses, the SPSS for Windows (Release 16, SPSS Inc., Chicago, IL, USA) statistical software package was used.

3 RESULTS AND DISCUSSION

Negative ecological and economic effects of invasive weeds have generated a large interest in investigating the growth and survival strategies of invasive weeds (Martina and von Ende, 2012). Conversely, thorough knowledge in the growth, reproduction and stress tolerance of those species are needed in employing successful eradication programs. Light, water and nutrient are the major sources that control the growth and survival of the plants. Water supply conditions affect the soil moisture content influencing the water availability to the plants. The present study focused on understanding the response of Mikania micrantha to the soil water availability under Sri Lankan climatic conditions. Soil moisture content was varied among the treatments in order to study this.

The experimental conditions were varied in terms of the water quantity and frequency of water supply for the plants. The variation of the soil moisture content in each treatment as a percentage of the saturated soil moisture content is shown in Table 1. The frequency of water supply and the quantity of the water supplied varied for varying soil moisture content in each treatment. When the water supply was two days, the variation was less than 5%, with four day interval the moisture percentage variations much higher than to 5% and it is more prominently high with 100ml with 4 day interval compare to 200ml with 4 day interval. However, the frequency and quantity of water supplied did not influenced M. micrantha growth and morphology significantly (P>0.05). Figure 1 shows the variation of the relative growth rate at different water conditions. A slight reduction in the relative growth rate can be observed when the supplied water quantity is increased. In contrast to these observations, significant variations in the relative growth rate have been observed for some invasive weeds in other studies (Burns, 2004).
Table 1: The variation of the soil moisture content in each treatment as a percentage of the saturated soil moisture content

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Variation in soil moisture content as a percentage of saturated soil moisture content</th>
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<tbody>
<tr>
<td>100-2</td>
<td>34%-37%</td>
</tr>
<tr>
<td>200-2</td>
<td>50%-55%</td>
</tr>
<tr>
<td>100-4</td>
<td>24%-37%</td>
</tr>
<tr>
<td>200-4</td>
<td>43%-50%</td>
</tr>
</tbody>
</table>

Total biomass and above ground and belowground biomass in a plant did not significantly varied among the plants grown under different water conditions (P>0.04) (Figure 1 and Table 2). Plant height, root length and shoot root ratio also did not vary significantly with the water quantity and water supplying frequency (Table 2). Results of this study show that the water supply conditions employed in the study did not influence significantly on Mikania micrantha growth and morphology. Conversely, most of the invasive plants have been observed showing plasticity in above parameters when exposed to different water availability (Burns, 2004; Mal and Doust, 2005; Monaco et al, 2005). However, M. micrantha is observed
to be less influenced by the water availability and soil moisture content (Zhang and Wen, 2009 a and b). Less sensitivity to the water availability may facilitate the growth and survival of *M. micrantha* under vast range of water conditions.

Table 2: Plant height, root length, above ground biomass, below ground biomass and root: shoot ratio under different water conditions

<table>
<thead>
<tr>
<th>Treatment</th>
<th>100-2</th>
<th>200-2</th>
<th>100-4</th>
<th>200-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant Height (cm)</td>
<td>28.61 ± 9.74</td>
<td>19.40 ± 8.38</td>
<td>28.33 ± 5.71</td>
<td>21.00 ±7.67</td>
</tr>
<tr>
<td>Root length (cm)</td>
<td>8.83 ± 5.23</td>
<td>7.41 ± 1.81</td>
<td>7.16 ± 1.94</td>
<td>7.42 ± 3.87</td>
</tr>
<tr>
<td>Above ground biomass (g)</td>
<td>0.40 ± 0.19</td>
<td>0.28 ± 0.23</td>
<td>0.42 ± 0.20</td>
<td>0.26 ± 0.15</td>
</tr>
<tr>
<td>Below ground biomass (g)</td>
<td>0.05 ± 0.03</td>
<td>0.06 ± 0.06</td>
<td>0.04 ± 0.04</td>
<td>0.05 ± 0.03</td>
</tr>
<tr>
<td>Root: shoot ratio (% DW)</td>
<td>0.13 ± 0.06</td>
<td>0.22 ± 0.03</td>
<td>0.10 ± 0.06</td>
<td>0.18 ± 0.02</td>
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</table>

4 CONCLUSIONS

*M. micrantha* plants grown under different water conditions did not show significant variations in the growth, morphology and biomass allocation patterns. Hence, it can be concluded that the species is less sensitive to the water availability in the soil and this trait may facilitate their invasion in natural ecosystems in Sri Lanka.

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6 REFERENCES


