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Biology and Distribution of the Invasive Alien Weed *Mikania micrantha* - A Review

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Invasion by alien perennial weed *Mikania micrantha* has created a serious problems in Southeast Asia. This climbing vine possesses very fast growth rate and could multiply from seed and vegetative parts. It climbs on other plants, create a dense cover and block sunlight thereby damage or kill the other plant. It compete for water, soil nutrient and release allele-chemicals inhibiting growth of plants. The weed creates economic loss to plantation, horticultural crops, displaces and kills native vegetation. It is designated as one of the worst invasive plants of the world. *M. micrantha* is native to Central and South America and is a harmless plant in its native range. It was widely distributed by man to tropical areas of Africa, Asia, Australia and many different countries. The growth of the weed depends on availability of sunlight and soil moisture. *M. Micrantha* flowers during cool dry season and produces large number of viable seeds. The seed losses its viability with time. Tenperature, light, soil moisture content effect the germination of seed and the seed may persist for about seven years in soil seed bank. The vegetative reproduction of the weed occurs through stem sections and its success depends upon maturity, length and orientation of the stem sections in soil as well as soil moisture content.

Introduction

Mikania micrantha H.B.K. commonly known as mile-a-minute weed is a perennial climbing vine and is one of the world's 100 worst alien species. It is commonly known as mile-a-minute as it possesses a phenomenal growth rate of 8 to 9 centimeters in 24 hr (Choudhury, 1972). It is one of the 32 worst invasive plants of the world (Lowe *et al.*, 2000). The weed is known for vigorous and fast growth in addition to rapid multiplication from both seed and vegetative parts (Kuo *et al.*, 2002). Unlike other invasive plants, *M. micrantha* not only displaces native vegetation but also also kills it. It climbs up to the top of the canopy and creates a dense cover that damages or kills other plants by blocking light and can smother even mature trees with its vine-like, twining growth form (Holm *et al.*, 1977). *M. micrantha* damages other plants by cutting out the light thereby disrupting photosynthesis and also by twinning and smothering (Huang *et al.*, 2000). Further, it competes for water and soil nutrient and releases allele-chemicals into soil inhibiting the growth of other plants (Huang *et al.*, 2000, Li and Jin, 2010). It is also called a plant-killer and it causes native species to disappear (Zhang *et al.*, 2004).

M. micrantha has created serious consequences on farming crops, native plant communities, and natural environments (Holm *et al.*, 1977) and caused economic losses and serious ecological problems in many countries (Barreto and Evans, 1995). In Chitwan National Park of Nepal, M. micrantha has disturbed the unique grass – tree–wetland mosaic and due to this the survival of one-horned rhinoceros is under threat (Sapkota, 2007). As such *M. micrantha* has become one of the most widespread and threatened invasive weeds in subtropics and tropics (Shen *et al.*, 2013).

The state-level environmental protection administration of China has listed *M. micrantha* among the top invasive species (Zhang *et al.*, 2004). The world conservation union (IUCN) has recognized *M. micrantha* as a major invasive alien species of Nepal and categorized it as high risk posed invasive alien species (Tiwari *et. al*, 2005). The United States Department of Agriculture (USDA) has declared *M. micrantha* as a serious agricultural and environmental weed (Weaver Jr and Dixon, 2010).

Distribution

The genus Mikania has about 430 species (King and Robinson, 1987), of perennial, herbaceous or semi-woody, twining vines, or less commonly shrubs, widely distributed in the tropics and subtropics (Mabberley 2008) and many are serious weeds (Wang *et al.*, 2001). *M. micrantha* is believed to be the native of Central and South America (Wirjahar, 1976; Holm *et al.*, 1977). In its native region, it grows in open habitats on the riverside, roadside, and forest areas from lowlands up to 2000 m (Bogidarmanti, (1989); Ipor, I.B. (1991). Out of its native range, *M. micrantha* has spread in tropical Africa, Asia, Australia, the islands of the South Pacific Ocean, and many subtropical countries (Xie *et al.*, 2010) and has become a serious problem in Southeast Asia (Shao *et al.*, 2005). The widespread distribution of *M. micrantha* may be attributed to human activities (Holmes, 1982). It is a harmless and minor species in its native range. But, the absence of co-evolved natural enemies and ecological analogy in newly introduced areas of moist tropics can be considered as the main factor for its rapid spread and colonization (Sankaran and Pandalai, 2004).

Growth and development

M. micrantha prefers habitats having good sunlight and vertical structures, such as trees. It occurs generally in agricultural fallows and wastelands but is rarely found in the intensively managed plantations (Wills *et al.*, 2008). The weed is extremely fast-growing. The growth of a single node reaches 20 cm within one day in summer, and 155 nodes could sprout from a single node within a year, with a total growing length of 1107 m (Lin *et al.*, 2003). The growth of the weed depends upon soil moisture content. Branch number of *M. micrantha* increased with the increase in soil moisture content.

The growth of *M. micrantha* is also dependant on photo synthetically active radiation (PAR). In Fiji, the relative stem growth rate of the longest stem of *M. micrantha* in the taro field was 3.4 and 2.7 cm cm^{-1} day^{-1} at the edges and in between crop rows, respectively. In the cassava field, the relative stem growth was 2.7 and 3.8 cm cm^{-1} day^{-1} for between crop rows and at the borders, respectively. Mikania plants had greater relative leaf, stem, and root dry matter growth at the edges of the field than plants growing in between crop rows of both crops (Macanawai *et. al*, 2012).

In Taiwan, maximum flowering of *M. micrantha* occurred in the winter months (November, December), with prolific seed production of 0.17 million seeds per square meter of ground. During the winter season, most of the leaves used to shed and the sprouting of new leaves started in the spring, indicating that the vine is a perennial (Kuo, 2003). The flowering season of *M. micrantha* in Fiji occurred in the cool, drier period of the year (April to October) (Macanawai, 2011). In Kerala, vigorous growth of *M. micrantha* is observed from June to August (Sankaran and Pandalai, 2004). In north-east India, this period is from March to November (Gogoi, 2001).

Seed production and germination

In Fiji, one to seven number of the seeds produced in each flower head (capitulum) of *M. micrantha* with 95% of the capitula were bearing four seeds. The number of viable seeds produced per m2 was 90,825 and 98,134 for the high and moderate rainfall regions, respectively (Macanawai, 2011). Whereas Kuo (2003) reported 0.17 million seeds produced by *M. micrantha* per square meter in Taiwan. M. micrantha seeds possessed no primary dormancy (Macanawai, 2011). However, Yang *et al*., (2005) reported that newly ripened M. micrantha seeds showed Innate dormancy which was broken by a two-month after-ripening period in dry storage. The seed viability of *M. micrantha* is highest in fresh seed and the viability decreases with time. In fresh seed, the seed viability was found to be 80% and it reduced to 35% after 5 months of storage. After 6 months of storage, the seed viability drastically reduced to 5% and at the 10 th month of storage, there was no germination at all (Abraham and Abraham, 2005).

Germination of *M. micrantha* seeds was affected by temperature, with 0.33%, 83.7%, and 1% of the seed germinating at 5, 25-30, and 40°C, respectively (Hu and Paul, 1994). The optimum temperature for seed germination was in the range of 14 to 29°C, with 87 to 94% germination (Macanawai, A. R.,2011). Light also affected the germination of *M. micrantha* seeds, germination percentage in the dark was less and it increased with increasing light intensity up to 700 lux. Germination was enhanced by the white, yellow, and red light. Seedling emergence percentage was both lower and slower when seeds were covered under the soil, and no emergence occurred when seeds were buried at 1.5 and 1.75 cm in clayey and sandy soil, respectively (Yang *et al.*, 2005). Seedling emergence of *M. micrantha* was increased and quickened with increased soil moisture content (MC) from 8% to about 20%. However, the emergence was reduced at MC greater than 23% (Yang *et al.*, 2005).

A laboratory-controlled aging test (LCAT) indicated that *M. micrantha* seed may survive in the soil seed bank for 1 to 3 years (Macanawai *et al*., 2010). However, this result does not agree with the result reported by Brooks *et al.*, (2008) who conducted similar trials and suggested that *M. micrantha* seed may persist for about 7 years in the soil seed bank. Variation in seed longevity may be attributed to the fact that the seeds came from plants grown under different environmental conditions, such as soil moisture and air temperature (Long *et al.,* 2008), which are known to modify many seed characteristics.

Vegetative reproduction

Soil moisture conditions affected the vegetative reproduction ability of M. micrantha. The clones of *M. micrantha* could survive at soil moisture conditions as low as 12.5%. In waterlogged conditions, it can survive at 1 cm water depth but not in 6 cm depth of water (Xu *et al.,* 2013). Stem sections of the weed with 2-3 nodes had significantly higher survival rate (30% and

25%, respectively) than those with only one node (12%). Mature stem sections had a significantly greater survival rate (31%) than young stem sections (13%) when buried in either horizontal or vertical position. Vertical plantings of the clones resulted significantly greater survival (43%) than those of horizontal plantings (10%), but in both the orientations, survival decreased with the depth of burial (Macanawai *et al.*, 2015). An increase in stolon thickness, internode length, and the presence of leaves increased the survival rate and growth of the stem sections of *M. micrantha* (Huang *et al.*, 2015).

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