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Harmful Effect of the Invasive Weed *Mikania micrantha* with Special Reference to India: A Review

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ABSTRACT

Mikania micrantha is an economically damaging invasive weed, which is widely naturalized in the tropical and subtropical regions of the world. This weed has reported yield losses in various cash crops and plantation crops in South East Asia including India. *M. micrantha* was found to change the soil microbial communities (bacteria, fungi and actinomycetes) as well as the soil chemical properties. It enhances a significant increase in aerobic bacteria but decreases in anaerobic bacteria due to which infested soil were free from other weeds. Similarly, in soil chemical characteristics significant increases in pH, total N and P were observed and a decrease in soil organic matter where *M. micrantha* is prevalent. It has allelopathic properties which affect neighbouring crops, weeds, insects and pathogens. This weed produces allelochemicals (phenolics, flavonoids, alkaloids and terpenes) that may be released by volatilization and decomposition of plant debris. It was also found that the aqueous leaf extract of invasive weed *M. micrantha* inhibited seed germination and seedling growth of various cereals, vegetables, and other plants. A similar result was found in test crops but there was no affected case found in the greenhouse experiment. This review will help the researchers and scientists in understanding the harmful effect of this invasive weed.

Key words: Crop growth and yield, *Mikania micrantha*, Soil chemical property, Soil microbes, Weed infestation,

Invasive plants have been found to adversely affect the ecosystems in habitats throughout the world, by reducing native species richness, altering water or fire regimes, changing the soil nutrient status and altering geomorphologic processes (Macdonald *et al*., 1989). In addition to affecting ecosystems and contributing to the local extinction of native species, invasive species can even cause major socio-economic damage (Pimentel *et al*., 2005).

There are about 250 species in the genus Mikania and it belongs to the tribe eupatorieae, within the family asteraceae. Most species of Mikania are native to America and *M. micrantha* is native to Central and South America. It has been reported as a weed in different Asian countries *viz*. Bangladesh, Sri Lanka, Nepal, Mauritius, Thailand, Philippines, Malaysia, Indonesia, Papua New Guinea and India. This weed has rapid growing habit especially in humid tropical environments and reported to be one of the worst weed intentionally introduced to India.

As a fast-growing vine, it climbs over other vegetation blocking sunlight, smothering forests and preventing forest tree regeneration and suppress the underlying vegetation. *M. micrantha* covers the tree crown, affecting the photosynthesis of the trees and habitats of birds. Li *et al*., 2006 and Li *et al*., 2007 have reported that Mikania can alter soil microbial communities thereby strengthening it to successfully invade the natural ecosystem. The weed has the capacity to influence soil nitrogen availability and its transformation. In India, the most severely affected crops by this weed are coffee, coconut, cocoa, tea and banana. It causes enormous damage over a broad range of sectors.

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Effect on crops

M. micrantha causes a significant reduction in the yield of cash crops like tea, coffee, pineapple, banana and ginger. In India, it is a major problematic weed in tea gardens particularly in the north-east and south-west states. A high infestation of *M. micrantha* was noticed in young rubber and teak plantations of Karbi Anglong district, Assam. The infestation was also high in banana plantations and open forests (Bora *et al*., 2019). Studies carried out in two tea gardens of Assam revealed that the yield of tea and revenue of the tea gardens were very adversely effected (Fig 1) by the presence of Mikania (Puzari, 2010). In Nattika, Kerala, the weed created high risk for coconut homesteads and farmers had to spend around Rs. 4800 per acre towards mechanical weeding to control it (Abhilash *et al*., 2013).

In Fiji, *M. micrantha* was the most frequently occurring weed species in sugarcane and banana fields (Macanawai, 2011). In the Yunan province of China, it has invaded sugarcane, lemon, banana, orange and caused over 60% yield loss (Shen *et al.,* 2013). A survey in Malaysia revealed that the weed problem of *M. micrantha* was associated with rubber and oil-palm plantations. Competition of Mikania was greatest in immature rubber and oil palms and declined as the crop matured (Ahmad-Faiz, 1992). The weed was also found smothering papaya, young cocoa, banana, taro, young oil palms and ornamental plants in Papua New Guinea. It caused severe impacts on crop production and reduced the income of the farmers through declined yields and high weeding costs, particularly in subsistence mixed cropping systems (Day *et al.,* 2012).

Effect on soil

The presence of *M. micrantha* altered both the soil microbial community and soil chemical characteristics. The total population of bacteria, fungi and actinomycetes increased in *M. micrantha* infested soil. Due to smothering by *M. micrantha*, many plants die and their residues accumulate on the surface soil thus providing nutrients for microorganisms. There was a significant increase in aerobic bacteria but a decrease in anaerobic bacteria in the *M. micrantha* infested soil as compared to the area free from the weed. This was accompanied by changes in soil characteristics such as pH, Soil Organic Matter, total N, NO3-N, NH4-N and total P. There was a significant increase in pH, total N and total P with the increase of *M. micrantha* but decrease in soil organic matter. There were increased activities of soil enzymes such as b-glucosidase, invertase, protease, urease, phenol oxidase, acid phosphatase and alkaline phosphatise in *M. micrantha* invaded soil than non-invaded area. Enhanced activities of these enzymes involved in the cycling of carbon, nitrogen, phosphorus and soil organic matter greatly enhanced the nutrient catabolic capacity of the invaded soils. Higher activity of enzymes related to N cycling was found in the soil where the concentration of mineral N was low. Therefore, N availability could be a strong determinant for *M. micrantha* expansion (Li *et al.*, 2006). Soil treated with *M. micrantha* leaf leachate had higher amounts of water-soluble phenolics (Kaur *et al*, 2012). As such, it may change the litter decomposition of native plants in *M. micrantha* invaded ecosystem. Aqueous extracts of *M. micrantha* increased the litter decomposition rates of *Ficus virens* and *Acacia richii* but decreased that of *Litsea glutinosa* (Chen *et al*., 2007).

Allelopathic effect

M. micrantha had allelopathic effects on crops, weeds, co-occurring plant species, insects and pathogens (Ismail and Mah, 1993; Ismail and Chong, 2002; Kong and Xu, 2002; Lan and Wang, 2001). Different phytochemicals such as seven phenolics, five flavonoids, one alkaloid and sixty six terpenes and their derivatives have been identified in *M. micrantha* (Table 1). However, the

Table 1: Phytochemicals recorded in *Mikania micrantha.*

Phytochemical	References
Phenolics	
Vanillic acid	(Ismail and Chong, 2002)
Resorcinol	(Ismail and Chong, 2002)
Caffeic acid	(Ismail and Chong, 2002)
p-Hydroxybenzaldehyde	(Ismail and Chong, 2002)
Isobutyl acetate	(Feng *et al*., 2004)
3,5-Di-o-caffeoylquinic acid n-butyl ester	(Wei *et al*., 2004)
3,4-Di-o-caffeoylquinic acid n-butyl ester	(Wei *et al*., 2004)
Flavonoids	
Mikanin	(Wei *et al*., 2004)
Eupalitin	(Wei *et al*., 2004)
Eupafolin	(Wei *et al*., 2004)
3,4',5,7-Tetrahydroxy-6-methoxyflavone 3-o-â-D-glcopyranoside	(Wei *et al*., 2004)
Luteolin	(Wei *et al*., 2004)
Alkaloid	
2-Butanamine	(Zhang *et al*., 2003)
Terpenes and their derivatives	
Dihydromikanolide	(Cuenca *et al*., 1988; Shao *et al*., 2005)
Deoxymikanolide	(Cuenca *et al*., 1988; Shao *et al*., 2005)
2,3-epoxy-1-hydroxy-4,9-germacradiene -12,8:15,6-diolide	(Shao *et al*., 2005)
Mikanolide	(Bakir *et al*., 2004)
Scandenolide	(Cuenca *et al*., 1988)
Dihydroscandenolide	(Cuenca *et al*., 1988)
Anhydroscandenolide	(Cuenca *et al*., 1988)
Mikanokryptin	(Herz *et al*., 1975)
Limonene	(Zhang *et al*., 2003)
α-, β-Copaene	(Feng *et al*., 2004; Zhang *et al*., 2003)
α-, β-, γ-Terpinene	(Feng *et al*., 2004; Zhang *et al*., 2003)
Longipinene	(Shao *et al*., 2001; Zhang *et al*., 2003)
α-, β-Bergiberene	(Feng *et al*., 2004; Shao *et al*., 2001; Shao *et al*., 2001;
α-Zingiberene	(Zhang *et al*., 2003)
α-Humulene	(Zhang *et al*., 2003)
α-, β-Caryophyllene, isocaryophyllene	(Feng *et al*., 2004; Shao *et al*., 2001; Zhang *et al*., 2003)
Curcumene	(Zhang *et al*., 2003)
α-Himachalene	(Shao *et al*., 2001; Zhang *et al*., 2003)

Table 1: Continue...

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α-, β-Cubeben	(Feng *et al*., 2004; Shao *et al*., 2001; Zhang *et al*., 2003)
Verbenone	(Zhang *et al*., 2003)
Germacrene	(Shao *et al*., 2001; Zhang *et al*., 2003)
α-, β-Pinene	(Feng *et al*., 2004; Shao *et al*., 2001)
Sabinene	(Feng *et al*., 2004; Shao *et al*., 2001)
Myrcene	(Feng *et al*., 2004; Shao *et al*., 2001)
α-Phellandrene	(Feng *et al*., 2004; Shao *et al*., 2001)
Ocimene	(Feng *et al*., 2004; Shao *et al*., 2001)
Elemene	(Feng *et al*., 2004; Shao *et al*., 2001)
1,9-Aristo-ladiene	(Shao *et al*., 2001)
Aromadendrene, allo-aromadendrene	(Feng *et al*., 2004; Shao *et al*., 2001)
α-, β-Farnesene	(Feng *et al*., 2004; Shao *et al*., 2001)
α-,γ-Muurolene	(Shao *et al*., 2001)
α-Thujene	(Feng *et al*., 2004)
α-, γ-Bisabolene	(Feng *et al*., 2004; Shao *et al*., 2001)
α-, β-, γ-, δ-Cadinene	(Feng *et al*., 2004; Shao *et al*., 2001; Zhang *et al*., 2003)
α-Guaiene	(Feng *et al*., 2004)
Arcurcumene	(Shao *et al*., 2001)
α-Copaenene-8-ol	(Feng *et al*., 2004; Shao *et al*., 2001)
Nerolidol	(Shao *et al*., 2001)
Cubenol	(Feng *et al*., 2004; Shao *et al*., 2001)
α-, δ-Cadinol	(Shao *et al*., 2001)
Bisabolol	(Feng *et al*., 2004; Shao *et al*., 2001)
3-Hexen-1-ol	(Feng *et al*., 2004)
3,7,11,15-Tetramethyl-2-hexadecen-1-ol	(Feng *et al*., 2004)
Geraniol	(Feng *et al*., 2004; Zhang *et al*., 2003)
Terpinene-4-ol	(Feng *et al*., 2004; Zhang *et al*., 2003)
γ-Cymene-2-ol	(Feng *et al*., 2004; Shao *et al*., 2001; Zhang *et al*., 2003)
Carveol	(Zhang *et al*., 2003)
Linalool	(Feng *et al*., 2004; Zhang *et al*., 2003)
Menthol	(Zhang *et al*., 2003)
Terpineol	(Feng *et al*., 2004)

presence of the compounds varies depending upon the geographic area where *M. micrantha* grows. These allelochemicals are released by volatilization or decomposition of plant debris.

Allelopathic potential of *M. micrantha* was evaluated through bioassays of volatile oil and extracts of roots, stems and leaves (Ni *et al.,* 2007). Results of bioassay showed that the volatile oils inhibited the growth of large number of plants (*Lolium multiflorum*, *Echinochloa crusgalli*, *Oryza sativa, Cucumis sativus, Raphanus sativus, Brassica chinensis, Brassica parachinensis* and *Brassica alboglabra*) and pathogenic fungi (*Fusarium oxysporum, Pyricularia grisea* and *Phytophthora nicotiacae*) (Ni *et al*., 2007). Inhibitory potential of volatile oil increased with an increase in concentration on plant and phytopathogenic fungi but had little effect on plant pathogenic bacteria (*Ralstonia solanacearum*). The volatile oil bioassays on phytophagous insects showed a significant deterrent effect on the oviposition of *Plutella xylostella, Phyllotreta striolata* and *Phaedon brassicae* (Zhang *et al*., 2002).

Seed germination and seedling growth of *Oryza sativa, Raphanus sativus* and *Triticum aestivum* were inhibited by aqueous leaf extract of *M. micrantha*. (Sahu and Devkota, 2013; Adhikari *et al*., 2013). Aqueous leaf extracts of *M. micrantha* under high extract concentration suppressed the germination and growth of *Zea mays* L. and *Oryza sativa* L. There was a slight decrease in 10% concentration in the case of both the test crops. As the concentration increased from 30-100% the aqueous leaf extract of *M. micrantha* had a detrimental effect on the root and shoot growth of both the test crops (Lalmuanpuii and Sahoo, 2011). In a greenhouse experiment, the incorporation of *M. micrantha* debris into the soil reduced the growth of *Brassica chinensis* and *Lycopersicon esculentum* whereas the emergence of *Zea mays* and *Vigna sesquipedalis* seedlings was not affected (Ismail and Chong, 2002). The aqueous leachates of *M. micrantha* had allelopathic potentials on *Raphanus sativus, Lolium multiforum, Lactuca sativa* and *Trifolium repens* (Shao *et al*., 2003). It also inhibits the growth of Chinese *Brassica parachinensis* and *Raphanus sativus* (Liang *et al*., 2006).

The shoot length and fresh weight of *Asystasia intrusa, Chrysopogon aciculatus* and *Paspalum conjugatum* seedlings were reduced by *M. Micrantha*. (Ismail and Mah, 1993). Aqueous extracts from *M. micrantha* roots and leaves inhibited the seed germination and seedling growth of two woody plants *i.e*. *Lagerstroemia indica* L. and *Robinia pseudoacacia* L in southern China. Allelopathic activity of the weed varied based on the concentration of the extracts, target species and the extract sources (*i.e*., leaves vs. roots of Mikania) (Wu *et al.,* 2009). Similarly, the seedling growth of *Acacia mangium, Pinus massoniana* and *Eucalyptus robusta* was inhibited by the aqueous and ethyl acetate extracts of aerial parts of *M. micrantha* (Shao *et al.,* 2003).

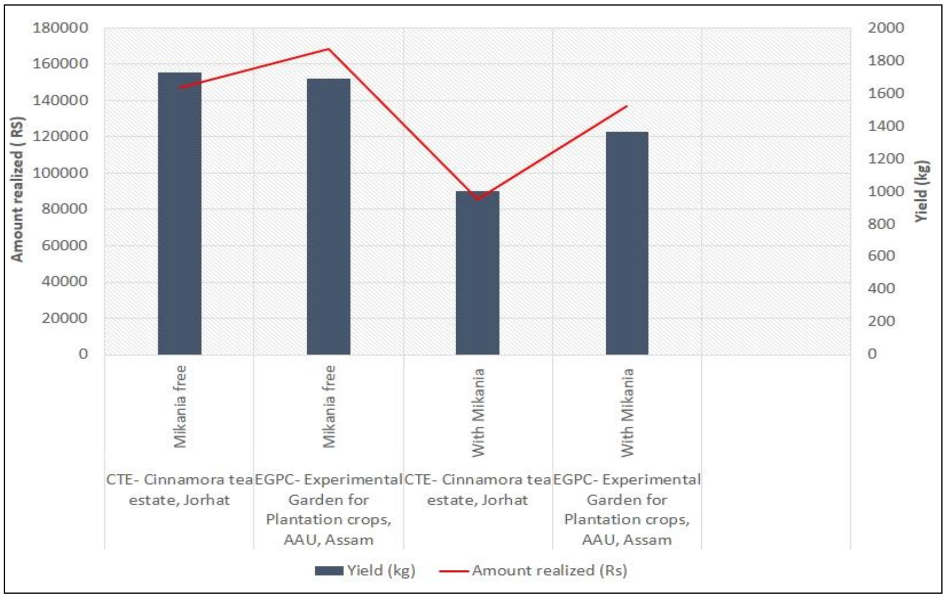

Fig 1: Graph depicting the impact of Mkania on yield of tea.

CONCLUSION

In conclusion, understanding the invasive weed is important to reduce population density and negative impact on crops and local plant communities. Moreover, an invasive weeds directly and indirectly effects the ecology and biology of soil. Therefore, to promote the restoration and management of agricultural crops, ecological measures need to be formulated to suppress the invasive weed *M. Micrantha.*

REFERENCES

Abhilash, E.S., Sheeja, P.P., Brijesh, S., Raju, A.R., Bilal, N.A. and Kafsa, B.S. (2013). A study on the ecology and economic impact of major invasive weed species of coconut homesteads of Nattika, India. Asia Pacific Journal of Environment Ecology and Sustainable Development. 1: 32-35.

Adhikari, B., Dhungel, P., Gauchan, D.P. and Parajuli, R. (2013). Allelopathic effect of aqueous extract of *Mikenia micrantha* (L.) kunth on seed germination, seedling growth and biochemical quality of *Triticum aestivum* Linn. Advances in Life Sciences. 2(2): 38-40.

Ahmad-Faiz, M.A. (1992). Comparison of three weeding methods in rubber cultivation. Planters' Bulletin Rubber Research Institute of Malaysia. 212-213: 99-101.

Bakir, M., Facey, P.C., Hassan, I., Mulder, W.H. and Porter, R.B. (2004). Mikanolide from Jamaican *Mikania micrantha*. Acta Crystallographica Section - Crystal Srtucture Communications. 60: 798-800.

Bora, A.R., Deka, J., Barua1, I.C. and Barman, B. (2019). Intensity of *Mikania micrantha* in coffee and other plantations of Karbi Anglong district, Assam. Indian Journal of Weed Science. 51(1): 95-97.

Chen, B., Ni, G., Ren, W. and Pengs, S., (2007). Effects of aqueous extracts of *Mikania micrantha* on litter decomposition of native plants in South China. Allelopathy Journal. 20(2): 307-3l4.

Cuenca, M.D.R., Bardon A., Catalan C.A.N. and Kokke, W.C.M.C. (1988). Sesquiterpene lactones from *Mikania micrantha*. Journal of Nutural Products. 51: 625-626.

Day, M.D., Kawi, A., Kurika, K., Dewhurst, C.F., Waisale, S., Saul-Maora, J., Fidelis, J., Bokosou, J., Moxon, J., Orapa, W., Senaratne, K.A.D. (2012). Mikania micrantha Kunth (Asteraceae) (Mile-a-Minute): Its distribution and physical and socioeconomic impacts in Papua New Guinea. Pacific Science. 66(2): 213.

Feng, H.L., Li,Y., Ye, W.H., Yu, Z. and Huang, Z.Y. (2004). Chemical Components of essential oil from stems and leaves of *Mikania micrantha* in Shenzhen. Chinese Traditional and Herbal Drugs. 35: 17-18.

Herz, W., Srinivasan, A and Kalyanraman S. (1975). Mikanokkryptin, a new guinolide from *Mikania.* Photochemistry. 14: 233-237.

Ismail, B.S. and Chong, T.V. (2002). Effects of aqueous extracts and decomposition of *Mikania micrantha* H.B.K. debris on selected agronomic crops. Weed Biology and Management. 2: 31-38.

Ismail, B.S. and Mah, L.S. (1993). Effects of *Mikania micrantha* H.B.K. on germination and growth of weed species. Plant and Soil. 157: 107-113.

Kaur, R., Malhotra, S. and Inderjit (2012). Effects of invasion of Mikania micrantha on germination of rice seedlings, plant richness, chemical properties and respiration of soil. Biol Fertil Soils. 48: 481-488.

Kong, C.H., Hu, F. and Xu, X.H. (2002). Allelopathic potential and chemical constituents of volatiles from *Ageratum conyzoides* under stress. Journal of Chemical Ecology. 28: 1173-1182.

Lalmuanpuii, R. and Sahoo, U.K. (2011). Allelopathic effects of *Tectona grandis* L. and *Mikania micrantha* L. on germination of *Zea mays* L. and *Oryza sativa* L. under laboratory condition. Sci. Vis. 11(4): 208-213.

Lan, C.Y. and Wang, Y.J., (2001). Research of Natural Resources and Ecology of Neilingding Island, Guangdong, China. China Forestry Publishing House, Beijing. 142: 22-23.

Li, W., Zhang, C., Jiang, H., Xin, G. and Yang, Z. (2006). Changes in soil microbial community associated with invasion of the exotic weed, *Mikania micrantha* H.B.K. Plant and Soil 281: 309-324.

Li. W., Zhang, C., Gao, G. and Yang, Z., (2007). Relationship between Mikania micrantha invasion and soil microbial biomass, respiration and functional diversity. Plant Soil 296: 197-207.

Liang, B., Yuan, Y.L., Gu, W.X. and Li, Y.J. (2006). Studies on the allelopathic effects of *M. micrantha*. Jiangxi Plant Protection. 29: 21-24.

Macanawai, A.R. (2011). Assessment of the impact of *Mikania micrantha* Kunth. ex. H.B.K. on crop production systems in Viti Levu Fiji. Thesis. The University of Queensland, School of Agriculture and Food Sciences.

Macdonald, I., Loope, L., Usher, M., Hamann, O., (1989). Wildlife conservation and the invasion of nature reserves by introduced species: A global perspective. In: Biological invasions: A Global Perspective. [Drake, J., Mooney, H., di Castri, F., Groves, R., Kruger, F., Rejmanek, M., Williamson, M. (Eds.)], Wiley, New York.

Ni, G.Y., Li, F.L., Chen, B.M., Song, L.Y. and Peng, S.L. (2007). Allelopathic plants 21. *Mikania micrantha* H.B.K. Allelopathy Journal. 19: 287-296.

Pimentel, D., Zuniga, R. and Morrison, D. (2005). Update on the environmental and economic costs associated with alien-invasive species in the United States. Ecological Economics. 52: 273-288.

Puzari, K.C., Bhuyan, R.P., Dutta, P. and Nath, H.K.D. (2010). Distribution of Mikania and its economic impact on tea ecosystem of Assam. Indian journal of forestry. 33(1): 71-76.

Sahu, A. and Devkota, A. (2013). Allelopathic effects of aqueous extract of leaves of *Mikania micrantha* H.B.K. on seed germination and seedling growth of *Oryza sativa* L. and *Raphanus sativus* L. Scientific World. 11(11): 90-93.

Shao, H., Nan, P., Peng, S.L. and Zhang, C. (2001). Study of chemical constituents of essential oil from flowers of *Mikania micrantha* H.B.K. Chinese Traditional and Herbal Drugs. 24: 341-342.

Shao, H., Peng, S.L., Zhang, C. and Nan, P. (2003). Allelopathic potential of *Mikania micrantha*. Chinese Journal of Ecology. 22: 62-65.

Shao, H., Peng, S.L., Wei, X.Y., Zhang, D.Q. and Zhang, C. (2005). Potential allelochemicals from an invasive weed *Mikania micrantha* H.B.K. Journal of Chemical Ecology. 31: 1657-1668.

Shen, S., Xu, G., Zhang, F., Jin, G., Liu, S., Liu, M., Chen, A. and Zhang, Y. (2013). Harmful effects and chemical control study of *Mikania micrantha* H .B.K in Yunnan, Southwest China. African Journal of Agricultural Research. 8(44): 5554-61.

Wei, X.Y., Huang, H.J., Wu, P., Cao H.L. and Ye, W.H. (2004). Phenolic constitutions from *Mikania micrantha*. Biochemical Systematics and Ecology 32: 1091-1096.

Wu, A.P., Hua, Y., Shu, Q.G., Zhen, Y.H., Wei, M.H., Shi, L.M. and Ming, D. (2009). Differential belowground allelopathic effects of leaf and root of *Mikania Micrantha*. Trees. 23(1): 11-17.

Zhang, M.X., Ling, B., Kong, C.H., Zhao, H. and Pang, X.F., (2002). Allelopathic potential of volatile oil from *Mikania micrantha*. Chinese Journal of Applied Ecology. 13: 1300-1302.

Zhang, M.X., Ling, B., Kong, C.H., Pang, X.F. and Liang, G.W. (2003). Chemical components of volatile oil from *Mikania micrantha* and its biological activity on insects. Chinese Journal of Applied Ecology. 14: 93-96.