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Changes of Microenvironment Component due to Invasion of *Mikania Micrantha* Kunth Ex Hbk. in Dilli Reserve Forest of Assam

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Abstract: *Mikania micrantha is identified as a most troublesome exotic invader in the forest ecosystem of Upper Assam. Understanding the role of M. micrantha in ecosystem function of Dilli reserve forest of Assam is necessary for the effective management of the weed, as it alter the microenvironment of the forest gradually. Study revealed that M. micrantha can easily occupied the localized canopy gap patches of the forest that acted as windows for successful invasion of the weed. Average maximum air temperature varies from 24ºC to 33.9ºC which supports the luxuriant growth of the weed. Soil temperature recorded highest in infested sites for all the seasons with distinct variations. Comparative assessment of light interception % and Mikania biomass at different growth season showed that minimum light was intercepted in pre monsoon season (39.46 ±0.59) because of early stage of Mikania seedlings. However, in post monsoon season maximum light was intercepted (78.13 ±0.57) owing to utmost vegetative growth. pH value was highest in Mikania infested site during winter season followed by post monsoon, pre monsoon and monsoon. Organic carbon % was more in pre monsoon season of natural site and least value was in winter season of infested site, may be due to leaching of heavy rain. Maximum NPK was recorded in un-infested areas in contrast to infested one. Correlation study of light interception, soil data with biomass accumulation of Mikania revealed positive correlation between biomass and interception of light by the canopy.*

Key words: *Mikania invasion, alteration, soil nutrient, microenvironment, Dilli Reserve Forest, Assam*

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I. Introduction

In forest ecosystems the understory plants are highly sensitive to their micro environment governed by the light intensity, temperature, soil moisture, etc. Any change of these environmental parameters might be detrimental for the existence of some of the susceptible species. Invasion of alien species is considered as the second worst threat for biodiversity that may cause changes in soil structure, profile, decomposition rate, moisture and nutrient content [16]. Plant invasion in a community is determined mainly by ecological factors of the invaded ecosystem. Success of invasion is a complex interaction between the invader and introduced community [13].

Among the hundreds of worst tropical alien species, *Mikania micrantha* Kunth. ex. H.B.K. is ranked 10^{th} in South and South East Asia [11]. It successfully competes with trees and other crop plants for soil nutrients, water and sunlight availability. *M. micrantha* invasion is a major contributing factor for change of local climate conditions, plant litter, root secretion, and soil physico-chemical properties that rapidly alters the environment in the forest.

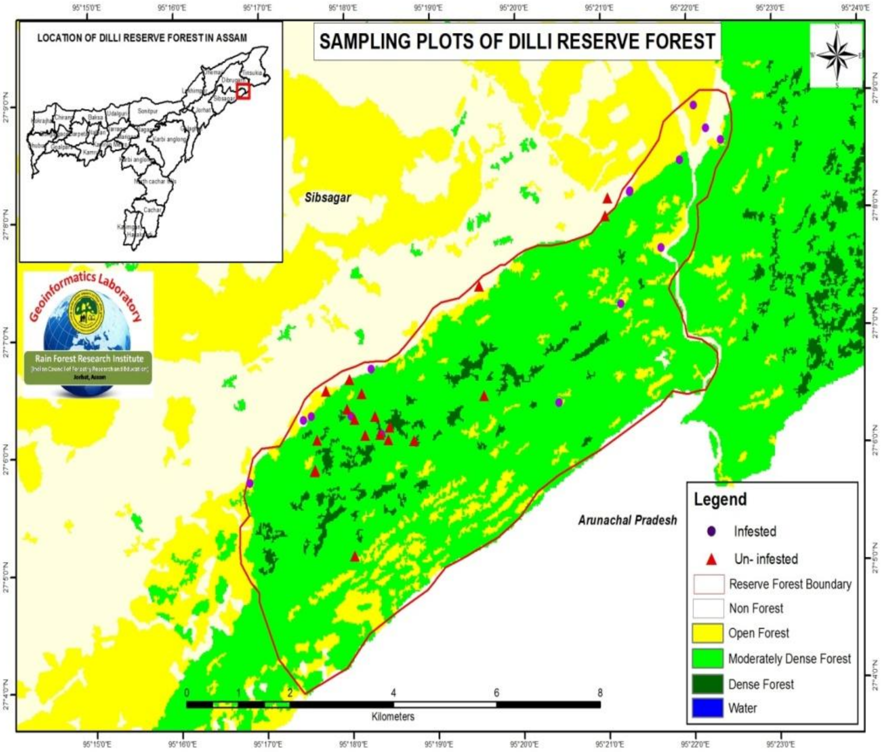
Maximum ecosystem disturbance and structural modification encourage the invasion of *M. micrantha* in Assam. The present study was an attempt to evaluate the impact of *M. micrantha* on soil properties and other microenvironment characters in Dilli Reserve Forest of Assam.

II. Materials and Methods

Study site

Dilli Reserve Forest is situated under Sivasagar district of Assam in the foothill of the Patkai range covering 16.7 sq km (3108 ha.). It lies between $27^0$4'14.31" N to $27^0$8'41.39" N and $95^0$17'25.40" E to $95^0$21'56.07" E, positioned in the western most part of the Assam Valley Tropical Wet Evergreen Forest with elevation of 179 to 197 m above MSL (Fig.1). The forest is in the track of alluvial formation over Tertiary sand stone and shale, terrain is flat with a gentle slope from south-eastern part. Soil covered with a deep layer of sandy loam rich in vegetative matter. Luxuriant growth of *Dipterocarpus retusus* and *Mesua faerea* occupied the emergent layer of this forest. The climate is humid sub-tropical monsoonic type with average annual rainfall of 2191.28 mm received from the southwest monsoon. The highest relative humidity was observed 98.84% in the month of June.

Fig.1 Study Map of Dilli Reserve Forest



III. Methodology

Extensive field survey was carried out during the period of 2014-2017 for record of microenvironment data in respect to *M. micrantha* infestation. The forest was divided into two sites as *M. micrantha* un-infested site and infested site.

Soil samples were collected from both the forest sites with three different depths (viz. 0-15 cm, 15-25 cm and 25-50 cm). Samples were air-dried, ground and passed through 2-mm sieve and stored in airtight bottles. pH, bulk density and moisture content was analysed following standard methods and available nitrogen by Kjeldhal method [9]. Organic carbon was estimated by Walkley and Black's wet oxidation modified method [10]. Available phosphorus was estimated by spectrophotometrically and potassium was estimated by Flame emission method [9]. Soil Temperature was recorded at seasonal intervals through soil thermometer.

Biomass was estimated by harvest method from a sample plot of 1m x 1m seasonally from ground flora of *M. micrantha* infested forest areas. Twenty five replications were taken from the site for representation of the area. The fresh weight of the samples was taken in the field and the fractions of the samples were brought to the laboratory for dry weight estimation. Samples were kept in the oven at 60-70^0 C until constant weight will obtained. Light intensity was periodically recorded above the canopy and at ground level through Lux meter. Intercepted light by the canopies was calculated by deduction method.

IV. Results and Discussion

M. micrantha is a light demanding perennial vine can easily established in a small open sunny place. Baker [4] stated that light availability encourages the invasion of exotic weeds. Considering the reference of *Lantana camara* invasion in Karnataka, higher density of the weed was reported from open forest areas [3]. Present study observed that *M. micrantha* can easily occupy in small opening patches, smother young trees within a very short time and gradually penetrated the dense forest. The weed invaded mostly in canopy gap areas and the peripheral region of natural forests, absent in closed canopy areas. Sporadic tree felling and lopping of trees created localized canopy gap patches. This canopy gap acted as windows for successful invasion of *Mikania* in the forest. Changes of soil moisture regime, greater solar flux created favourable condition for luxuriant growth of this weed. Influx of *Mikania* hindered light intensity on forest floor. Barua and

Hazarika [5] reported that invasion of *M. micrantha* encourage the alteration of evergreen species and prompted the changes in vegetation component. The species that survive in the infested sites are mostly of deciduous nature viz. *Ficus hispida Balakata baccata, Lagerstroemia speciosa, Bischofia javanica, Bombax ceiba* and *Hydnocarpus kurzi.* The dense shade below canopies suppresses the growth of other plant species [8]. Present study revealed that light availability immediately below the *Mikania* canopy was very limited and affected the regeneration of several tree species.

Soil temperature was observed highest in *M. micrantha* infested sites for all the seasons. Maximum temperature was recorded in Monsoon season (29.00^0 C ± 0.36) and winter temperature falls down to 17.13^0C. In un –infested natural forest sites the maximum temperature goes up to 27.57^0 C and minimum was found as 15.97^0 C. Considering the Light interception (%) by the weed, minimum light was intercepted in pre monsoon season (39.46 ±0.59). However, in post monsoon season maximum light was intercepted (78.13 ±0.57). In un-infested forest the interception of light was high due to close canopy structure of the forest (Table -1).

Table no1: Seasonal variation of Light interception (%) and Soil Temperature of Dilli Reserve Forest

Trait	Site	Pre Monsoon	Monsoon	Post Monsoon	Winter
Soil temperature	Infested	21.03^0C ±1.4	29.00^0 C ±0.36	26.83^0 C ±1.19	17.13^0C ±0.81
	Un- infested	19.57^0C ±0.85	27.57 C ±0.47	26.30^0 C ±1.11	15.97^0C ±0.38
Light interception (%)	Infested	39.46 ±0.59	66.21 ±0.57	78.13 ±0.57	67.74 ±0.23
	Un- infested	85.17 ±0.25	92.43 ±0.57	90.03 ±0.51	81.23 ±0.35

The population of *Mikania* was positively correlated with temperature [12]. Present study showed the average maximum temperature varies from 24ºC to 33.9ºC in the study sites which support the luxuriant growth of the weed. Maximum Precipitation and Humidity also prop up the intensification of the weed (Fig.-2).
Mikania contributed a rational quantity of biomass production in the infested forest sites, where biomass accumulation of the weed was found maximum in post monsoon season. Otherwise, contribution of *Mikania* biomass in close canopy natural forest site was very negligible. Present study revealed that the forest was invaded by the weed in buffer zones, inside forest roads and canopy gaps at an alarming rate. Fig.3 explained the relative

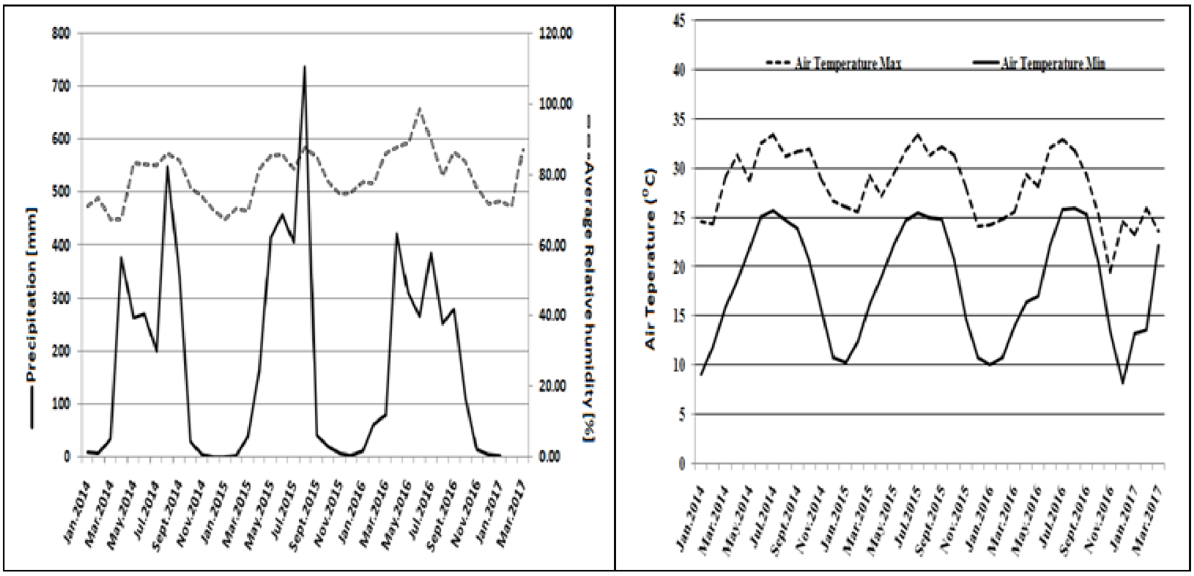


Fig 2. Variation of Precipitation, Humidity and Air Temperature of Dilli Reserve Forest during study period

assessment of light interception % and *Mikania* biomass at different growth season. In the post monsoon season maximum light was intercepted by the *Mikania* canopy owing to highest vegetative growth. In pre monsoon season *Mikania* seedlings were in developing stage. Therefore, during this season interception of light observed minimum. The growth of *Mikania* is mainly depending on water accessibility hence, profuse vegetative growth was recorded in the monsoon (Jun-August) and post monsoon (September-November) season. Gogoi *et al.*, also reported the maximum vegetative growth of *Mikania* during March to November [7].

Soil is a vital component of forest and regulates important ecosystem processes such as water availability, nutrient uptake, decomposition etc. and vegetation plays a major role on the properties of soil. Changes of vegetation composition due to exotic invasion are always connected with the changes of soil properties [17]. Study showed that in *Mikania* infested soil maximum value of pH was recorded (ranges from 4.76 to 5.04), whereas, least value was found in un-infested soil (4.62). This may be due to release of acidic compound by the decomposition of organic residues from forest vegetation [7 2 1]. Bulk density of soil was increases with increasing soil depths and it varies from 0.98-1.18g ^{cm3} in different soil layers. Lowest value of bulk density in surface layer may be due to the addition of organic matter through litter fall. Sharma and Gupta [15] also stated that higher humus level lowers the bulk density. Soil moisture Content recorded more in un-infested forest site than infested site due to high humid closed canopy cover of Dipterocarp-Mesua–Artocarpus association. Soil moisture level in infested soil lies between 20.66% -22.81% (Table-2). Maximum proliferation of surface absorbing roots of *Mikania* contributed higher absorption of moisture in the surface layer. Chen *et al.*, [6] also reported the massive influence of *Mikania* extract in nutrient cycling of 3-forest vegetation viz., Coniferous masson pine forest, Coniferous broad leaf mixed forest and Subtropical monsoon evergreen broad – leaf forest.

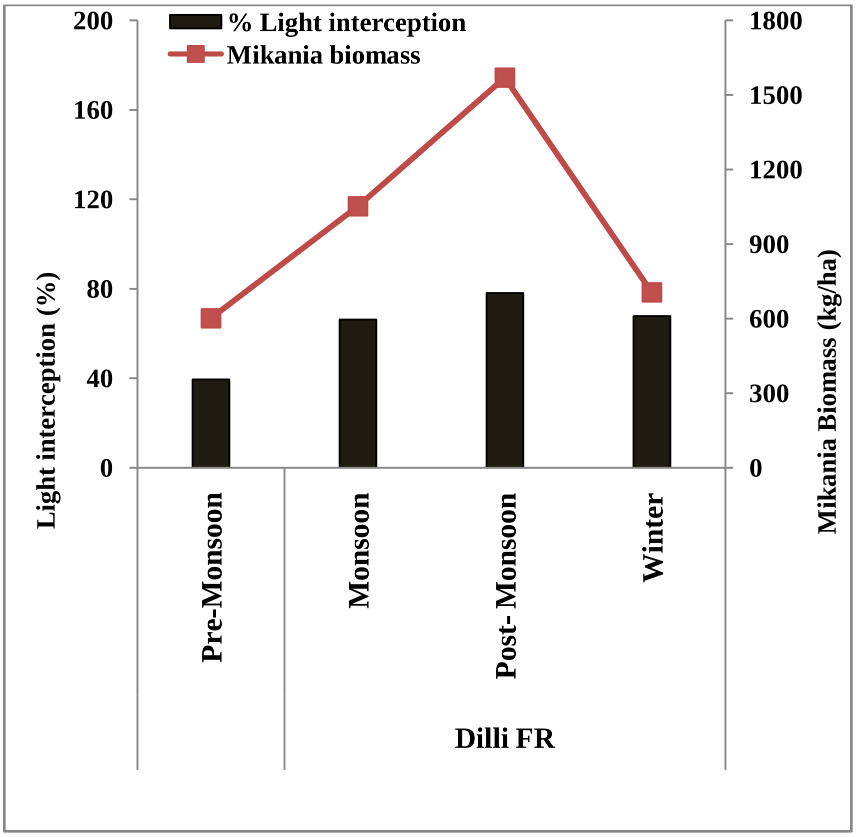


Fig.-3: Comparative assessment of light interception % and *Mikania* biomass at different growth season

Table no 2: Physical properties of soil in Dilli Reserve Forest

Seasons		pH			Bulk Density (g- cm3)			Moisture (%)		
		0-15	15-25	25-50	0-15	15-25	25-50	0-15	15-25	25-50
Pre Monsoon	**I**	4.78 ±0.02	4.59 ±0.03	4.54 ±0.03	1.01 ±0.01	1.04 ±0.02	1.04 ±0.02	22.81 ±0.04	29.60 ±0.03	31.08 ±0.03
	UI	4.62 ±0.02	4.32 ±0.01	4.29 ±0.02	0.97 ±0.02	0.99 ±0.02	1.02 ±0.01	26.5 ±0.15	30.55 ±0.03	32.48 ±0.02
Monsoon	**I**	4.76 ±0.02	4.55 ±0.04	4.53 ±0.02	0.86 ±0.04	0.87 ±0.03	1.02 ±0.01	30.11 ±0.04	35.26 ±0.02	38.46 ±0.03
	UI	4.66 ±0.01	4.28 ±0.02	4.22 ±0.02	1.01 ±0.01	1.01 ±0.01	1.07 ±0.01	33.56 ±0.02	38.72 ±0.02	40.58 ±0.02
Post Monsoon	**I**	4.76 ±0.02	4.72 ±0.02	4.72 ±0.02	1.03 ±0.01	1.05 ±0.01	1.06 ±0.01	20.66 ±0.02	24.8 ±0.03	28.94 ±0.02
	UI	4.69 ±0.02	4.48 ±0.02	4.43 ±0.02	1.05 ±0.02	1.07 ±0.01	1.08 ±0.01	29.71 ±0.03	34.50 ±0.04	33.86 ±0.03
Winter	**I**	5.04 ±0.02	4.86 ±0.02	4.78 ±0.02	0.99 ±0.02	1.03 ±0.01	1.05 ±0.02	21.78 0.03	24.94 ±0.03	26.86 ±0.04

	UI	4.98 ±0.03	4.86 ±0.01	4.72 ±0.02	1.01 ±0.01	1.03 ±0.01	1.11 ±0.02	26.35 ±0.03	28.65 0.05	29.55 ±0.03

I= infested, UI= un- infested

Table no 3: Chemical properties of soil in Dilli Reserve Forest

Seasons		**Organic Carbon(%)**			**Available Nitrogen (kg h^{-1})**			**Available Phosphorus (kg h^{-1})**			**Exchangeable Potassium (kg h^{-1})**		
		0-15	**15-25**	**25-50**	**0-15**	**15-25**	**25-50**	**0-15**	**15-25**	**25-50**	**0-15**	**15-25**	**25-50**
Pre Monsoon	**I**	1.76 ±0.02	1.58 ±0.03	1.47 ±0.02	136.8 ±0.2	125.5 ±0.3	115.8 ±0.1	34.56 ±0.04	30.12 ±0.03	25.44 ±0.04	284.22 ±0.02	261.45 ±0.04	196.90 ±0.08
	UI	2.84 ±0.03	2.66 ±0.04	1.88 ±0.03	272.5 ±0.28	236.8 ±0.28	214.9 ±0.18	37.68 ±0.04.	27.22 ±0.03	22.15 ±0.02	298.38 ±0.04	270.03 ±0.02	242.29 ±0.04
Monsoon	**I**	1.41 ±0.03	1.26 ±0.02	1.08 ±0.02	114.8 ±0.58	109.2 ±0.16	104.8 ±0.17	25.32 ±0.02	20.65 ±0.05	18.72 ±0.04	229.6 ±0.28	216.5 ±0.4	208.01 ±0.01
	UI	2.38 ±0.03	1.37 ±0.01	1.22 ±0.03	249.8 ±0.32	228.6 ±0.20	214.5 ±0.16	36.15 ±0.02	25.48 ±0.05	20.64 ±0.04	238.7 ±0.12	224.61 ±0.03	214.14 ±0.04
Post Monsoon	**I**	1.98 ±0.03	1.65 ±0.02	1.34 ±0.01	245.4 ±0.16	220.7 ±0.24	211.5 ±0.20	15.42 ±0.04	14.55 ±0.03	12.49 ±0.04	189.5 ±0.12	164.2 ±0.32	125.9 ±0.28
	UI	2.56 ±0.02	2.27 ±0.02	1.62 ±0.02	260.0 ±0.24	226.2 ±0.2	220.8 ±0.2	21.40 ±0.09	20.59 ±0.02	18.64 ±0.04	284.3 ±0.12	236.5 ±0.2	218.2 ±0.24
Winter	**I**	1.32 ±0.02	1.24 ±0.03	1.15 ±0.01	109.4 ±0.36	104.8 ±0.12	100.2 ±0.47	12.88 ±0.03	10.59 ±0.03	9.85 ±0.03	158.6 ±0.12	136.5 ±0.08	118.5 ±0.2
	UI	2.26 ±0.02	2.08 ±0.03	1.86 ±0.04	235.2 ±0.73	146.5 ±0.24	115.8 ±0.16	18.65 ±0.01	16.42 ±0.02	14.55 ±0.02	168.4 ±0.16	148.8 ±0.16	122.6 ±0.02

I= infested, UI= un- infested

Highest amount of organic carbon was recorded in un-infested (2.84%±0.028) soil during pre monsoon season. Least value was found in infested soil (1.32% ±0.02) that may be due to the uptake by the fast growing *Mikania* species. Percentage of organic carbon was gradually decline in deeper layer during monsoon season owing to leaching by heavy rain. Maximum amount of available nitrogen was found in surface layer of un - infested site during pre monsoon season (272.5 kg h^{-1}). Invasion of *Mikania* reduced nitrogen content of soil gradually as of quick absorption [6]. Highest available phosphorus as well observed in un- infested soil during pre monsoon season (37.68 kg h^{-1} ± 0.04). Study revealed that the values of organic C, N and available phosphorus were high in un-infested forest as compared to *Mikania* invaded areas (Table-3). In *Mikania* infested forest potassium concentration was also less [7]. Invasion of weed species could alter the forest cover as well as soil structure [15] which was supported the present observation.

Correlation study of light interception, soil data with biomass accumulation revealed that *Mikania* biomass and interception of light by the canopy showed positive correlation. *Mikania* biomass and soil temperature also exhibited correlation but, statistically it is not significant (Table-4).

Table no 4 : Correlation of different parameters of Dilli Forest Reserve relevant to *Mikania* infestations

	ST	**LI**	**BIOMASS**	**SM**
ST	-	0.3582	0.71	0.5700
LI	0.3582	-	0.7769*	-0.0639
BIOMASS	0.7106	0.7769*	-	0.084
SM	0.5700	-0.0639	0.084	-

ST: Soil Temperature, LI: Light interception, SM: Soil Moisture

A driver species is responsible for fundamental alteration of ecosystem properties which is followed the alteration of the native community. *Mikania micrantha* is one of the most troublesome driver species. It has extreme capacity to enter the open forest edges of the natural forest vegetation and gradually altered the entire ecosystem functions as well as native vegetation. Thus, it makes a passage for invasion of other passenger species.

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