ISSN (Online): 2349-1183; ISSN (Print): 2349-9265
TROPICAL PLANT RESEARCH
The Journal of the Society for Tropical Plant Research
7(2): 460–471, 2020
DOI: 10.22271/tpr.2020.v7.i2.054

Research article

Floristic composition and natural regeneration status in Abhoypur reserve forest of Assam following *Mikania micrantha* Kunth. ex. H.B.K. invasion

Kuntala N. Barua* and Protul Hazarika

Forest Ecology & Climate Change Division, Rain Forest Research Institute, Jorhat-785010, Assam, India

*Corresponding Author: kuntalabarua@gmail.com

[Accepted: 13 August 2020]

Abstract: *Mikania micrantha* is a fast growing perennial vine of Asteraceae family, native to Central and South America. Recently the open sunny patches of Abhoypur Reserve Forest of Upper Assam was severely infested by this invasive species. The present study was undertaken to assess the impact of *M. micrantha* on vegetation pattern and natural regeneration of trees in Abhoypur reserve forest. Survey was carried out randomly lined quadrats of 10 m × 10 m, and 5 m × 5 m and 1 m × 1 m for tree, shrubs and herbs, respectively, in *Mikania* infested and un-infested forest areas. Study on floristic pattern has recorded a total of 417 plant species distributed within 321 genera and 102 families and Euphorbiaceae as the dominant family with16 species followed by Lauraceae (14 species). In herbaceous strata of infested site, *Mikania* attained dominating position with IVI of 99.53 during the full growth period and causing displacement of a number of native species. *Dipterocarpus retusus* was the dominant species with IVI 22.21 followed by *Artocarpus chama* (IVI 20.82), *Mesua ferrea* (IVI 14.62) in un-infested site, whereas, in *M. Micrantha* infested site the upper canopy was dominated by *Ficus hispida* (IVI 17.21), *Dysoxylum gotadhora* (IVI 9.52), *Macaranga peltata* (IVI 9.14). Diversity index were relatively high in un-infested sites for all tree, shrub and herb communities (4.45, 3.23 and 2.53). Altogether 140 tree species were regenerated during the study period, of which, 101 species in un-infested and 58 species in infested forest sites. Invasion of *Mikania* promotes the recruitment of some light demanding deciduous species such as *Alangium chinense*, *Bischofia javanica*, *Bombax ceiba*, *Mallotus ferrugineus*, *Balakata baccata* other than evergreen species. The 'none' regeneration and 'poor' regeneration group contributed 15.52% and 24.13%, respectively, that gradually created instability among the tree species which need attention.

Keywords: Phytosociology - Regeneration pattern - Trees - Abhoypur reserve forest - Assam.

[Cite as: Barua KN & Hazarika P (2020) Floristic composition and natural regeneration status in Abhoypur reserve forest of Assam following *Mikania micrantha* Kunth. ex. H.B.K. invasion. *Tropical Plant Research* 7(2): 460–471]

INTRODUCTION

Biodiversity is essential for the ecosystem function and stability (Singh 2002). The problem of invasive species is recognized around the world and it can cause severe disruption to both natural and managed ecosystems (Webb & Sah 2003). Convention on Biological Diversity emphasized on the invasion of alien species which is considered as the second worst threat for biodiversity. Alien invasive species are successful colonizers of disturbances, are capable to form monocultures and thereby compete aggressively with the native species (Mack *et al*. 2000, Martin *et al*. 2003). *Mikania micrantha* Kunth. ex. H.B.K. is a very fast growing perennial vine of Asteraceae family, native to Central and South America, placed among the 10 worst exotic species in South and South East Asia (Lowe *et al.* 2000). It is already established that high ecosystem disturbance and structural modification of the locations promoted invasion of *Mikania*. On the other hand, natural regeneration is the only processes for recovering the forest vegetation after any disturbance. In forest ecosystem, tree seedling regeneration is affected by the gap created or ceased by invasion of weed which in turn,

Received: 04 April 2020 Published online: 31 August 2020
https://doi.org/10.22271/tpr.2020.v7.i2.054

determined the phytodiversity. As *Mikania* infestation has created severe menace to the forest ecosystem of Assam, a study was undertaken to evaluate the changes of floristic composition and natural regeneration status of tree seedlings due to infestation of *Mikania Micrantha* in Abhoypur reserve forest of upper Assam.

MATERIALS AND METHODS

Study area

Abhoypur reserve forest is a semi evergreen type of forest, positioned in the foothills of the Patkai range, is a part of the Assam Valley Tropical Wet Evergreen Forest under the Eastern Himalayan biogeographic zone (Fig. 1 & 2). It is located in south–east direction of Charaideo district between 26° 56' 31″ to 26° 60' 25″ N latitude and 94° 00' 0.2″ to 95° 03' 21.7″ E longitude and having elevation of 60–463 m from mean sea level. The forest

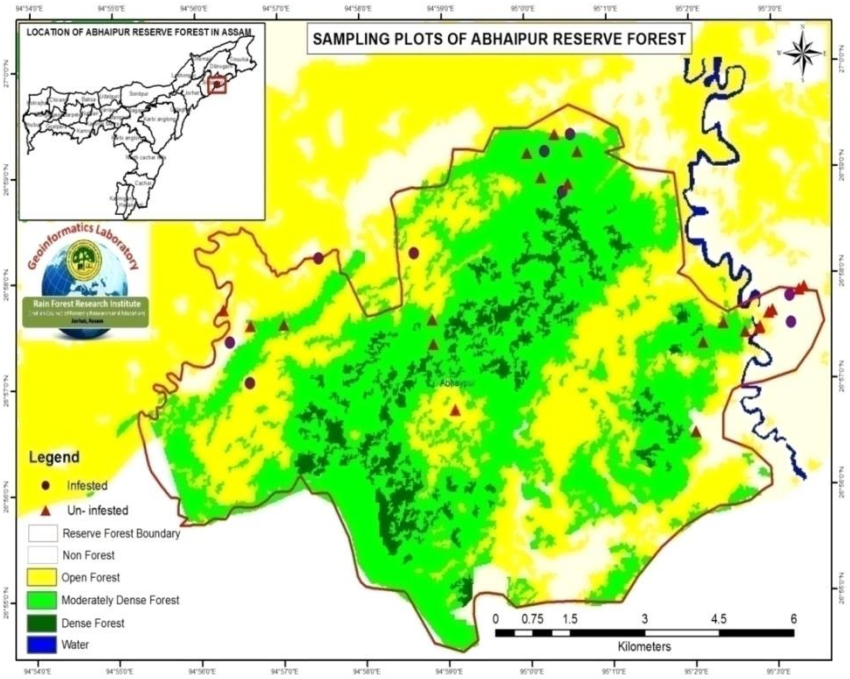

Figure 1. Map of Abhoypur reserve forest showing the sampling plots during 2014–18.

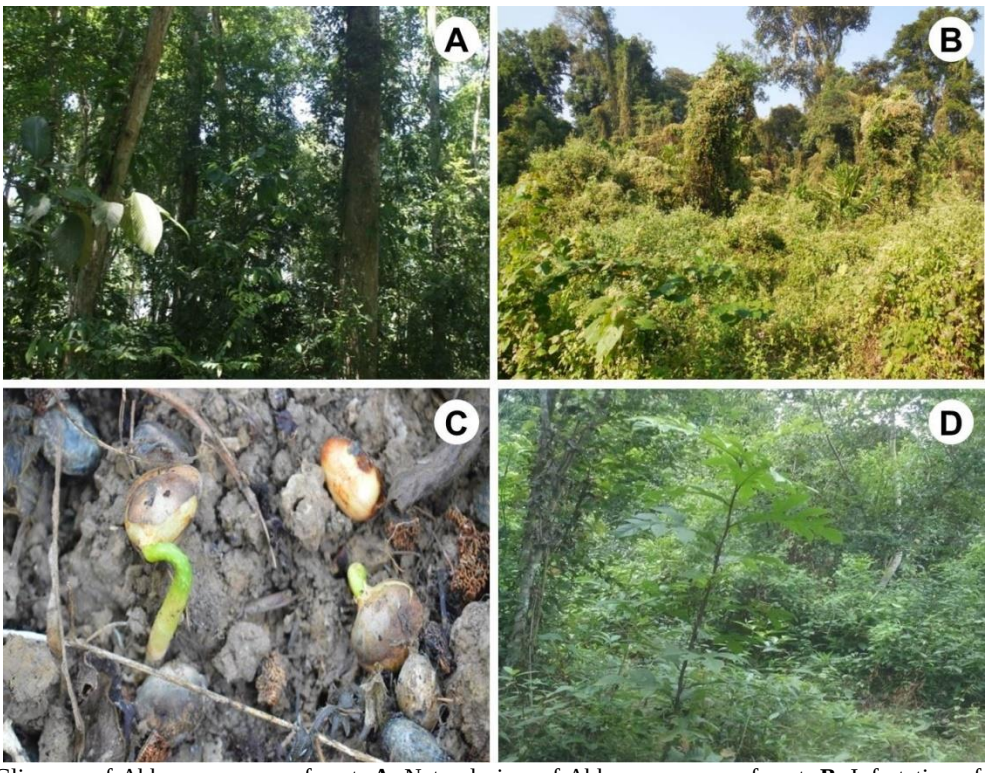

Figure 2. Glimpses of Abhoypur reserve forest: **A**, Natural view of Abhoypur reserve forest; **B**, Infestation of *Mikania* in Abhoypur reserve forest; **C**, Germination of *Gynocordia odorata* R.Br.- A highly valued medicinal plant; **D**, *Artocarpus chama* Buch.-Ham.

comprised an area of 6737.98 hectares of land and formed a contiguous belt with forests of Nagaland state. The climate is distinguished as humid sub-tropical monsoon type. Rainy season lasts from May to September with average annual rainfall of 1700 mm. Average maximum summer temperature varied from 27.3ºC to 41ºC and winter temperature from 5.6ºC to 24.8ºC. July was the hottest month and January was the coldest month. Average relative humidity during the study period was 84.92%. The rise of Himalayas, up liftmen of Patkai Range and formation of Assam valley attributed to its geology. Soil in the tract was found to be of rich loamy alluvial formation with silt and clay in the foothills of Nagaland, acidic in nature having pH 4.18 to 4.65.

Methodology

Survey was carried out during 2014–2018 for floristic enumeration and regeneration study. The Forests were divided into two sites based on *Mikania Micrantha* infestation as *Un-infested* site and *Infested* site. Survey was carried out by randomly laied 25 quadrats of 10 m × 10 m for trees, 100 quadrats of 5 m × 5 m for shrubs/saplings and 125 quadrats of 1 m × 1 m for herbs/seedlings in each site. Quantitative analysis for density, frequency and basal area of vegetation were calculated following Misra (1968). Site comparison for vegetation structure was done by using Shannon & Weaver (1963) diversity index (H′) and Simpson (1949) index of dominance. Species richness is the total number of species in a community that is measured by Margalef Index (Margalef 1958). Similarity co-efficient for common and rare species were calculated by following Sorenson and Jaccard's co-efficient (Magurran 1988). Regeneration of species was determined based on population size of young ones (saplings) and mature trees (Uma Shankar 2001). Individual having ≥30cm girth (gbh) were considered as adult, sapling with ≥10 cm to≤30 cm girth and seedling with <10 cm girth for regeneration study. The adopted characters and designations for regeneration status have been shown in table 1.

Table 1. Characters and designations for regeneration status.

Characterization	Designation
seedling> or < sapling> adult	'good'
seedling > or ≥ sapling ≤ adults	'fair'
a species survive only in sapling stage, but no seedling (sapling may be <, > or= adult)	'poor'
Species is present only in adult form	'none'
Species has no adult, but only young one	'new'

Identification of plant species was done with the help of local floras (Kanjilal *et al.* 1934–40, Hooker 1872–1897, Chowdhury 2005), by consulting herbaria of 'ASSAM', Botanical Survey of India, Eastern Regional Centre, Shillong, and Central National Herbarium (CNH), Kolkata. Nomenclature of the species was confirmed with the help The Plant List database (http://www.theplantlist.org/).

RESULTS AND DISCUSSION

Study on floristic pattern of the Abhoypur reserve forest showed that a total of 417 plant species found distributed within 321 genera and 102 families belonging to phanerogams and higher cryptogams. Out of these, trees comprised 44 families comprising of 105 genera of 140 species. Euphorbiaceae was the dominant family having 16 species followed by Lauraceae (14 species) and Meliaceae (12 species). Shrubs were comprised of 76 species belonging to 58 genera under 39 families. In herbaceous group, 201 species were recorded in the study area belonging to 158 genera under 63 families. Study revealed that *Dipterocarpus retusus* Blume was the most dominant species (IVI 22.21) followed by *Artocarpus chama* Buch.-Ham. (IVI 20.82), *Mesua ferrea* L. (IVI 14.62), *Magnolia hodgsonii* Hook.f. & Th. (IVI 6.37), *Canarium resiniferum* Bruce ex King (IVI 5.76) amongst the trees of un-infested forest site. Structural composition and community association of Nambor Wild Life Sanctuary, Assam also showed that *Artocarpus chama*, *Mesua ferrea* and *Morus laevigata* were predominant in moist semi evergreen forest which was floristically allied with studied Abhoypur reserve forest (Barua *et al.* 2018a). Saplings of *Dipterocarpus retusus* exhibited maximum density in the shrub strata along with other tree saplings like *Baccauria ramiflora* Lour., *Altingia excelsa* Noronha, *Mesua ferrea*. Tree fern species *Angiopteris assamica* de Vriese (IVI 19.27) and *Blechnum orientale* L. (16.21) were found dominant in shrub layer. Phytosociological study in herbaceous taxa revealed that *Amischotolype hookeri* (Ridl.) I.M. Turner, *Oplismenus burmanii* Beauv., *Phrynium pubinerve* Blume., *Selaginella biformis* A. Br. ex Kuhn were observed as primary element in the humid forest floor intermingled with highly populated seedlings of *Mesua ferrea*, *Terminalia bellirica* (Gaertn.) Roxb. and *Vatica lancaefolia* (Roxb.) Bl. Whereas, in *Mikania Micrantha* infested site the upper canopy was dominated by *Ficus hispida* Vahl. (IVI 17.21), *Dysoxylum gotadhora* Mabb (IVI 9.52), *Macaranga peltata* Muel-Arg. (IVI 9.14), *Alangium chinense* (Lour.) Harms (IVI 8.15) and *Balakata*

baccata (Roxb.) Esser (IVI 7.75) (Fig. 3). Saplings of *Dysoxylum binectariferum* (Roxb.) Hook.f, *Macaranga peltata*, *Dillenia indica* L., *Balakata baccata* and some straggler species *viz.*, *Croton caudatus* Geiseler (IVI 27.78), *Combretum acuminatum* Roxb. (IVI 23.70), *Caesalpinia bonduc* (L.) Roxb. (IVI 18.09) were habitually distributed in shrub layer. In infested forest site, *Mikania micrantha* expressed the highest dominance in the herbaceous strata (IVI 99.53) (Fig. 3).

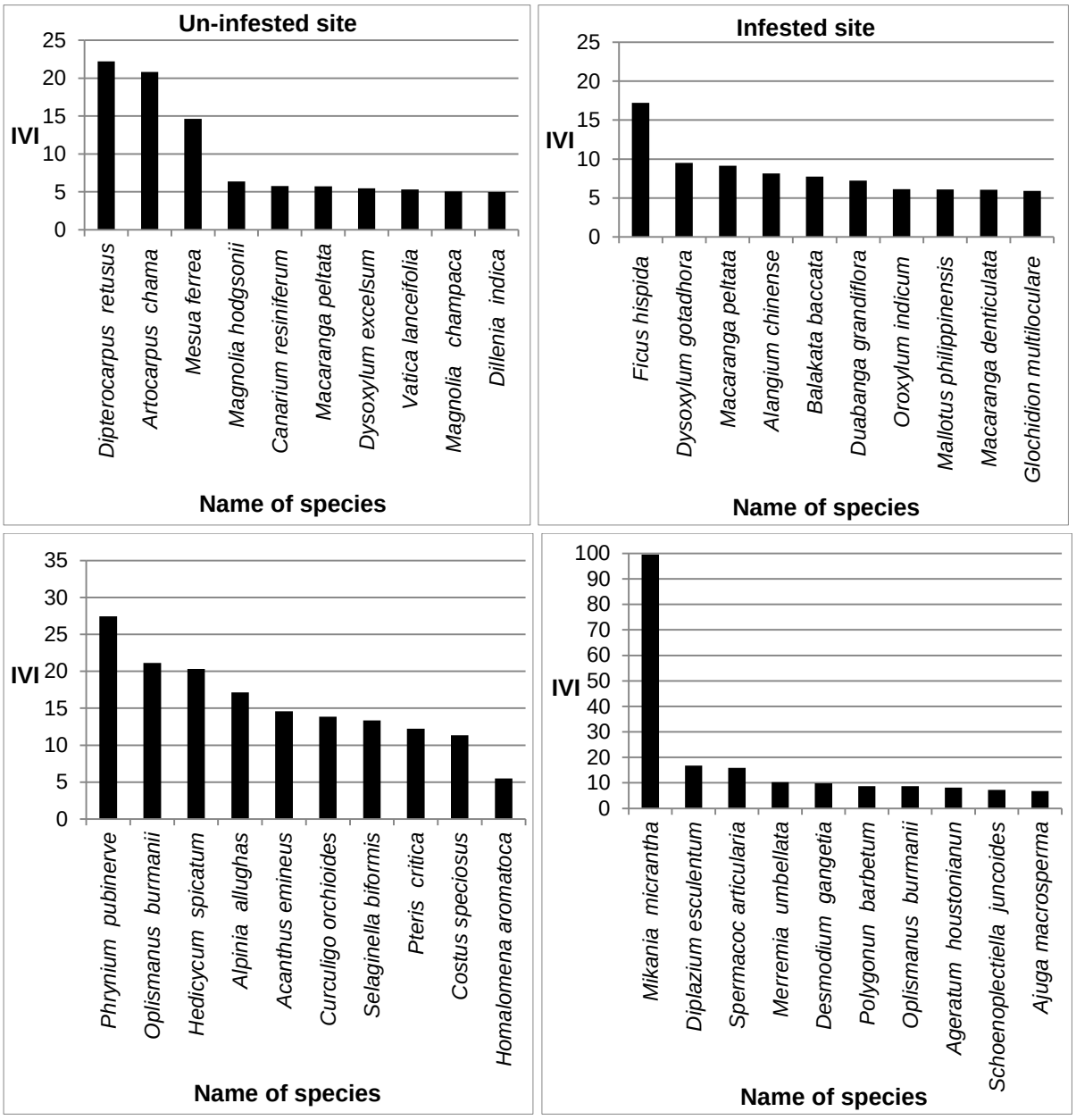

Figure 3. Importance Value Index of top ten Tree and herb species of Abhoypur reserve forest during 2014–18.

Study of diversity patterns in the *Mikania* infested and un-infested forest sites revealed that the values of species diversity index were relatively high in un-infested sites for all tree, shrub and herb communities. Tree diversity of un-infested forest sites exhibited the maximum value (4.45), otherwise in infested site it was 4.17. Index of dominance showed the opposite trend of diversity. According to an observation of Knight (1975), the species diversity Index varied from 5.06–5.40 in tropical forests. The studied forest belonged to Tropical Wet Evergreen Forest and present value of diversity index was found between this ranges. Higher dominance value was recorded in herbaceous communities of infested site (0.33). Margalef's Index of Richness was the maximum in un-infested forest sites for tree communities. However, no significant difference was found in the evenness index between infested and un-infested forest sites (Table 2).

Paired comparisons using binary similarity coefficients are shown in table 3. The measurement of Sorenson's similairity co-efficient was higher than Jaccard's co-efficient (0.3085 and 0.1824, respectively). Only 44.62% similarity was recorded between the infested and un-infested forest sites.

Table 2. Changes in different indices of Abhoypur Reserve Forest due to Mikania-infestation during 2014–18.

Index	Type of Forest	Tree	Shrub	Herb
Species Diversity	Infested	4.17	2.96	1.752
Index (H′)	Un-infested	4.45	3.23	2.53
Dominance	Infested	0.01	0.017	0.33
	Un-infested	0.01	0.043	0.07
Margalef Index	Infested	12.40	12.36	5.54
	Un-infested	19.80	8.82	7.79
Eveness Index	Infested	0.99	0.94	0.67
	Un-infested	0.93	0.94	0.44

Table 3. Similarity co-efficient of Abhoypur Reserve Forest between *Mikania* infested (I) and un-infested (UN) sites during 2014-18.

Similarity Index	UN-I
Sorenson co-efficient (Ss)	0.3085
Jaccard's co-efficient (Sj)	0.1824
Motyka's index	44.6200

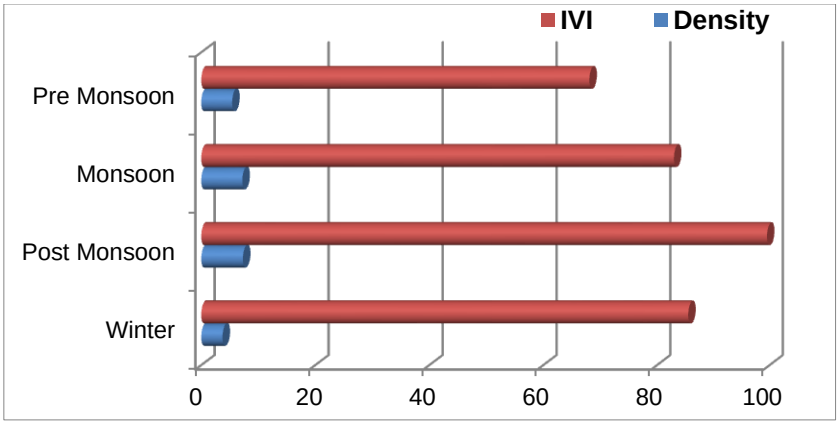

Figure 4. Changes of population density m^{-2} and IVI of *Mikania micrantha* Kunth. ex. H.B.K. in Different Seasons.

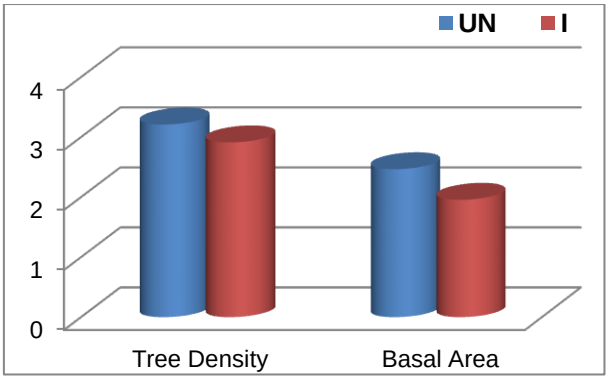

Figure 5. Changes of tree density (No. ha^{-1}) and Basal area (m^2 ha^{-1}) forest (log transformed).

Comparative study on population density of *Mikania micrantha* in different season revealed that highest density of *Mikania* is recorded in Monsoon and post monsoon seasons. During winter after fruit setting the plant gradually dries up and population declines up to pre monsoon season (Fig. 4). Variation of tree density and basal areas of *Mikania* infested and un-infested forest sites were quite prominent (Fig. 5). Anthropogenic disturbances and exotic invasion leads the forest edges and canopy opening areas of the forest towards denuded one.

Population density of trees is mainly depending upon the response of the germination and establishment of seedlings to the prevailing microenvironment. Study on regeneration status of Abhoypur reserve forest observed that altogether 140 tree species naturally regenerate in the forest site (Appendix I). In *Mikania* un-infested forest area a total of 101 species were regenerated; 69.31% tree species exhibited 'good' regeneration and only 2.97% showed 'fair' regeneration category. Absence of young ones in the species belonging to 'poor' regeneration status occupied 13.86%, whereas, 18.81% species were found under 'none' regenerating category. It is noteworthy that the genus *Magnolia* occupied a dominant position in the forest along with *Dipterocarpus*

retusus, *Artocarpus chama* and *Mesua ferrea* in the study site, however, .Among them *Magnolia baillonii* Pierre and *M. nilgirica* (Zenker) Figlar were not seen in the sapling and seedling stage though their adult populations were recorded in *Mikania* un-infested areas. In contrary, species like *Cinnamomum glaucescens* Hand-Mazz., *Sapindus rarak* DC., *Symplocos glauca* (Thunb.) Koidz and *Vitex paniculata* Lam. were the 'new 'arrivals in the site. The highest seedling tree ratio was observed in *Cinnamomum bejolghota* (Buch-Ham) Sweet. but, in sapling stage its establishment was not so good. *Gynocordia odorata* R. Br., a highly medicinal valued plant, exhibited very good regeneration. *Litsea monopetala* Pers., *Elaeocarpus sikkimensis* Mast., *Bischofia javanica* Bl. and *Macaranga denticulata* (Bl.) Muel. Arg revealed highest sprouting state with a lot of saplings. A critically endangered species *Mangifera sylvatica* Roxb. was sparsely distributed in the forest but not observed in seedling stage. The percentage of regeneration ratio of evergreen and deciduous species maintained 54% & 46%, respectively.

Regeneration status of *Mikania* infested forest sites showed that all total 58 species were regenerated naturally and only three species were found as new arrival *viz. Casearia tomentosa* Roxb., *Sapindus rarak* and *Toona ciliata* Roem. *Mikania* appeared as monotypic strand in surrounding areas, forest road side and open canopy sites, where the regeneration percentage was less. The 'none' regeneration and 'poor' regeneration group contributed 15.52% and 24.13% respectively, that gradually created instability of the tree species. Only single species *Kydia calycina* Roxb. showed 'fair' regeneration. Absence of young individuals in most of the species in the disturbed sites indicated anthropogenic disturbance as well as biological invasion of exotic weeds. Differences of seedlings and saplings population might indicate divergence of disturbances amid the forests. Webb & Sah (2003) stated that a small opening in the canopy leads higher light penetration in the forest floor which promotes the recruitment of some light demanding species. Present study also observed that some of the species *viz*. *Alangium chinense*, *Balakata baccata*, *Bischofia javanica*, *Bombax ceiba* Burm., *Macaranga paltata* Muel-Arg., *Mallotus ferrugineus* (Roxb) Muel. Arg., *Terminalia myriocarpa* Van Heurck & Müll. Arg. were found to flourish in *Mikania* infested area .along with these species *Lagerstroemia speciosa* (L.) Pers. and *Glochidion ellipticum* Wight showed maximum seedling tree ratio. The regeneration percent ratio of evergreen and deciduous species in the site was 39% & 61%, respectively (Fig. 6). Barua *et al*.(2018b) studied the impact of *Mikania micrantha* in Dilli reserve forest of Assam revealed that smothering effect of the fast growing vine have severe impact in regeneration and seedling establishment of indigenous tree species mainly in periphery and open canopy areas. Present study showed that invasion of *Mikania* promotes the recruitment of some light demanding deciduous species other than evergreen species. Baruah *et al*. (2018c) also recorded soil fertility status associated with *Mikania micrantha* infestation in Abhoypur and Dilli reserve forest of Assam and clearly stated that the invasion of *Mikania* reduced the soil nutrient component of the forests. Earlier Palit (1981) reported the flourishing growth of *Mikania* all over North Bengal which were successfully established in the sanctuaries like Jaldapara, Gorumara etc. and creating shortage of natural fodder for the herbivores. *Mikania micrantha* also established faster in Western Ghats and spread at alarming rates (Saravanane & Nanjappa 2003). In the forest of upper Assam *Mikania micrantha* was observed as a growing threat too.

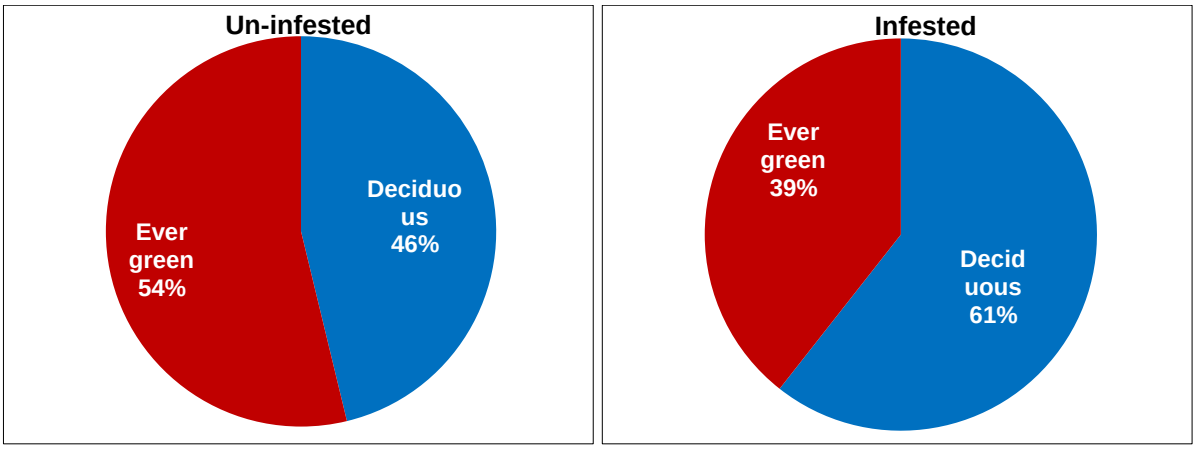

Figure 6. Regeneration percent ratio of evergreen and deciduous species in ghe study site.

Study on regeneration status of Abhoypur reserve forest of upper Assam showed alteration of evergreen patches to deciduous nature due to severe infestation of *Mikania micrantha* by displacing several autochthonous species. The initial micro environment for natural regeneration of tree seedlings might be repressed by

infestation of *Mikania* resulting in gradual changes the scenario of the vegetation component, as depicted by the differences recorded between *Mikania* infested and un-infested sites during the present study.

ACKNOWLEDGEMENTS

The authors would like to thank the Director, Rain Forest Research Institute, Jorhat for his kind guidance and support. Authors are also grateful to the State Forest Department of Assam especially the Divisional Forest Officer, Sivasagar, and his office for rendering active co-operation.

REFERENCES

Baruah A, Bora IP & Barua Kuntala N (2018a) Seasonal fluctuation of soil fertility status associated with *Mikania micrantha* HBK. infestation in Abhoypur and Dilli Reserve Forest of Assam, India. *Research Journal of Agriculture and Forestry Science* 6(10): 1–5.

Barua KN, Hazarika P & Hazarika PK (2018b) Forest tends transformation in the course of invasion of *Mikania micrantha* Kunth ex HBK. in Dilli Reserve Forest of Assam - emphasis on vegetation characters. *International Journal of Current Microbiology and Applied Sciences* 7(9):1478–1487.

Barua KN, Gogoi G & Hazarika P (2018c) Comparative study on Structure composition and community association of Nambor Wild Life Sanctuary and its southwest ward extended Bornewria forest, Assam, India. *Tropical Plant Research* 5(2): 233–242.

Chowdhury S (2005) *Assam Flora (Present Status of Vascular Plants)*. Assam Science Technology and Environment Council, Guwahati.

Hooker JD (1872–1897) *Flora of British India (Vol. I–VII)*. Reeves & Co., London.

Kanjilal UN, Kanjilal PC, De RN & Das A (1934–40) *Flora of Assam (Vol. 1–4)*. Govt. of Assam. Shillong.

Knight DH (1975) A phytosociological analysis of species rich tropical forest on Barro-Colorado Island: Panama. *Ecological Monograph* 45: 259–289.

Lowe S, Browne M, Boudjelas S & de Poorter M (2000) *100 of the World's Worst Invasive Alien Species: A Selection from the Global Invasive Species Database*. The Invasive Species Specialist Group, Auckland.

Mack RN, Simberloff D, Mark Lonsdale, Wevans H, Clout M & Bazzaz FA (2000) Biotic invasions: Causes, epidemiology, global consequences, and control. *Ecological Applications* 10: 689–710.

Magurran AE (1988) *Ecological Diversity and Its Measurement*. CroomHelm, London, United Kingdom, 179 p.

Margalef R (1958) Information Theory in Ecology. *General Systems* 3: 36–71.

Martin PH, Peter LM & Charles DC (2003) Norway maple invasion of forest stands: 4-years of seedling establishment and demography in small gaps and deep shade. In: 7th International Conference on "*The Ecology and Management of Alien Plant Invasions"*. 3rd–7th Nov.2003, Wyndham Bonaventure Resort, Ft. Lauderdale, Florida, pp. 56.

Misra R (1968) *Ecology Work Book*. Oxford and IBH Publishing Company, Calcutta.

Palit S (1981) *Mikania* - a growing menace in plantation forestry in West Bengal. *Indian Forester* 107: 97–107.

Saravanane P & Nanjappa HV (2003) *Mikania micrantha* HBK - a growing menace in Western Ghats. In: National Seminar on Alien Invasive Weeds in India. Assam Agricultural University, Jorhat, Assam in association with National Research Centre for Weed Science, Jabalpur (M.P.), p. 61.

Shannon CE & Weaver W (1963) *The Mathematical Theory of Communication*. University of Illinois Press.

Simpson EM (1949) Measurement of diversity. *Nature* 163: 688.

Singh SP (2002) Balancing the approaches of environmental conservation by considering ecosystem services as well as biodiversity. *Current Science* 82: 1331–1335.

Uma Shankar (2001) A case of high tree diversity in a Sal (*Shorea robusta*) dominated low land forest of eastern Himalaya: Floristic composition, regeneration and conservation. . *Current Science* 81(7): 776–805.

Webb EL & Sah RN (2003) Structure and diversity of natural and manage Sal (*Shorea robusta* Gaertn.f.) forest in the Terai of Nepal. *Forest Ecology and Management* 176: 337–353.

Supporting information

Appendix I: Regeneration status of tree species in Abhoypur reserve forest during 2014–18.

Appendix I: Regeneration status of tree species in Abhoypur reserve forest during 2014–18.

S.N.	Name of the species	Un-infested						Infested					
		Tree	Sapling	Seedling	Sapling: Tree	Seedling: Tree	Status	Tree	Sapling	Seedling	Sapling: Tree	Seedling: Tree	Status
1	*Actinodaphne gullavara* Almaida	0.12	0.36	10	3.00	83.33	Good	-	-	-			-
2	*Actinodaphne obovata* (Nees) Blume	0.24	0.4	4	1.67	16.67	Good	0.08	0.32	5	4.00	62.50	Good
3	*Aesculus assamica* Griff.	0.08	NS	NS			None	-	-	-			-
4	*Aglaia spectabilis* Jain & Bennet	0.08	0.64	10	8.00	125.00	Good	-	-	-			-
5	*Ailanthus integrifolia* Lam.	0.04	1.68	10	42.00	250.00	Good	-	-	-			-
6	*Alangium chinense* (Lour.) Harms	0.08	0.28	NS	3.50		Poor	0.24	0.28	16	1.17	66.67	Good
7	*Albizia lucidior* (Steud.) I.C.Nielsen	-	-	-			-	0.12	0.24	15	2.00	125.00	Good
8	*Albizzia procera* Benth.	-	-	-			-	0.12	0.36	20	3.00	166.67	Good
9	*Alstonia scholaris* (L.) R. Br.	0.08	0.64	30	8.00	375.00	Good	0.16	0.2	15	1.25	93.75	Good
10	*Altingia excelsa* Noronha	0.12	1.68	20	14.00	166.67	Good	-	-	-			-
11	*Amoora cucullata* Roxb.	0.2	0.8	10	4.00	50.00	Good	-	-	-			-
12	*Antidesma bunius* (L.) Spreng.	0.08	0.64	20	8.00	250.00	Good	0.12	0.96	2	8.00	16.67	Good
13	*Aporosa wallichii* Hook.f.	0.12	0.32	20	2.67	166.67	Good	0.12	0.16	2	1.33	16.67	Good
14	*Aquilaria malaccensis* Lam.	0.08	0.08	NS	1.00		Fair	-	-	-			-
15	*Artocarpus chama* Buch.-Ham.	0.72	1.12	10	1.56	13.89	Good	0.16	0.24	6	1.50	37.50	Good
16	*Artocarpus lacucha* Buch.-Ham.	0.12	0.12	NS	1.00		Fair	-	-	-			-
17	*Aesculus assamica* Griff.	-	-	-			-	0.04	NS	NS			None
18	*Baccaurea ramiflora* Lour.	0.12	2	10	16.67	83.33	Good	0.16	0.24	16	1.50	100.00	Good
19	*Bischofia javanica* Blume	0.04	0.16	20	4.00	500.00	Good	0.08	0.32	9	4.00	112.50	Good
20	*Bombax ceiba* L.	-	-	-			-	0.12	0.2	NS	1.67		Poor
21	*Bridelia assamica* Hook.f.	0.08	NS	NS			None	-	-	-			-
22	*Casearia tomentosa* Roxb.	0.08	0.16	5	2.00	62.50	Good	NS	NS	4			New
23	*Callicarpa arborea* Roxb.	0.08	0.24	NS	3.00		Poor	0.16	0.04	NS	0.25		Poor
24	*Canarium resiniferum* Bruce ex King	0.36	0.32	10	0.89	27.78	Good	-	-	-			-
25	*Castanopsis armata* (Roxb.) Spach	0.08	0.48	10	6.00	125.00	Good	0.08	NS	NS			None

26	*Castanopsis hystrix* Hook. f. & Thomson ex A. DC.	0.08	0.16	10	2.00	125.00	Good	-	-	-			-
27	*Castanopsis indica* (Roxb. ex Lindl.) A.DC.	0.16	1.08	10	6.75	62.50	Good	0.12	0.72	7	6.00	58.33	Good
28	*Catunaregam spinosa* Tirveng.	0.08	0.48	4	6.00	50.00	Good	0.12	0.96	2	8.00	16.67	Good
29	*Chukrasia tabularis* A.Juss.	0.04	0.36	10	9.00	250.00	Good	0.16	0.12	4	0.75	25.00	Good
30	*Cinnamomum bejolghota* Sweet	0.04	0.36	40	9.00	1000.00	Good	0.12	0.28	6	2.33	50.00	Good
31	*Cinnamomum glanduliferum* (Wall.) Meisn.	0.08	0.28	20	3.50	250.00	Good	-	-	-			-
32	*Cinnamomum glaucescens* (Nees) Hand.-Mazz.	NS	NS	20			New	-	-	-			-
33	*Cordia myxa* L.	0.12	0.32	NS	2.67		Poor	0.04	NS	NS			None
34	*Croton persimilis* Müll. Arg.	0.08	0.16	20	2.00	250.00	Good	0.12	0.16	2	1.33	16.67	Good
35	*Dillenia indica* L.	0.2	0.64	20	3.20	100.00	Good	0.08	1.28	20	16.00	250.00	Good
36	*Dillenia pentagyna* Roxb.	0.04	NS	NS			None	-	-	-			-
37	*Dipterocarpu sretusus* Blume	1.84	3.68	40	2.00	21.74	Good	0.08	0.2	NS	2.50		Poor
38	*Drimycarpu sracemosus* Hook. f.	0.04	0.4	NS	10.00		Poor						
39	*Duabanga grandiflora* (DC.) Walp.	0.04	NS	NS			None	0.16	NS	6		37.50	Poor
40	*Dysoxylum gotadhora* Mabb.	0.04	1.24	10	31.00	250.00	Good	0.32	1.28	16	4.00	50.00	Good
41	*Dysoxylum excelsum* Blume	0.4	0.24	20	0.60	50.00	Good	0.08	0.24	16	3.00	200.00	Good
42	*Dysoxylum grande* Hiern.	0.04	0.28	10	7.00	250.00	Good	-	-	-			-
43	*Ehretia acunimata* R. Br.	0.04	0.32	10	8.00	250.00	Good	0.08	0.48	8	6.00	100.00	Good
45	*Elaeocarpus floribundus* Blume	0.04	0.16	10	4.00	250.00	Good	0.16	0.12	NS	0.75		Poor
46	*Elaeocarpus sphaericus* (Gaertn.) K.Schum.	0.04	NS	NS			None	-	-	-			-
47	*Elaeocarpus sikkimensis* Mast.	0.04	0.36	20	9.00	500.00	Good	-	-	-			-
48	*Elaeocarpus stapfianus* (Gaertn.) K. Schumann	0.04	0.12	10	3.00	250.00	Good	-	-	-			-
49	*Elaeocarpus tectorius* (Lour.) Poir.	0.04	0.2	10	5.00	250.00	Good	-	-	-			-
50	*Endospermum chinense* Benth.	0.12	NS	NS			None	-	-	-			-
51	*Evodea meliaefolia* Banth.	0.04	NS	NS			None	-	-	-			-
52	*Eurya japonica* Thunb.	0.04	0.8	10	20.00	250.00	Good	0.08	0.08	2	1.00	25.00	Good
54	*Ficus benghalensis* L.	0.04	NS	NS			None	0.12	0.2	2	1.67	16.67	Good
55	*Ficus hirta* Vahl.	0.04	0.2	10	5.00	250.00	Good	-	-	-			-

56	*Ficus hispida* Vahl.	0.08	0.32	20	4.00	250.00	Good	0.32	0.8	14	2.50	43.75	Good
57	*Ficus rumphii* Blume	0.04	NS	NS			None	-	-	-			-
58	*Flueggea virosa* Royle	0.08	1.2	10	15.00	125.00	Good	0.2	0.08	NS	0.40		Poor
59	*Garcinia cowa* Roxb. ex DC.	0.04	0.2	NS	5.00		Poor	-	-	-			-
60	*Garcinia keydia* Roxb.	0.04	0.16	4	4.00	100.00	Good	-	-	-			-
61	*Garcinia pedunculata* Roxb. ex Buch.-Ham.	0.04	0.04	NS	1.00		Fair	-	-	-			-
62	*Garcinia spicata* (Wight & Arn.) Hook.f.	0.04	NS	NS			Poor	-	-	-			-
63	*Garcinia xanthochymus* Hook.f.	0.2	0.04	30	0.20	150.00	Good	-	-	-			-
64	*Garuga pinnata* Roxb.	0.04	NS	NS			None	-	-	-			-
65	*Glochidion ellipticum* Wight.	0.08	0.32	20	4.00	250.00	Good	0.04	0.64	6	16.00	150.00	Good
66	*Glochidion multiloculare* Rottler ex Willd.) Voigt	0.08	0.44	10	5.50	125.00	Good	0.12	NS	NS			None
67	*Gmelina arborea* Roxb.	0.04	NS	NS			None	0.08	NS	NS			None
68	*Gynocordia odorata* R. Br.	0.04	0.4	10	10.00	250.00	Good	0.08	NS	NS			None
69	*Haldinia cordifolia* (Roxb.) Radsdale	0.08	0.2	5	2.50	62.50	Good	-	-	-			-
70	*Horsfieldia amygdalina* Warb.	0.04	NS	NS			None	-	-	-			-
71	*Hydnocarpus kurzii* (King) Warb.	0.08	0.36	10	4.50	125.00	Good	0.12	0.2	NS	1.67		Poor
72	*Ilex godhajam* Colebr ex Hook. f.	-	-	-			-	0.08	0.08	4	1.00	50.00	Good
73	*Kydia calycina* Roxb.	0.16	0.16	20	1.00	125.00	Good	0.08	0.08	NS	1.00		Fair
74	*Lagerstroemia speciosa* (L.) Pers.	0.04	1.08	20	27.00	500.00	Good	0.12	0.68	20	5.67	166.67	Good
75	*Lannea cormondalica* (Hautt.) Merr.	0.04	0.32	NS	8.00		Poor	-	-	-			-
76	*Litsea laeta* (Wall ex Nees) Hook. f.	0.04	0.44	10	11.00	250.00	Good	0.12	0.2	NS	1.67		Poor
77	*Litsea monopetala* (Roxb.) Pers.	0.04	0.28	20	7.00	500.00	Good	0.16	0.2	5	1.25	31.25	Good
78	*Macaranga dentiulata* Muell. Arg.	0.08	0.6	30	7.50	375.00	Good	0.16	0.2	2	1.25	12.50	Good
79	*Macaranga paltata* Muel-Arg.	0.08	0.28	4	3.50	50.00	Good	1	12	6.25	75.00	1	Good
80	*Maclura cochinchinensis* Corner	0.04	0.6	20	15.00	500.00	Good	-	-	-			-
82	*Magnolia baillonii* Pierre	0.04	NS	NS			None	-	-	-			-
83	*Magnolia champaca* (L.) Baill. ex Pierre	0.2	0.32	NS	1.60		Poor	-	-	-			-
84	*Magnolia griffithii* Hook. f. & Th.	0.04	0.8	10	20.00	250.00	Good	-	-	-			-
85	*Magnolia gustavi* King.	0.08	0.2	NS	2.50		Poor	-	-	-			-
86	*Magnolia hodgsonii* Hook.f. & Th.	0.32	1.24	10	3.88	31.25	Good	-	-	-			-

87	*Magnolia hookeri* Raju & Nayar	0.08	0.2	5	2.50	62.50	Good	-	-	-			-
88	*Magnolia insignis* Wall.	0.2	0.36	20	1.80	100.00	Good	-	-	-			-
89	*Magnolia montana* (Blume) Figlar	0.12	0.2	5	1.67	41.67	Good	-	-	-			-
90	*Magnolia mannii* (King) Figlar	0.16	0.24	10	1.50	62.50	Good	-	-	-			-
92	*Magnolia nilgirica* (Zenker) Figlar	0.08	NS	NS			None	-	-	-			-
93	*Magnolia pterocarpa* Roxb.	0.04	0.2	5	5.00	125.00	Good	-	-	-			-
94	*Mallotus tetracoccus* (Roxb.) Kurz	0.04	NS	NS			None	0.2	0.92	11	4.60	55.00	Good
95	*Mallotus philippinensis* Muell. Arg.	-	-	-			-	0.16	0.24	6	1.50	37.50	Good
96	*Mangiferasylvatica* Roxb.	0.04	0.52	NS	13.00		Poor	-	-	-			-
97	*Mansonia dipikae* Purkayastha	0.24	0.8	20	3.33	83.33	Good	-	-	-			-
98	*Mesua ferrea* L.	0.52	2.24	60	4.31	115.38	Good	0.16	0.24	2	1.50	12.50	Good
99	*Meyna spinosa* Roxb. ex Link	0.04	0.32	NS	8.00		Poor	-	-	-			-
100	*Micromelum minutum* Wight & Arn.	0.08	0.44	20	5.50	250.00	Good	0.04	0.16	2	4.00	50.00	Good
101	*Morinda augustifolia* Roxb.	0.12	0.24	10	2.00	83.33	Good	-	-	-			-
102	*Morus macroura* Miq.	0.12	0.04	NS	0.33		None	-	-	-			-
103	*Neolamarckia cadamba* Bosser.	-	-	-			-	0.08	0.12	NS	1.50		Poor
104	*Nyssa javanica* (Blume) Wangerin	0.04	0.16	NS	4.00		Poor	0.08	0.48	2	6.00	25.00	Good
105	*Oroxylumindicum* (L.) Kurz.	-	-	-			-	0.12	0.2	4	1.67	33.33	Good
106	*Ostodespaniculata* Bl.	0.2	0.6	10	3.00	50.00	Good						
107	*Premna benghalensis* Cl.	-	-	-			-	0.16	0.08	3	0.50	18.75	Good
108	*Pterospermum acerifolium* Willd.	0.08	0.6	10	7.50	125.00	Good	-	-	-			-
109	*Pterospermum lanceaefolium* Roxb.	0.04	NS	NS			None	-	-	-			-
110	*Rhus succedanea* L.	0.04	1	4	25.00	100.00	Good	0.08	NS	NS			None
111	*Sapindus mukorossii* Gaertn.	0.08	0.56	40	7.00	500.00	Good	NS	NS	7			New
112	*Sapindus rarak* DC.	NS	NS	10			New						
113	*Balakata baccata* Roxb.	0.04	0.88	10	22.00	250.00	Good	0.08	0.32	17	4.00	212.50	Good
115	*Sapium eugeniaefolium* Buch.-Ham.	-	-	-			-	0.24	0.12	12	0.50	50.00	Good
116	*Saurauria nepaulensis* DC.	0.04	0.4	NS	10.00		Poor	0.08	NS	NS			None
117	*Shorea robusta* Gaertn.	0.04	NS	NS			None	-	-	-			-
118	*Spondia spinnata* (L.f.) Kurz.	-	-	-			-	0.12	0.4	6	3.33	50.00	Good

120	*Sterculia villosa* Roxb.	0.04	0.64	10	16.00	250.00	Good	0.08	0.32	12	4.00	150.00	Good
121	*Stereospermum colais* Mabb.	0.08	0.36	10	4.50	125.00	Good	0.12	0.28	4	2.33	33.33	Good
122	*Symplocos glauca* (Thunb.) Koidz.	NS	NS	10			Good	-	-	-			-
123	*Syzygium fruticosum* DC.	0.04	0.2	20	5.00	500.00	Good	-	-	-			-
124	*Syzygium jambos* (L.) Alston	0.08	0.96	10	12.00	125.00	Good	-	-	-			-
126	*Tectona grandis* L. f.	0.04	NS	NS			None	0.04	NS	NS			None
127	*Terminalia bellirica* (Gaertn.) Roxb.	0.2	0.88	50	4.40	250.00	Good	0.08	0.64	6	8.00	75.00	Good
128	*Terminalia chebula* Retz.	0.08	0.36	10	4.50	125.00	Good	0.04	0.2	4	5.00	100.00	Good
129	*Terminalia myriocarpa* Van Heurck & Müll. Arg.	0.16	0.2	10	1.25	62.50	Good	-	-	-			-
130	*Toona ciliata* Roem.	0.04	0.6	30	15.00	750.00	Good	NS	NS	6			New
131	*Trema orientalis* (L.) Blume	0.04	0.32	10	8.00	250.00	Good	0.08	0.48	2	6.00	25.00	Good
133	*Trevesia palmate* Vis.	0.16	0.32	10	2.00	62.50	Good	0.08	0.2	5	2.50	62.50	Good
134	*Trewia nudiflora* L.	0.04	0.24	10	6.00	250.00	Good	0.08	0.08	6	1.00	75.00	Good
135	*Vatica lancaefolia* (Roxb.) Bl.	0.4	1.6	40	4.00	100.00	Good						
136	*Vernonia arborea* Buch.-Ham.	-	-	-			-	0.08	0.2	8	2.50	100.00	Good
137	*Vitex glabrata* R.Br.	0.04	0.44	10	11.00	250.00	Good	-	-	-			-
138	*Vitex panicularis* Wall ex Schauer	NS	NS	20			Good	-	-	-			-
139	*Walsurarobusta* Roxb.	0.12	0.2	NS	1.67		Poor	-	-	-			-
140	*Zanthoxylumr hetsa* DC.	0.04	0.2	10	5.00	250.00	Good	-	-	-			-