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The impact of *Tithonia diversifolia* (Hemsl.) A. Gray on phytosociology and native plants diversity of Aizawl, Mizoram, North East India

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ABSTRACT

Invasive plant species are increasingly being recognized as global threat. The biotic invasions can harm the environment, socio-economy, and human health. In India, the studies on invasive plants species are scanty and limited to few aggressive plant invaders (such as *Lantana camara* and *Parthenium hysterophorus*) while *Tithonia diversifolia* is rarely investigated. Therefore, the present study aims to analyze the impact of *T. diversifolia* on phytosociology and vegetation at the selected sites along a disturbance gradient. The case study was conducted in Aizawl, Mizoram which is located in North East (NE) India lying in an Indo-Burma biodiversity hotspot. The analysis was carried out during winter and monsoon seasons by using random quadrat method. The species richness, density, frequency, abundance, and importance value indices (IVI) were calculated. The results showed that *T.diversifolia* has the highest IVI values in all the vegetation analysis performed which indicated that they are the most important species in the study area and offer competitive advantage over the other plant invaders. Further, *Ageratum conyzo*ides and *Mikania micrantha* were also found as the phytosociologicaly co-dominant species. Therefore, important strategies and methods are warranted to control these invasive plant species to prevent further multiplication, establishment, and landscape spread.

Key words : *Phytosociology, Socioeconomy, Tithonia diversifolia, Plant invasion, Human health*

Introduction

The invasive alien plant species are those species that have been introduced outside their natural habitat and are capable to establish, invade, and compete with the native species. Invasive plant species are increasingly being recognized as global threat (Narasimhan, 2010). Invasive plant species are those which can exhibit rapid growth and spread, thereby, establishes over larger landscapes. The spread of invasive plant species threatens the ecosystem socio-economy and have a potential to harm the environment as well as human well-being (Shackleton, 2007; Witt, 2019; Rai, 2020a). The most important aspect of an alien plant is how they are capable to invade novel or pristine environment (Raghubanshi, 2005; Rai, 2020b).

Most of the invasive plant species were introduced from South American region. Out of the total 3,74,000 plants species found worldwide, 6075 plants were documented as invasive plants species around the world (Christenhusz, 2016; Willis, 2017). In India, 173 plant species were documented as invasive alien species, representing 1% of the Indian flora (Reddy, 2008; Rai, 2021). The studies on invasive plants species are scanty and limited to few ag-

gressive plant invaders (such as *Lantana camara, Parthenium hysterophorus*) (Divakara, 2013; Hiremath, 2013), while *Tithonia diversifolia* is rarely investigated. The invasion of *T. diversifolia* has been widely distributed in the eastern part of India yet the exploration on the habitat and distribution pattern are not often recognized (Reddy, 2008).

T. diversifolia belongs to Asteraceae family, commonly called as 'tree marigold' or 'Mexican sunflower' native to North and Central America. In Mizoram they are called as 'Bawngpu-par' or 'Vaivakawn-par'. Habitat wise, *T. diversifolia* is a wild perennial or annual shrubs/bushy plants which can grow up to more than 3m (Buragohain, 2016). They are purposely or accidently introduced into many parts of the countries. *T. diversifolia* is mostly confined to the roadside, nearby fields, disturbed sites, and on the edge of the forest (Witt, 2019). Furthermore, the plant parts of *T. diversifolia* possess large amount of allelochemicals and had a phytotoxic potency that could inhibit the growth, nutrient accumulation, and physiological aspects of the neighbouring native plants. Thus, the plant has been recorded as harmful invasive species (Otusanya, 2007; Noguchi, 2020).

The invasion process of *T.diversifolia* occurs rapidly due to large production of seeds (Putnam, 1988; Chou, 1998). Hence their effects on spatial pattern and sociological behavior of the native plants through vegetation analysis need urgent attention. Phytosociological analysis is the main method for the study of plant community relationship as well as the normal functioning of any community (Shahid, 2016; Sakachep, 2021). The phytosociology mainly focuses on plant communities, composition, diversity, and relationship among the component species. Phytosociological studies tend to characterize the habitat conditions, distributional pattern, and the disturbance status (Rao, 2015). The impact assessment of *T.diversifolia* on native plants through the vegetation analysis is necessary to understand the plant invasion ecology and formulate the strategies for prevention and management of the species in the future (Dengler, 2017).

Materials and Method

Aizawl is the capital of Mizoram and is located in the north eastern part of India. As per the latest record by Indian State Forest Report, Mizoram holds the highest forest cover in percentage accounting for 85.41%, the state lies in an Indo-Burma biodiversity hotspot (Chatterjee, 2008). Aizawl lies between 92°3'- 92°60' E longitude and 21°58'- 24°85' N latitude, it occupies an area of 3576.31 square kilometers and accounts for 16.96% of the total geographical area of the state. Two experimental sites were selected in Aizawl city on the basis of disturbance gradient. In this sense, the site located in Tanhril locality was considered as disturbed vegetation. Whereas, the site located at Ramthar locality was selected as undisturbed vegetation.

The vegetative analysis of selected study sites in Aizawl was carried out during winter (i.e., during the month of January) and monsoon (i.e. during the month of September) season by using quadrat method. From both the disturbed and undisturbed sites 5 quadrats (each of 5m x 5m size) were laid out randomly. The phytosociological study analyses the community structure for species density, frequency, abundance, and the relationship of the species as per the methods devised by Curtis (1951) and Mishra (1968).

Results and Discussion

The data presented in all the tables (i.e., Table 1-4) showed that *T. diversifolia* has the maximum important value index (IVI) which represented that they were the most important and dominant species in both the study areas. The study on phytosociological attributes of all species at two sites revealed the varying degree of dispersion. During winter, *T. diversifolia* at disturbed site (IVI=61.798789) has higher IVI value than the undisturbed site (IVI=42.2855142), while *Mussaenda pubescens* (IVI=12.582175) and *Digitaria sanguinalis* (IVI=12.2497834) recorded the lowest IVI values at

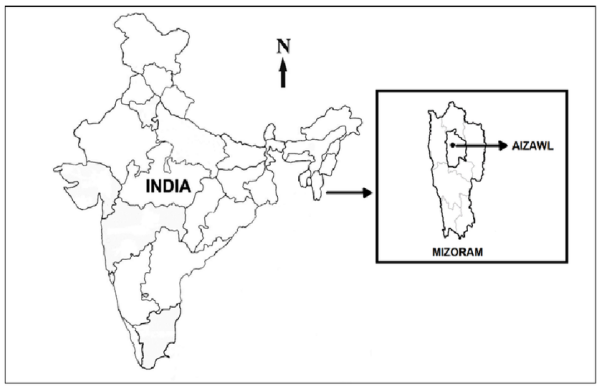

Fig. 1. Map of study area in Aizawl, Mizoram

Table 1. Phytosociological attributes at disturbed site during winter (i.e., January, 2020)

Sl No.	Nmae of the species	Quadrats I	II	III	IV	V	No. of individual	Density	Frequency	Abundance	Relative density	Relative frequency	Relative Abundance	IVI
1	*Tithoniadiversifolia*	9	4	8	9	9	46	9.2	100	9.2	25.274725	14.70588235	21.81818182	61.798789
2	*Lantana camara*	4	3	6	2	2	17	3.4	100	3.4	9.3406593	14.70588235	8.063241107	32.109783
3	*Mikaniamicrantha*	7	9	10	3	5	34	6.8	100	6.8	18.681319	14.70588235	16.12648221	49.513683
4	*Ageratum conyzoides*	6	5	3	4	9	27	5.4	100	5.4	14.835165	14.70588235	12.80632411	42.347371
5	*Mussaendapubescens*	-	2	3	-	-	5	1	40	1.6666667	2.7472527	5.882352941	3.95256917	12.582175
6	*Cosmos caudatus*	-	3	0	6	-	9	1.8	40	4.5	4.9450549	5.882352941	10.67193676	21.499345
7	*Biden pilosa*	-	3	4	6	-	13	2.6	60	4.33333	7.1428571	8.823529412	10.27667984	26.243066
8	*Digitariasanguinalis*	2	1	-	-	2	5	1	40	1.6666667	2.7472527	5.882352941	3.95256917	12.582175
9	*Spilanthesoleracea*	7	5	5	5	4	26	5.2	100	5.2	14.285714	14.70588235	12.33201581	41.323612

Table 2. Phytosociological attributes at undisturbed site during winter (i.e., January, 2020)

Sl no.	Name of the Species	Quadrats I	II	III	IV	V	No. of indiv-idual	Den-Sity	Frequency	Abundance	Relative density	Relative frequency	Relative Abundance	IVI
1	*Tithoniadiversifolia*	11	13	9	12	10	55	11	100	11	17.7993528	10.4166667	14.06949	42.2855142
2	*Lantana camara*	4	3	-	-	2	9	1.8	60	3	2.9126214	6.2500000	3.83713	12.9997563
3	*Mikaniamicrantha*	11	13	9	10	3	46	9.2	100	9.2	14.8867314	10.4166667	11.76721	37.0706119
4	*Ageratum conyzoides*	9	12	9	7	-	37	7.4	80	9.25	11.9741100	8.3333333	11.83117	32.1386094
5	*Biden pilosa*	5	6	9	3	3	26	5.2	100	5.2	8.4142395	10.4166667	6.65103	25.4819400
6	*Digitariasanguinalis*	2	4	2	-	-	8	1.6	60	2.666666667	2.5889968	6.2500000	3.41079	12.2497834
7	*SpilanthesOleracea*	8	10	5	7	8	38	7.6	100	7.6	12.2977346	10.4166667	9.72074	32.4351431
8	*Galinsogaparviflora*	5	4	5	2	2	18	3.6	100	3.6	5.8252427	10.4166667	4.60456	20.8464713
9	*Cyperusinvolucratus*	17	13	-	0	-	30	6	40	15	9.7087379	4.1666667	19.18567	33.0610792
10	*Colocasiaesculenta*	3	4	-	3	4	14	2.8	80	3.5	4.5307443	8.3333333	4.47666	17.3407351
11	*Kyllingiabrevifolia*	7	-	2	-	5	14	2.8	60	4.666666667	4.5307443	6.2500000	5.96888	16.7496209
12	*Setaria italic*	3	4	-	3	4	14	2.8	80	3.5	4.5307443	8.3333333	4.47666	17.3407351

Table 3. Phytosociological attributes at disturbed site during monsoon (i.e., September, 2020)

Sl No.	Name of the Species	Quadrats I	II	III	IV	V	No. of individual	Den Sity	Frequency	Abun Dance	Relative density	Relative frequency	Relative Abundance	IVI
1	*Tithoniadiversifolia*	13	11	9	8	12	53	10.6	100	10.60	18.402778	13.157895	15.273775	46.83445
2	*Lantana camara*	-	-	3	5	4	12	2.4	60	4.00	4.1666667	7.8947368	5.7636888	17.82509
3	*Mikaniamicrantha*	7	10	7	12	14	50	10	100	10.00	17.361111	13.157895	14.409222	44.92823
4	*Ageratum conyzoides*	8	6	7	13	15	49	9.8	100	9.80	17.013889	13.157895	14.121037	44.29282
5	*Mussaendapubescens*	-	-	5	4	-	9	1.8	40	4.50	3.125	5.2631579	6.4841499	14.87231
6	*Cosmos caudatus*	-	7	-	6	-	13	2.6	40	6.50	4.5138889	5.2631579	9.3659942	19.14304
7	*Biden pilosa*	-	7	6	6	5	24	4.8	80	6.00	8.3333333	10.526316	8.6455331	27.50518
8	*Digitariasanguinalis*	9	4	7	6	7	33	6.6	100	6.60	11.458333	13.157895	9.5100865	34.12631
9	*Spilanthesoleracea*	6	8	7	6	10	37	7.4	100	7.40	12.847222	13.157895	10.662824	36.66794
10	*Galinsogaparviflora*	-	4	-	4	-	8	1.6	40	4.00	2.7777778	5.2631579	5.7636888	13.80462

Table 4. Phytosociological attributes on undisturbed site during monsoon (i.e. September, 2020)

Sl No.	Name of the species	Quadrats I	II	III	IV	V	No. of individual	Den Sity	Frequency	Abun Dance	Relative density	Relative frequency	Relative Abundance	IVI
1	*Tithoniadiversifolia*	15	20	18	11	13	77	15.4	100	15.4	19.25	9.259259259	16.385884	44.90
2	*Lantana camara*	4	-	-	4	3	11	2.2	60	3.6666667	2.75	5.555555556	3.901401	12.21
3	*Mikaniamicrantha*	11	9	12	7	6	45	9	100	9	11.25	9.259259259	9.576166	30.09
4	*Ageratum conyzoides*	18	14	10	9	12	63	12.6	100	12.6	15.75	9.259259259	13.406632	38.42
5	*Biden pilosa*	3	5	4	4	2	18	3.6	100	3.6	4.50	9.259259259	3.8304664	17.59
6	*Digitariasanguinalis*	7	6	6	-	-	19	3.8	60	6.3333333	4.75	5.555555556	6.7387835	17.04
7	*Spilanthesoleracea*	14	7	-	3	-	24	4.8	60	8	6.00	5.555555556	8.5121475	20.07
8	*Galinsogaparviflora*	12	7	9	11	9	48	9.6	100	9.6	12.00	9.259259259	10.214577	31.47
9	*Cyperusinvolucratus*	19	7	-	2	-	34	6.8	60	11.333333	8.50	5.555555556	12.058876	26.11
10	*Colocasiaesculenta*	6	7	-	3	4	17	3.4	80	4.25	4.25	7.407407407	4.5220784	16.18
11	*Kyllingiabrevifolia*	7	7	4	2	5	18	3.6	80	4.5	4.50	7.407407407	4.788083	16.70
12	*Setaria italic*	3	7	4	2	3	16	3.2	100	3.2	4.00	9.259259259	3.404859	16.66
13	*Urena lobate*	2	7	3	-	2	10	2	80	2.5	2.50	7.407407407	2.6600461	12.57

disturbed and undisturbed site, respectively.

Whereas, in monsoon season, *T. diversifolia* at disturbed site (IVI=46.83445) showed higher IVI value when compared with undisturbed site (IVI=44.90). On the other hand, *Ganlisoga parviflora* (IVI=13.80462) and *Lantana camara* (IVI=12.21) were also found to have lowest IVI values during monsoon season at disturbed and undisturbed site, respectively. The species having low IVI indicates that they were of the rare occurrence in the study area. In this respect, there exists a strong correlation between structural diversity and species data to other potential plant invaders such as *Ageratum conyzoides* and *Mikania micrantha*.

In this study, the plant diversity was highly influenced by temperature, soil conditions, rainfall, and light availability. In addition to *T. diversifolia*, other invasive alien plants such as *A.conyzoides* and *M. micrantha* were also noted for their wide occurrence in Aizawl (Rai, 2015). The reproductive attributes e.g., the dispersal through lightweight seed could be the reason of site-specific spread of *T. diversifolia* offering competitive advantage over the other plant invaders (Otusanya, 2015). *Ageratum conyzoides* also belongs to the member of the family Asteraceae with quick reproductive potential as well as a great adaptability in the area (Rai, 2021). This invasive plant was the most occurring invasive plant species recorded at all sites after *T. diversifolia*. Herein, wide occurrence of *A. conyzoides* was in accordance with the study of Divakara (2013). Another invasive alien plant, *Mikania micrantha* is a branched perennial vine abundant at undisturbed sites. This invasive plant can damage other plants by cutting out the light thereby, hampering the plant photosynthesis (Chengxu, 2011; Rai, 2015).

Management of plants invasion is an utmost important for restoring the native diversity. The control of invasive plants is carried out by physical, chemical and biological control. In order to control the spread of invasive plants, biological control is the most effective and sustainable option (Rai, 2015).

Conclusion

The present study revealed first-hand information on the impact of *Tithonia diversifolia* on phytosociology and plant diversity in Aizawl. The study concluded that this emerging invasive alien species was highly dominant as compared to other plant species. Thus, the present study can help the local people, farmers, and stakeholders for the control of *T. diversifolia* in view of their deleterious effects on native plants/agro-biodiversity. Important strategies and methods are warranted to control these invasive plant species at an early stage of succession to prevent further multiplication and establishment.

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