Original Article *Journal of Multidisciplinary Research Advancements (JOMRA), Vol. 4, No. 1 (2026), 196 – 203*
e-ISSN 2990-7721 Available online at https://www.nepjol.info/index.php/jomra

Occurrence and Spatial Distribution of *Mikania Micrantha* Kunth in the Forestry Campus Complex, Hetauda, Nepal

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Abstract: Invasive alien plant species (IAPS) present a significant threat to biodiversity and ecosystem health in Nepal's tropical environments, particularly in areas facing extensive anthropogenic disturbances. This research assessed composition, dominance, and habitat-specific distribution of IAPS, particularly *Mikania micrantha*, in the vicinity of the Forestry Campus Complex (FCC) in Hetauda, central Nepal. A total of 120 quadrats were surveyed across six distinct habitat types: forest area (FA), wetland area (WA), grassland area (GA), roadside area (RA), built-up area (BA), and non-forested area (NA) using a systematic transect method. Phytosociological characteristics, relative frequency, relative density, relative abundance, and Importance Value Index (IVI), were determined to assess species dominance, and one-way ANOVA was employed to examine variation in *Mikania micrantha* dominance across habitats. A total of 23 IAPS from 12 different families were recorded, with Asteraceae being the most prevalent family. *Mikania micrantha* was found as the most ecologically dominant invasive species, showing the highest IVI (37.08%), followed by *Chromolaena odorata* and *Lantana camara.* Habitat-wise dominance analysis showed that *Mikania micrantha* was distributed to built-up, forested, and roadside areas, showing considerably higher dominance in built-up areas (IVI = 57.72%) than in forest and roadside areas ($p<0.002$). The results also highlight that anthropogenically disturbed habitats can act as invasion hotspots and potential sources for spreading into nearby forest ecosystems. This research emphasizes the urgent need for habitat-specific management approaches to control *Mikania micrantha* and safeguard forest ecosystems in rapidly urbanizing areas of Nepal.

Keywords: *Ecosystems, Invasive species, Habitat, Mikania micrantha*

Conflicts of interest: None
Supporting agencies: None

Received 26.02.2026 Revised 19.04.2026 Accepted 12.05.2026

Cite This Article: Ghimire, P. (2026). Occurrence and Spatial Distribution of *Mikania micrantha* Kunth in the Forestry Campus Complex, Hetauda, Nepal. *Journal of Multidisciplinary Research Advancements*, *4*(1), 196-203.

1. Introduction

Biological invasions are extensively regarded a major factor contributing to the loss of biodiversity, the degradation of ecosystems, and alteration in ecosystem functioning globally (Dark, 2004; Shrestha, 2016; Gallardo et al., 2024). Invasive alien plant species (IAPS) frequently exhibits rapid growth, high reproductive potential, and strong competitive ecological traits that enable them to outcompete native flora, alter habitat composition, and disrupt ecological functions (Campbell, 2005; Baral et al., 2017; Rai & Singh, 2020; Gallardo et al., 2024). These effects are particularly evident in tropical and subtropical regions landscape, where ideal climatic conditions along with extensive land-use changes accelerate invasion processes (Shrestha & Shrestha, 2021; Bhatta et al., 2021; Subedi et al., 2024). Due to its extensive elevation variation, diverse climatic conditions, and growing anthropogenic disturbance, Nepal is considered very susceptible to plant invasions (Shrestha et al., 2018; Shrestha et al., 2025). In recent decade, spread of IAPS has intensified across forests, wetlands, grasslands, farm land and urban areas, posing serious threats to native biodiversity, forest regeneration, and ecosystem services (Shrestha, 2019; Shah et al., 2020; Dhakal et al., 2024). Recent studies show that invasive species are no longer confined to degraded or open habitats but are increasingly penetrating forest edges and interiors, especially in lowland tropical forests of eastern and central Nepal (Shrestha et al., 2018; Khaniya & Shrestha, 2020; Shah et al., 2020; Aryal et al., 2022).

Among the reported invasive alien plant species in Nepal, *Mikania micrantha*, commonly known as mile-a-minute weed, is considered as one of the most aggressive and harmful invaders (Shrestha, 2016). Native to tropical Central and South America, *Mikania micrantha* is a fast-expanding perennial climber that forms dense layers over herbs, shrubs, and mature trees, severely reducing light availability and hindering the growth and survival of native plants (Cock, 1982; Prabu et al., 2014). Its capacity to flourish in partial shade, quick vegetative growth, and abundant seed production has enabled its extensive spread throughout South Asia (Rameshprabu & Swamy, 2015; Banerjee et al., 2017; Paudel et al., 2024). In Nepal, *Mikania micrantha* has been documented in protected regions, community forests, riparian areas, and urban-forest boundaries, with notably serious effects noted in the tropical lowland regions (Sapkota, 2009; Shrestha & Shrestha, 2021; Neupane et al., 2025). Research conducted in community-managed forests and national parks has recorded its negative impacts on forest structure, the diversity of native species, and regeneration dynamics (Sapkota, 2009; Shrestha, 2019a; Paudel et al., 2024). While there is increasing recognition of its ecological threat, detailed assessments of *Mikania micrantha* dominance in mixed land-use areas, particularly in institutional forest campuses and urban-adjacent forests are still limited.

Urban growth, infrastructure development, and associated disturbances such as road construction, deforestation, and altered hydrology are recognized to foster invasion-prone environments by boosting resource availability and propagule pressure (Shrestha & Shrestha, 2021; Kim et al., 2025). Built-up areas and highway corridors often serve as gateways and dispersal routes for invasive species, facilitating their spread into adjacent forest ecosystems (Liang et al., 2014; Kim et al., 2025). Nevertheless, there is still limited empirical evidence quantifying the relative dominance of *Mikania micrantha* across various habitat types within such landscapes in Nepal. The Forestry Campus Complex (FCC), Hetauda, represents a distinctive mosaic of forest, grassland, wetland, roadside, built-up, and non-forested environments integrated within a rapidly urbanizing landscape (Poudel et al., 2022). This area offers an excellent opportunity to analyze the composition of invasive alien plant species and to evaluate how habitat type and anthropogenic disturbance influence the prevalence and distribution of *Mikania micrantha*. Understanding habitat-specific invasion trends is essential for identifying invasion hotspots, prioritizing management interventions, and preventing further spread into ecologically sensitive forest areas (Rawat et al., 2024; Shrestha et al., 2015). In light of this context, the current research intends to identify the composition and diversity of invasive alien plant species within and around the FCC, assess the ecological dominance of *Mikania micrantha* through phytosociological indices, and analyze the variation in its dominance across different habitat types. This research offers site-specific evidence for invasive species management and contributes to the broader understanding of invasion dynamics in tropical urban forest landscapes of Nepal.

2. Materials and methods

2.1. Study area

The study was conducted within and around the Forestry Campus Complex (FCC) campus, Hetauda, Makawanpur District, Nepal (Fig.1). The complex covers approximately 102.57 ha and lies between the latitude of 27°21’ to 27°40′N and longitude of 84°41′to 84°35′E in a tropical climatic zone with mean annual rainfall of about 2,100 mm (Ghimire, 2022). It is bordered by the Karra River to the south, the Bhutandevi Temple and adjacent settlements to the north, the East–West Highway to the east, and the Rapti River to the west. The area comprises a mosaic of habitat types, including natural and plantation forests, wetlands along riverbanks, grasslands, open lands, roadsides, and surrounding settlement areas (Poudel et al., 2022). The area harbors a high diversity of flora and fauna. The forest vegetation is predominantly composed of *Shorea robusta*, *Bombax ceiba*, *Schima wallichii*, *Terminalia alata*, *Albizia lebbeck*, *Trewia nudiflora*, and *Syzygium cumini*, along with plantation stands of *Pinus roxburghii* and *Eucalyptus* species. Grassland communities are mainly dominated by *Imperata cylindrica* and Saccharum spontaneum. The fauna is represented by common wildlife species such as spotted deer, monkeys, and jackals. In recent years, the spread of various invasive alien plant species (IAPS) has been increasingly evident, posing a serious threat to local biodiversity by suppressing the regeneration of native plant species.

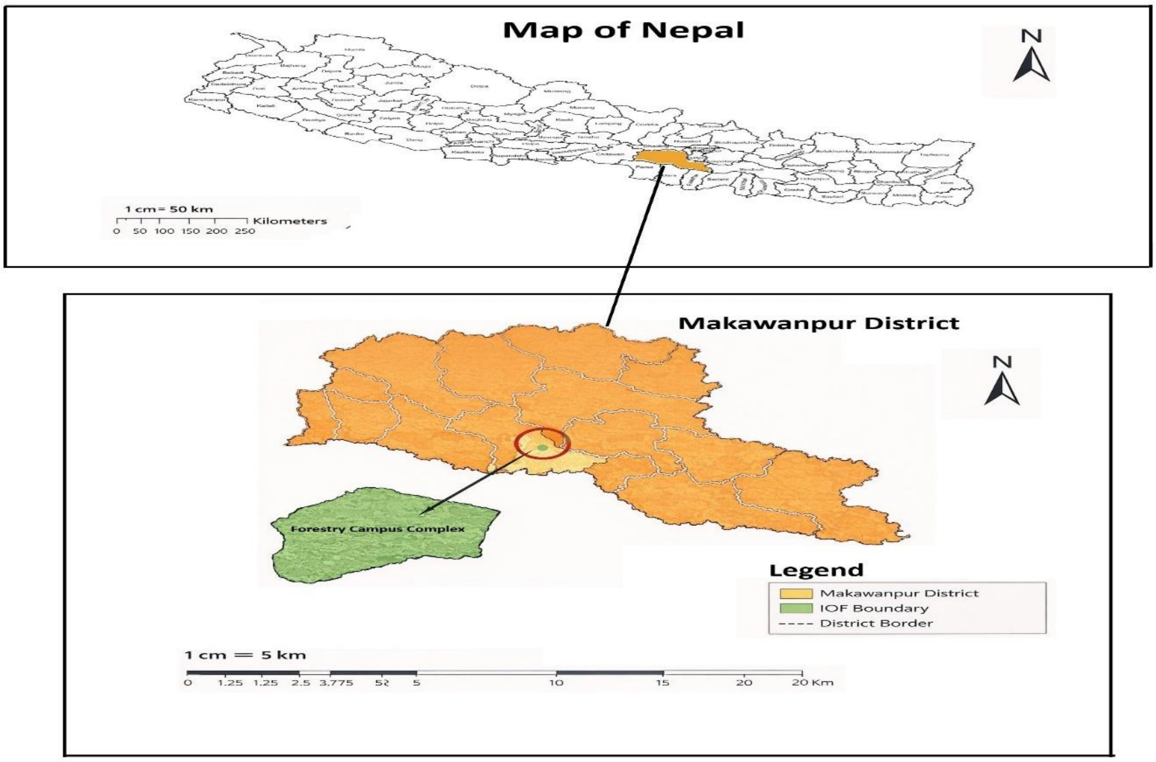

Figure 1: Map showing the study site

2.2. Sampling Design and data collection

The study area was stratified into six habitat types: forest area (FA), wetland area (WA), grassland area (GA), roadside area (RA), built-up area (BA), and non-forested area (NA). Among the different habitat types, forest area occupies the largest proportion of the study site (74.55 ha), followed by built-up (8.88 ha), wetland (8.80 ha), grassland (6.84 ha), and no-forested area (2.48 ha). Roadside habitat represents the smallest area, covering only 1.02 ha. A total of 30 transect lines were systematically established at a minimum interval of 200m to ensure representative coverage of all land-use types within the study area. Among these, 14 transects were laid in forested area, while 3 transects were placed in each of the remaining habitat types, except for roadsides where 4 transects were established to cover 3 km of road networks. The allocation of transects was purposively designed to ensure adequate representation of habitat heterogeneity and spatial coverage. Forest area covers approximately 74.55 ha (over 70% of the total study area), necessitating a higher number of transects to capture its structural variability. In contrast, roadside habitats, although limited in area (1.02 ha), extend linearly across the landscape and act as dispersal corridors. Along each transect, 4 quadrats were established at 50 m intervals. In total, 120 quadrats were sampled with nested quadrat size of 5 m × 2 m for shrub and 1 m × 1 m for herbs species. The survey was carried out during June-July 2024. All IAPS within quadrats were recorded. Species identification followed national IAPS checklists and standard floras. For each species, frequency, density, and abundance were calculated.

2.3 Data Analysis

Based on the inventory data obtained from the sampled quadrats, Phyto-sociological attributes, including Relative Frequency (RF), Relative Abundance (RA) and Relative Density (RD) were calculated for each recorded species. These parameters were subsequently integrated to compute the Importance Value Index (IVI), which provides a comprehensive measure of the ecological significance and dominance of individual species within the community. The IVI for each species was determined using the following formula recommended by Curtis & McIntosh (1950):

Frequency = Total number of quadrats in which the species occurs/ Total number of quadrats studied…………………….(i)
Relative Frequency (RF) = (Frequency of individual species / Total frequency) *100%………………………………….(ii)
Density = Total number of individuals of species in all the quadrats/ Total number of quadrats studied………(iii)
Relative Density (RD) = (Total number of individuals of the species/ Total number of individuals of all the species) * 100%……..….(iv)

Abundance = Total number of individuals of a species /Number of quadrat in which the species occurred……………………………………………………………………………………………………….(v)
Relative Abundance (RA) = (Number of individuals of a specific species / Total number of individuals of all species) *100.......... (vi)
Important Value Index (IVI) = RF + RA+ RD……………………………………………………………………………(vii)

Species richness was calculated for each habitat type. Differences in mean *Mikania micrantha* abundance among habitat types were tested using one-way Analysis of Variance (ANOVA) after checking for normality and homogeneity of variances. Habitat-wise mean IVI values were used as a proxy measure of abundance and dominance of *Mikania micrantha* for comparative statistical analysis. Statistical significance was assessed at 5% level of significance. All analyses were performed using Statistical Package for Social Science (SPSS) version 26.0.

3. Results

3.1. Composition of IAPS in the Study Area

A total of 23 invasive alien species (IAPS), belonging to 12 families, were recorded across 120 sample plots across the Forestry Campus Complex (FCC), Hetauda, Nepal (Table 1). This comprised 56 plots in forest areas, 16 in roadside areas, and 12 plots each in built-up, grassland, wetland, and non-forested areas. Of the total sample plots 115 quadrats contained at least one invasive species, while five quadrats (four in forest areas and one in non-forested areas) were free from IAPS. Among the documented families, Asteraceae was the most prevalent, contributing 9 species, followed by Fabaceae with 3 species, Amaranthaceae with 2 species, whereas the other 9 families were each represented by one species (Table 1). Assessment of life-form composition showed that herbs constituted the majority of invasive species (78%, 18 species), followed by shrubs (about18%, 4 species) and climbers (4%, 1 species).

Table 1: Characteristic information of the studied IAPS in study area

S.N.	Common name (Local name)	Scientific name	Family	Life forms@	Habitat types
1	Bitter nine/ Mile-a-minute (Lahare Banmara)	*Mikania micrantha* Kunth.	Asteraceae	PC	FA, BA, RA
2	Parthenium (Pati Jhar)	*Parthenium hysterophorus* L.	Asteraceae	AH	BA, NA, WA, RA
3	Crofton weed (Kalo Banmara)	*Ageratina adenophora* (Spreng.) R.M.King & H.Rob	Asteraceae	PS	FA
4	Siam weed (Seto Banmara)	*Chromolaena Odorata* (L.) R.M.King & H. Rob	Asteraceae	PS	FA, BA, RA
5	Black jack/Hairy beggar-tick (Kalo Kuro)	*Bidens pilosa* L.	Asteraceae	AH	FA, GA, BA, NA, RA
6	Billygoat weed (Raunne or Gandhe)	*Ageratum Conyzoides* L.	Asteraceae	AH	FA
7	Blue billygoat weed (Nilogandhe)	*Ageratum houstonianum* Mill.	Asteraceae	AH	FA, GA, BA, RA
8	Rough cocklebur (Bhede Kuro)	*Xanthium strumarium* L.	Asteraceae	AH	GA
9	Shaggy soldier (Jhuse Chitlange)	*Galinsoga quadriradiata* Ruiz & Pav.	Asteraceae	AH	RA

10.	Sleepy grass (Lajjawati Jhar)	*Mimosa pudica* L.	Fabaceae	PH	GA, BA, WA
11	Sicklepod senna (Tapre)	*Senna tora* (L.) Roxb.	Fabaceae	AH	FA, GA, BA, NA, RA
12	Coffee senna (Panwar)	*Senna occidentalis* (L.) Link	Fabaceae	AS	FA
13	Spiny pigweed (Kandelude)	*Amaranthus Spinosus* L.	Amaranthaceae	AH	NF, BA
14	Alligator weed (Jala Jambhu)	*Alternanthera philoxeroides* (Martius) Grisebach	Amaranthaceae	PH	WA
15	Wild sage (Kande Banmara)	*Lantana camara* L	Verbenaceae	PH	FA, GA, BA, RA
16	Water hyacinth (Jalkumbhi)	*Eichhornia crassipes* (Mart.) Solms**.**	Pontederiaceae	PH	WA
17	Bushmint (Tulsi Jhar)	*Mesosphaerum Suaveolens* (L.) Kuntze	Lamiaceae	PH	RA
18	Bush morning Glory (Besharam)	*Ipomoea carnea* Jacq.	Convolvulaceae	PS	BA
19	Purple wood sorrel (Chari amilo)	*Oxalis latifolia* Kunth.	Oxalidaceae	PH	BA
20	Southern cut grass (Karaute ghan)	*Leersia hexandra* Sw.	Poaceae	PH	FA, BA, WA
21	Mexican poppy (Satyanashi Jhar)	*Argemone mexicana* Linn.	Papaveraceae	AH	BA
22	Water lettuce (Panibanda)	*Pistia stratiotes* L.	Araceae	PH	WA
23	Broadleaf button weed (Alu Pate Jhar)	*Spermacoce alata* Aubl.	Rubiaceae	PH	FA

CA: Central America; SA: Central America; TA: Tropical America; NA: North America; PC: Perennial climber; AH: Annual herb; PH: Perennial herb; AS: Annual shrub; PS: Perennial shrub
@ (Tiwari et al., 2005; Shrestha et al., 2016)

3.2 Dominance Pattern of *Mikania Micrantha*

Study of phytosociological attributes showed a strong prevalence of a limited number of invasive species. Among them *Mikania micrantha* showed the greatest relative frequency (18.12%), indicating its widespread occurrence across study area. Similarly, it also showed a high relative density (11.7%), reflecting a large number of individuals per unit area (Table 2). Other dominant species included *Chromolaena odorata*, *Lantana camara,* and *Ageratum houstonianum*, whereas species such as *Galinsoga quadriradiata*, *Argemone mexicana*, and *Spermacoce alata* showed very low dominance.

Table 2: Dominance and IVI of *Mikania micrantha* and other top ten IAPS in the study area

Species	RF (%)	RA (%)	RD (%)	IVI (%)
Mikania micrantha	18.12	7.26	11.7	37.08
Chromolaena odorata	7.88	9.26	17.15	34.29
Lantana camara	14.3	5.7	11.45	31.45
Ageratum houstonianum	12.42	5.40	3.12	20.94
Senna tora	8.8	3.24	6.1	18.14
Ipomoea carnea	1.15	6.5	9.8	17.45

Eichhornia crassipes	2.1	9.84	5.42	17.36
Xanthium strumarium	2.3	5.08	8.2	15.58
Alternanthera philoxeroides	2.25	7.43	4.38	14.06
Parthenium hysterophorus	2.15	5.58	2.26	9.99
Others	28.53	34.71	20.42	83.66

The Importance Value Index (IVI) analysis revealed that *Mikania micrantha* is the most ecologically dominant invasive species in the study area, with IVI value of 37.08%, the highest of all documented IAPS. This IVI was due to its combined high relative frequency, abundance, and density. Accordingly, *Chromolaena odorata* (IVI = 34.29%) and *Lantana camara* (IVI = 31.45%) were positioned in second and third places, respectively.

3.3. Habitat-wise dominance of *Mikania micrantha*

Results of habitat-wise analysis revealed that *Mikania micrantha* was present in three habitat types: forest area, built-up areas and roadside area while it was entirely absent from the wetlands, grasslands and non-forested area (Figure 2). *Mikania micrantha* was observed to be the most prevalent in built-up area exhibiting the highest frequency and density relative (IVI=57.72%) to other habitat categories. Moderate dominance was recorded in roadside area (IVI=44.41%) with forest area positioned in second (Figure 2). The prevalence of *Mikania micrantha* in built-up area indicates its significant invasive influence on surrounding forest landscapes, indicating that urban expansion and anthropogenic disturbances may act as key drivers of its establishment and subsequent impacts on forest structure and regeneration. One-way Analysis of Variance (ANOVA) was conducted to evaluate differences in the average dominance of *Mikania micrantha* across forest, roadside, and built-up habitats, utilizing habitat-specific IVI values as an indicator of abundance, at a 5% significance level. The results showed a statistically significant variation in the mean IVI of *Mikania micrantha* across the three habitat types ($F= 6.78$, $p= 0.002$, $\eta^2 =0.104$). This suggests that the abundance of *Mikania micrantha* differs significantly among habitat types, with built-up area experiencing the highest level of invasion.

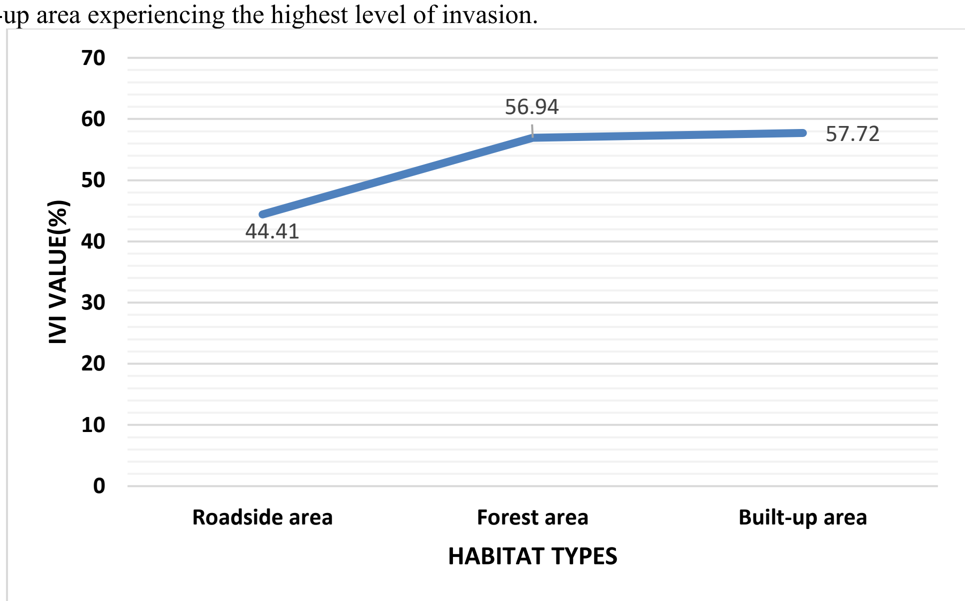

Figure 2: Habitat wise dominance of *Mikania Micrantha*

4. Discussion

The current research revealed that *Mikania micrantha* is the most prevalent invasive species found in and around the Forestry Campus Complex (FCC) in Hetauda, Nepal as reported by its higher IVI (37.08%) and significant variation in dominance across habitat types. This finding shows the species' strong invasive potential in tropical lowland ecosystems of central Nepal and is consistent with previous studies recognizing Mikania micrantha as one of the most intense invaders in Nepal and South Asia (Shrestha, 2019a; Bora et al., 2023; Paudel et al., 2024). The relatively high IVI of *Mikania micrantha* suggests its widespread occurrence, high density, and strong competitive ability relative to other invasive species recorded in the study area. As a fast-growing perennial climber, *Mikania micrantha* rapidly spreads over shrubs, saplings, and mature trees, forming dense mats that light access and hinder the growth of native plants (Paudel et al., 2024; Neupane et al., 2025).

The one-way ANOVA using habitat-specific IVI values revealed a statistically significant variation in the dominance of *Mikania micrantha* across built-up area, forest, and roadside area ($F= 6.78$, $p= 0.002$, $\eta^2 =0.104$). Built-up area showed significantly higher IVI values compared to forest and roadside habitats, indicating that built-up area or anthropogenic disturbed area within FCC are currently the most vulnerable to invasion by *Mikania micrantha*. This pattern of invasion can be linked to the species' notable preference for disturbed forest margins, canopy openings, and partially shaded areas, where adequate light and humidity foster rapid plant establishment (Rameshprabu & Swamy, 2015; Poudel et al., 2019; Bora et al., 2023; Neupane et al., 2025). While roadside habitats showed moderate dominance, probably serving as dispersal corridors. Research conducted in the tropical forests of the Western Ghats of India, has likewise noted increased establishment and distribution of *Mikania micrantha* in disturbed forest openings compared to access grasslands or wetlands (Muniappan & Viraktamath, 1993; Prabu et al., 2014). Interestingly, *Mikania micrantha* was not found in wetlands, grasslands, and non-forested areas, a pattern that was likely driven by ecological constraints such as excessive soil moisture in wetlands that restrict root aeration and establishment, high light exposure in open grasslands and non-forested areas that may not favor its optimal growth compared to partially shaded environments, and competition from dense grass species like *Imperata cylindrica* and *Saccharum spontaneum* in grasslands. These results are consistent with previous studies conducted in tropical regions and suggest that *Mikania micrantha* prefers disturbed, semi-shaded habitats with moderate moisture conditions (Sapkota, 2009; Paudel, 2011).

5. Conclusion

This study provides strong evidence that invasive alien plant species are prevalent throughout the Forestry Campus Complex, Hetauda, with *Mikania micrantha* standing out as the most dominant and ecologically significant invader. Out of the 23 documented IAPS, Mikania micrantha showed the higher Importance Value Index, indicating its wide distribution, high density, and strong competitive strength compared to other invasive species in the study area. The prevalence of certain aggressive species, especially *Mikania micrantha*, *Chromolaena odorata*, and *Lantana camara*, suggests an extensive invasive community structure with potential long-term effects for native vegetation and forest regeneration. Habitat-wise dominance analysis revealed a significant difference in the prevalence of *Mikania micrantha*, with built-up areas displaying notably greater invasion intensity compared to forest and roadside environments. The significant differences between habitat types indicate that anthropogenic disturbances, canopy gaps, and urban growth within the campus area are critical in aiding the establishment and spread of this species. Further, the absence of *Mikania micrantha* in wetlands, grasslands, and non-forested areas highlights its habitat specificity and preference towards disturbed, partially shaded environments. These results emphasize the importance of timely identification, continued observation, and targeted management strategies, especially in built-up area–forest boundaries and affected forest edges. Specific management interventions should include: periodic manual removal of *Mikania micrantha* before flowering and seed setting (May–July) to reduce propagule pressure; promotion of biological control agents such as *Puccinia spegazzinii*, which has proven effective at suppressing its growth; and active participation of local communities and institutional stakeholders in monitoring and early removal programs.

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