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Invasion status of alien weeds in the historical Chobhar area of Kathmandu valley, Nepal

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ABSTRACT

Invasive alien weeds in Nepal have become a great problem. Many of them have been naturalized and threatening native ecosystems and biodiversity. This assessment was carried out to measure the density, frequency and coverage of four major invasive weeds in a historical place, Chobhar of Kathmandu, Nepal. It was found that *Ageratina adenophora* had the highest density, frequency, and cover in the Pine forest. Similarly, *Ageratum conyzoides, Bidens pilosa,* and *Parthenium hysterophorus* were dense and frequent with high cover along the roadside. The frequency of *B. pilosa* and *P. hysterophorus* was comparatively high in the fallow land. It shows that the ecological parameters of the particular invasive alien weeds vary with land-use types and aspects. These weeds should be regularly monitored and appropriate methods of controlling them should be implemented in the study area.

The invasion of alien species has been challenging the conservation of biodiversity and natural resources (Maèiæ *et al.* 2018). The invasive alien plant species (IAPS) compete with native plants for nutrients, water and light (Vilà *et al.* 2011). They can change the native ecosystems and diversity which is irreversible (Barton *et al.* 2007).

With the increasing globalization, trade and human movement the number of IAPS has been increasing in all climatic regions and continents from tropics to high mountains (Seebens *et al.* 2017). Nepal's physiographic and climatic diversity are suitable for alien plant species introduction and establishment. The number of highly problematic IAPS in Nepal has reached up to 26 which are mostly native of tropical Americas (Shrestha *et al.* 2016). These species are distributed in various habitats such as roadsides, fallow lands, agroecosystems, and even in the forests throughout Nepal (Thapa *et al.* 2015, 2016, 2017, Shrestha *et al.* 2016). In addition, the natural beauty of many historical places has been also destroyed by the invasion of such alien species but the community people, governmental and non-governmental authorities are unaware on these issues. This study aims to highlight the status of invasion of major problematic invasive weeds in a famous historical place, the Chobhar area of Kathmandu valley, Nepal.

The Chobhar area lies in Kirtipur municipality of the valley (27°27' N and 85°28' E and elevation ranges from 1310 to 1346 m above the sea level). The area is famous for the Chobhar Gorge cut by Manjushree, Chobhar caves, Jal Binayak and Adinath Lokeshwar temples. The area is surrounded by beautiful herbs, shrubs, and a patch of Pine forest patches. Kathmandu-Dakshinkali road makes a half-circle to the Chobhar area and there is another road running up to the hill through Pine forest towards the North aspect. The roadsides, fallow land, and forest patches of Chobhar are invaded by mainly four invasive weeds named *Ageratina adenophora* (Spreng.) King and H.Rob., *Ageratum conyzoides* L., *Bidens pilosa* L. and *Parthenium hysterophorus* L.

A field survey was conducted from September to November 2018. A total of 100 quadrats of size 1×1 m² were sampled in 3 sites (forest, fallow land, and road sides of North and South aspects) in the study area. There were 25 quadrates at each site. In the forest and fallow land, five transects were made having a distance about 20 m apart and in each transect 5 quadrats were sampled. The distance between the two quadrates was at least 10 m. The remaining 25 quadrats were sampled along the roadside towards each North and South aspect of Chobhar. Density and cover of the weeds were measured in each quadrat. The number of each

weeds per plot was counted as the density and cover estimation was done by visual observation method starting from >5, 5, 10, 15, 20%, and so on. The frequency was calculated using the following formula:

$$\text{Frequency (\%)} = \frac{\text{No. of quadrats in which selected invasive plant species occurred}}{\text{Total no. of quadrats studied}} \times 100$$

Density, frequency, and coverage of the weeds among the forest, fallow land, and roadsides were compared using a non-parametric Kruskal-Wallis test as the data were not normal.

Density, frequency and cover of weeds

Ageratina adenophora had the highest density in the forest (27 plants per plot) and the lowest in the fallow land. In the case of *A. conyzoides,* the highest density was found along the roadside towards the North aspect while it was absent in the fallow-land (**Figure 1a, Table 1**). The density of *B. pilosa* was the highest in the roadside (28 plants per plot) towards the North aspect followed by the roadside towards the South aspect. Fallow land was the site where the density of *B. pilosa* was the least *i.e.* 4 plants per plot. The density of *P. hysterophorus* was the highest in the road towards the South aspect. The least density of *P. hysterophorus* was measured in the forests and roadside towards the North aspect (**Figure 1a, Table 1)**.

The highest cover of *A. adenophora* was found in the forest (38%) and the least in the fallow land (**Figure 1b, Table 1**). Similarly, *A. conyzoides* had the maximum coverage in the forest and roadside towards the North aspect in comparison to the fallow land and roadside towards the South aspect. *B. pilosa* had maximum cover in the road towards North aspect (34%) followed by road towards South aspect (31%) and the minimum cover was found in the forest. The highest cover of *P. hysterophorus* was found on the roadside towards South aspect (18%) followed by fallow land and the least in the roadside towards North aspect (**Figure 1b, Table 1**).

Table 1. Kruskal-Wallis test result for density and frequency of IAPS in different sites

	IAPS density			
	Forest	FA	RTNA	RTSA
Chi-square	51.45	57.27	42.38	55.68
P value	<0.001	<0.001	<0.001	<0.001
	IAPS cover			
Chi-Square	61.113	41.302	47.112	46.730
P value	<0.001	<0.001	<0.001	<0.001

FA: Fallow land; RTNA: Roadside towards the North aspect; RTSA: Roadside towards the South aspect

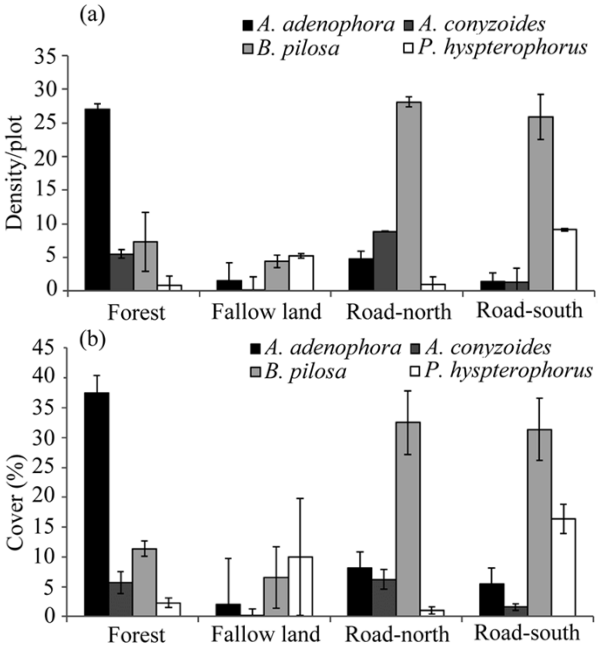

Figure 1. Density (a) and cover (b) of IAPS in different sites

All the weeds were present in all the sampling sites in the study area. In the case of *A. adenophora,* the highest frequency was found in the forest (100%) followed by the roadside towards the North and South aspects and the fallow land (**Figure 2**). Similarly, the highest frequency of *A. conyzoides* was found in the road towards the North aspect and the lowest in the fallow land. In the case of *B. pilosa*, the maximum frequency was found in the road towards the North aspect (100%) and forest (100%) followed by the road towards the South aspect (95%) and fallow land (91%). The frequency of *P. hysterophorus* was the highest in the road towards the South aspect (85%) and the least in the road towards the North aspect (18%) **(Figure 2)**.

The results show that the fallow land had a low density of weeds than the forest and roadsides might be due to high disturbance. In the Pine forest, there was high density, frequency, and cover of *A. adenophora* comparing to the other weeds. Its high density inside the forest may affect native species and seedling regenerations (Thapa *et al.* 2020a, 2020b). *B. pilosa* showed the highest density and cover in the roadsides towards both North and South aspect whereas it was the most frequent species in all sites although the density and cover were low in the forest and fallow land. It indicates that this species is one of the highly invading species in all types of habitats. Regarding the ecological impacts, this species is also responsible to reduce native diversity, alters soil characteristics, and inhibits plant growth and development (Khanh *et al.* 2009). It can be expected

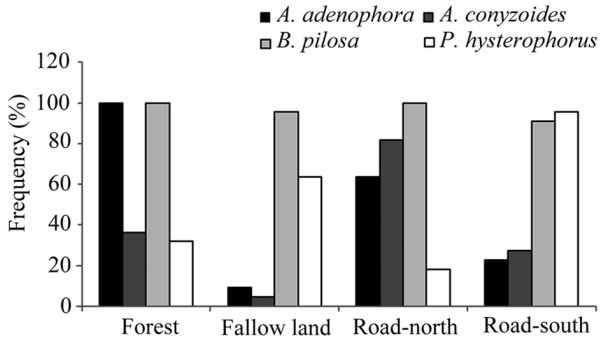

Figure 2. Frequency of IAPS in different sites

that the native species of the area might have negatively impacted by this weed.

Ageratum conyzoides is also known as a troublesome species having an adverse ecological, economic and social impact (Kohli *et al.* 2006). It was denser, more frequent with high cover in the forest and roadside towards the North aspect comparing to the fallow land and roadside towards South aspect but this weed is not a severer one in terms of its abundance in the Chobhar area. As the *P. hysterophorus* was abundant along the roadside (South aspect) and fallow land than the forest and roadside towards North aspect indicating the effect of aspect on its frequency and cover.

In conclusion, *A. adenophora, A. conyzoides, B. pilosa,* and *P. hysterophorus* were the major invasive alien weeds in the historical Chobhar area of Kathmandu valley, Nepal. Forest patches were heavily invaded by *A. adenophora* and *B. pilosa* showing their ability to invade under the tree canopies. Invasion of these weeds is deteriorating the natural beauty of the historical place and the native species diversity might have severely impacted. Hence, regular monitoring and appropriate methods of controlling these weeds should be implemented.

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