

DISTRIBUTION OF *PARTHENIUM* WEED IN PESHAWAR VALLEY, KHYBER PAKHTUNKHWA- PAKISTAN

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Abstract

Parthenium hysterophorus L. is a weed of national significance in Pakistan. Although infesting many districts of Khyber Pakhtunkhwa province, but more affected districts are Swabi, Mardan, Charsadda and Peshawar where it is highly invasive and invaded most of the open spaces roadsides, etc and threatening the local biodiversity. Field survey of four districts of the Peshawar valley, Khyber Pakhtunkhwa viz. Swabi, Mardan, Charsadda and Peshawar were carried out during May-June, 2009-2010 to study the distribution and invasion of parthenium weed. Twenty five locations were sampled from each district. Data regarding absolute and relative density, frequency, relative frequency, importance value %, average importance value, constancy classes and importance value constancy index of parthenium weed and other weeds of the area were recorded by using (1x1 m²) quadrat. The mean data across the surveyed districts reveals that the flora is predominated by parthenium weed with the highest relative density of 42.68% among all species. It was followed by *Cannabis sativa*, *Cynodon dactylon* and *Cyperus rotundus*, with relative densities of 15.17, 13.49 and 5.96, respectively. At different locations, it was observed that parthenium weed is competing with *Cannabis sativa* which is not so aggressive and problematic weed. While in some areas parthenium weed has already replaced *Cannabis sativa*. Mean distribution data showed that parthenium weed infestation was abundant and almost not uniform in all districts, however highest relative frequency of 26.14% was recorded for parthenium weed followed by *Cannabis sativa*, *Cynodon dactylon* and *Cyperus rotundus* having relative frequency of 15.17, 13.49 and 9.14, respectively. *Rumex crispus* and *Xanthium strumarium* infatuated the smallest relative frequency at most of the locations studied thereby indicating them as insignificant among the weed flora of the study area. Importance value data revealed that *P. hysterophorus*, *Cannabis sativa*, *Cynodon dactylon* and *Coronopus didymus* having IV % of 34.41, 16.30 13.42 and 7.14, respectively. Looking at the overall distribution of flora in Peshawar valley, parthenium weed is spreading rapidly along the roadsides, into agricultural fields and on wastelands. The dominance of parthenium weed is attributable to its invasive ability due to its allelopathic properties, higher growth rate, rapid flowering and higher fecundity.

Introduction

Parthenium weed also known as white top, whitehead, congress grass or carrot grass belongs to family Asteraceae; is an erect annual herb with alternate, deeply-dissected leaves, growing up to 2m tall, originated either in the Gulf of Mexico or in Central South America (Navie *et al.*, 1996). However, parthenium weed has been observed to behave as a perennial plant under the agro-ecological condition of Pakistan (Hassan & Amin, 2009). Through accidental introductions it has revealed considerable malleability and has spread to Eastern and Southern Africa, Southern USA, South Asia, The South China Region, Vietnam, Australia and the South Pacific (Tamado & Milberg, 2000) and is now a serious weed of agriculture in India, Ethiopia, Australia and recently Pakistan. Because of this status, it is recognized in the world's top ten worst weeds (Medhin, 1992; Parsons & Cuthbertson, 1992).

Parthenium hysterophorus L. an alien invasive weed is becoming a major weed of cropped and non-cropped areas in Pakistan (Adkins & Navie, 2006). In Pakistan, it was first recorded in 1980s. It is a recent introduction in Islamabad and is spreading to other areas in Khyber Pakhtunkhwa and Punjab (Hussain *et al.*, 2000). An earlier 1980's ecological survey of several locations of Islamabad does not report parthenium weed from a single location (Anonymous, 2011), whereas nowadays no location in Islamabad is without parthenium infestation (Hassan & Amin, 2009). Parthenium weed not only competes with desirable crops and pasture species but also causes farmers and stock

animals to suffer an allergic skin condition while in contact with it (Chippendale & Panetta, 1994). Parts of parthenium weed and Sorghum are allelopathic, exhibiting strong competitive ability for soil moisture and nutrients while inhibiting the germination and growth of neighboring plant species (Adkins & Sowerby, 1996; Ashraf & Akhlaq, 2007). Moreover parthenium weed is the causal agent for serious economic, health and environmental problems (Adkins *et al.*, 1997).

Parthenium weed has infested almost all field crops, pastures, wastelands, yards, fencerows, and rights-of-ways and when left uncontrolled, it can reduce crop yields by 40 to 97% (Navie *et al.*, 1998; Tamado & Milberg, 2004). In Pakistan Khan *et al.*, (2013) recorded 30% yield losses in sorghum and 20% in maize crop due to parthenium weed. (Kohli *et al.*, 2006) reported that it can badly impact agriculture, environment, human and animal health and biodiversity and thus contribute to social and economic instability, placing constraints on sustainable development, economic growth, poverty alleviation and food security.

Parthenium weed has been quickly spreading in different parts of Pakistan for the last 20 years (Javaid & Riaz, 2012) and enormous losses to crop and rangeland production have been observed. In addition farmers and livestock are known to suffer allergic skin and asthmatic reactions in the parthenium weed infested areas. This weed has been found in some of the most important rangelands (Swat & Pothohar valley) in the country as well as in fodder crops such as maize, sorghum, Persian clover and Egyptian clover. Other reports also show

parthenium weed to be threatening to infest other fodder and cereal crops, as well as vegetables like bitter gourd, gourd and melons as well as timber crops (Shabbir & Bajwa, 2006). Parthenium weed has attained the status of most frequently and densely occurring weed in Swabi, Mardan and Charsadda districts (Khan *et al.*, 2012).

Parthenium weed is rapidly spreading in Pakistan and causing severe damage to the agriculture productivity of the country. Due to its recent

introduction; parthenium weed distribution and invasion are little understood and documented in Khyber Pakhtunkhwa, Pakistan. The objectives of this field survey were: 1) to ascertain the dominance and agro-ecological distribution of parthenium weed in Peshawar valley, KPK- Province; 2) to develop a distribution map for parthenium weed in KPK- Province; 3) to decipher the association of parthenium weed with other weeds (Fig. 1).

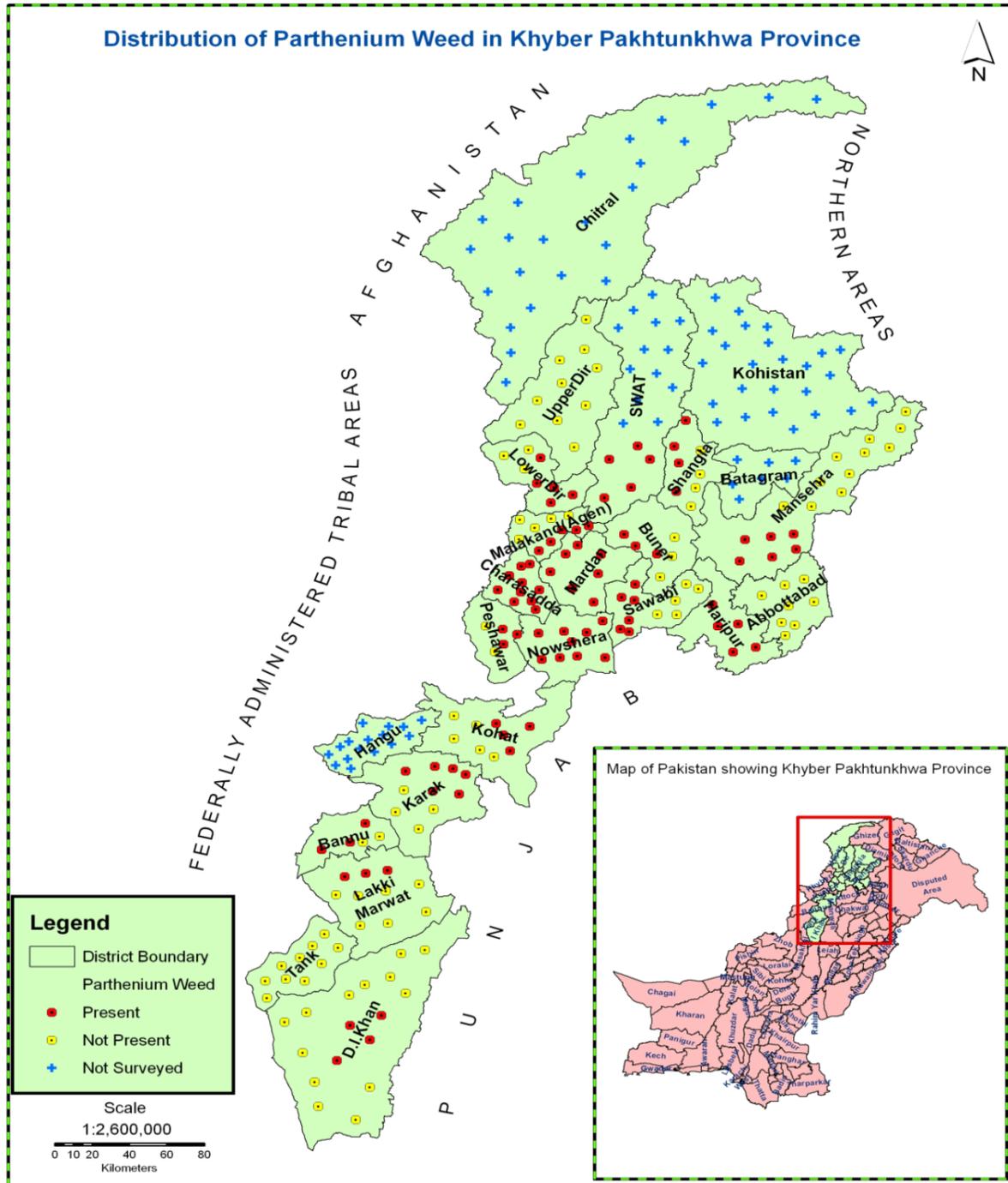


Fig. 1. Map showing parthenium weed distribution in Khyber Pakhtunkhwa.

Materials and Methods

Field surveys of different districts of the Khyber Pakhtunkhwa Province, viz. Swabi, Mardan, Charsadda and Peshawar were carried out during the May-June, 2009-2010 to record the distribution and invasion of parthenium weed on wastelands, along the roadsides and beside and inside of the fields of agricultural crops. Twenty five locations were randomly sampled from each district. Ten quadrates (1x1 m²) were randomly placed along an inverted horizontal pattern in each site following the methodology of Thomas, 1985, 1991 and McCully *et al.*, 1991 with slight modifications. The distance between each quadrate depended upon the size and shape of the field and any obstructions that may have been present in the field. The larger was the field, the greater was the distance between the quadrates.

Density m⁻² and frequency of parthenium weed and other weed species were recorded by using

quadrate and from the same data, Relative density (%), Frequency (%), Relative frequency (%), Importance value (%), Average importance value, Constancy classes and Importance value constancy index (IVCI) of weed species were computed. The impacts of parthenium weed on biodiversity were assessed, using the importance value index to describe its importance. The importance value index is useful to compare the ecological significance of a particular species (Girma *et al.*, 2004; Hassan *et al.*, 2010). During the survey, all weed species were collected and identified from the Department of Weed Science, The Agriculture University Peshawar. The samples were deposited into the herbarium of the Department of Weed Science, The Agriculture University, Peshawar. Grower's perceptions about parthenium weed were also recorded. During the course of studies, the data were recorded on the following parameters as adopted from Hussain, 1989 and Hussain *et al.*, 2004:

1. Absolute Density m⁻² (AD)

$$\text{Absolute density (AD)} = \frac{\text{Total no. of individuals of a species in all quadrates}}{\text{Total no. of quadrates}}$$

2. Relative Density (%)

$$\text{Relative density (RD) (\%)} = \frac{\text{Mean of individual species}}{\text{Mean of total species}} \times 100$$

3. Frequency (%)

$$\text{Frequency (F) (\%)} = \frac{\text{Number of quadrates in which species occurs}}{\text{Total number of quadrates}} \times 100$$

4. Relative Frequency (%)

$$\text{Relative Frequency (RF) (\%)} = \frac{\text{Frequency value of single species}}{\text{Total frequency}} \times 100$$

5. Importance Value %

$$\text{Importance Value (IV) \%} = \frac{\text{Relative density \%} + \text{Relative frequency \%}}{2}$$

6. Importance Value Constancy Index (IVCI)

$$\text{Importance Value Constancy Index} = \text{Average Importance Value (AIV)} \times \text{Constancy Class}$$

Results Absolute Density m⁻²: The survey data shows that among the districts, the highest density 36.63 m⁻² was recorded in Swabi, closely followed by 34.98 m⁻², 33.35 m⁻² and 30.49 at Mardan, Charsadda and Peshawar, respectively. The mean density across the districts depicts the *Parthenium hysterophorus* (14.67 m⁻²) as the premier component of flora infesting the Peshawar valley followed by *Cannabis sativa* (5.04 m⁻²) and *Cynodon dactylon* (4.62 m⁻²). While *Rumex crispus*, (0.63 m⁻²) and *Xanthium strumarium* (0.39 m⁻²) had the lowest density among the species infesting the study area (Table 1). The highest infestation of *P. hysterophorus* 22.30 m⁻² was

recorded at Charsadda district, followed by 18.12, 13.03 and 5.22 at Swabi, Mardan and Peshawar, respectively. In all districts parthenium weed having the mean maximum density of 22.30 m⁻² was followed by *Cannabis sativa* (7.46 m⁻²) and *Cynodon dactylon* (6.52 m⁻²) (Fig. 2).

Relative density (%): Analysis of the data revealed that weed species growth was in abundance. Highest relative density 66.87% was recorded for *P. hysterophorus* in Charsadda followed by 49.47% at Swabi and 37.25% in Mardan district (Table 2). While the lowest relative density (17.12%) of parthenium weed was recorded in

Peshawar district. The major weed communities prevailing in whole study area were comprised of *Parthenium-Cannabis-Cynodon*. The data reveal the dominance of parthenium weed in Charsadda, Swabi and Mardan districts (Fig. 3). Mean data shows that parthenium weed was the most prevalent species with relative density of (42.68%) followed by *Cannabis sativa* (15.17%) and *Cynodon dactylon* (13.49%). While *Rumex crispus* and *Xanthium strumarium* having minimum means relative densities % of 1.85 and 1.16, respectively. However, at Peshawar district, the maximum relative density of *Cannabis sativa* (24.47%) was recorded compared to other weeds. At different locations it was observed that parthenium weed is competing with *Cannabis sativa* which is not so hostile and problematic weed. While in some areas parthenium weed has already replaced *Cannabis sativa*.

Frequency (%): A core infestation of parthenium weed is present in the whole Peshawar valley having mean frequency of 85%. The growth of the weed was so dense that most of the thrown quadrates included the parthenium weed (Table 3). The data show that the highest frequency (100%) of *Parthenium hysterophorus* was observed in Swabi and Charsadda districts while the minimum frequency of (60%) of parthenium weed was observed at Peshawar. After parthenium weed in all surveyed locations, *Cannabis sativa* and *Cynodon dactylon* occurred in abundance having frequencies of 56.3% and 43.3%, respectively (Fig. 4). The weed frequency status at Swabi had similarities with Charsadda district.

Relative frequency (%): The data (Table 4) exhibit the predominance of parthenium weed at all 4 locations studied. The relative frequency of weeds is a good statistic showing the distribution of flora in an area. The highest relative frequency (31.95%) of parthenium weed was recorded in district Charsadda. The data further manifest that parthenium weed infestation was almost uniform at Charsadda, Swabi and Mardan, however minimum relative frequency (19.35%) was recorded at Peshawar district. *Rumex crispus* and *Xanthium strumarium* possessed the smallest relative frequency at most of the sites examined thereby indicating them as insignificant among the weed flora of the study area (Fig. 5).

Importance value %: The Importance value of weeds is a good indicator of the flora distribution in the area. Among the locations surveyed the highest importance value of 49.41% for *P. hysterophorus* was recorded at Charsadda closely followed by 39.06% at Swabi. Parthenium weed however ranked at the top emerging as the most prevalent weed at all the locations as well as its mean values for all four districts is the highest (34.41%) (Table 5). The perusal of data further exhibit that *Parthenium-Cannabis-Cynodon* community dominated in all districts. The data exhibit that parthenium weed is spreading in district Peshawar and competing with *Cannabis sativa* (Fig. 6). The Average Importance Value (AIV), Constancy and Importance value Constancy Index (IVCI) also confirm the preponderance of *P. hysterophorus*, *Cannabis sativa* and *C. dactylon*.

Table 1. Density m⁻² of various weed species in four district of Peshawar valley.

Weed species	Peshawar	Mardan	Charsadda	Swabi	Means
<i>Parthenium hysterophorus</i>	5.22	13.03	22.30	18.12	14.67
<i>Cannabis sativa</i>	7.46	5.70	3.00	4.00	5.04
<i>Cynodon dactylon</i>	4.00	5.54	2.40	6.52	4.62
<i>Euphorbia heloiscopeia</i>	3.28	2.00	0.50	2.10	1.97
<i>Amaranthus viridus</i>	2.00	1.00	0.85	1.60	1.36
<i>Chenopodium</i> spp.	2.45	1.36	0.50	1.74	1.51
<i>Coronopus didymus</i>	3.00	1.45	1.20	1.10	1.69
<i>Rumex crispus</i>	0.60	0.80	0.50	0.60	0.63
<i>Cyperus rotundus</i>	1.98	3.70	1.80	0.50	2.00
<i>Xanthium strumarium</i>	0.50	0.40	0.30	0.35	0.39
Total	30.49	34.98	33.35	36.63	

Table 2. Relative density % of weed species in four district of Peshawar valley.

Weed species	Peshawar	Mardan	Charsadda	Swabi	Means
<i>Parthenium hysterophorus</i>	17.12	37.25	66.87	49.47	42.68
<i>Cannabis sativa</i>	24.47	16.30	9.00	10.92	15.17
<i>Cynodon dactylon</i>	13.12	15.84	7.20	17.80	13.49
<i>Euphorbia heloiscopeia</i>	10.76	5.72	1.50	5.73	5.93
<i>Amaranthus viridus</i>	6.56	2.86	2.55	4.37	4.08
<i>Chenopodium</i> spp.	8.04	3.89	1.50	4.75	4.54
<i>Coronopus didymus</i>	9.84	4.15	3.60	3.00	5.15
<i>Rumex crispus</i>	1.97	2.29	1.50	1.64	1.85
<i>Cyperus rotundus</i>	6.49	10.58	5.40	1.37	5.96
<i>Xanthium strumarium</i>	1.64	1.14	0.90	0.96	1.16

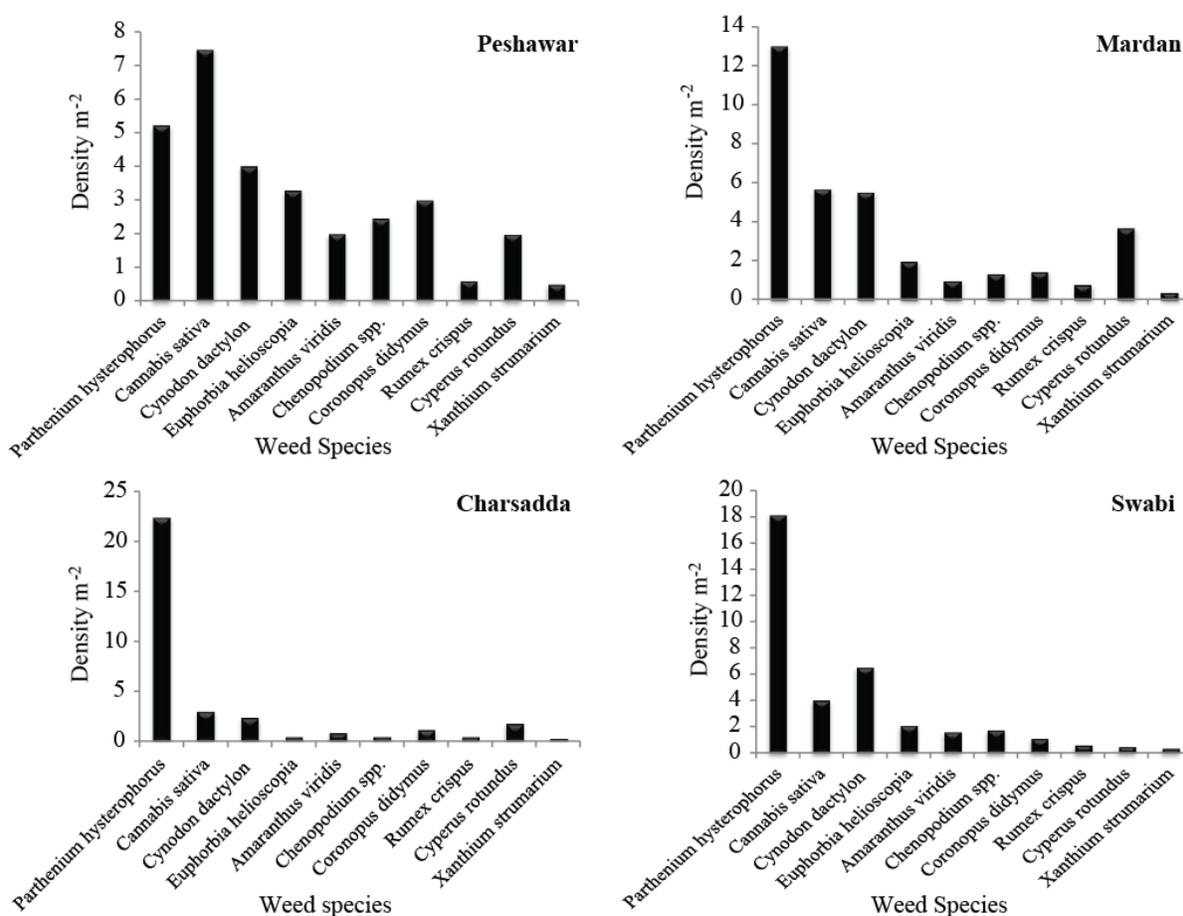
Fig. 2. Density m^{-2} of various weed species in Peshawar, Mardan, Charsadda and Swabi District.

Table 3. Frequency % of weed species in four district of Peshawar valley.

Weed species	Peshawar	Mardan	Charsadda	Swabi	Means
<i>Parthenium hysterophorus</i>	60	80	100	100	85.0
<i>Cannabis sativa</i>	70	60	45	50	56.3
<i>Cynodon dactylon</i>	40	50	40	43	43.3
<i>Euphorbia helioscopia</i>	20	20	20	43	25.8
<i>Amaranthus viridis</i>	20	10	20	40	22.5
<i>Chenopodium spp.</i>	20	30	25	20	23.8
<i>Coronopus didymus</i>	30	32	30	26	29.5
<i>Rumex crispus</i>	10	10	15	5	10.0
<i>Cyperus rotundus</i>	30	25	13	15	20.8
<i>Xanthium strumarium</i>	10	8	5	7	7.5

Table 4. Relative frequency % of weed species in four district of Peshawar valley.

Weed species	Peshawar	Mardan	Charsadda	Swabi	Means
<i>Parthenium hysterophorus</i>	19.35	24.62	31.95	28.65	26.14
<i>Cannabis sativa</i>	22.58	18.46	14.38	14.33	17.44
<i>Cynodon dactylon</i>	12.90	15.38	12.78	12.32	13.35
<i>Euphorbia helioscopia</i>	6.45	6.15	6.39	12.32	7.83
<i>Amaranthus viridis</i>	6.45	3.08	6.39	11.46	6.84
<i>Chenopodium spp.</i>	6.45	9.23	7.99	5.73	7.35
<i>Coronopus didymus</i>	9.68	9.85	9.58	7.45	9.14
<i>Rumex crispus</i>	3.23	3.08	4.79	1.43	3.13
<i>Cyperus rotundus</i>	9.68	7.69	4.15	4.30	6.46
<i>Xanthium strumarium</i>	3.23	2.46	1.60	2.01	2.32

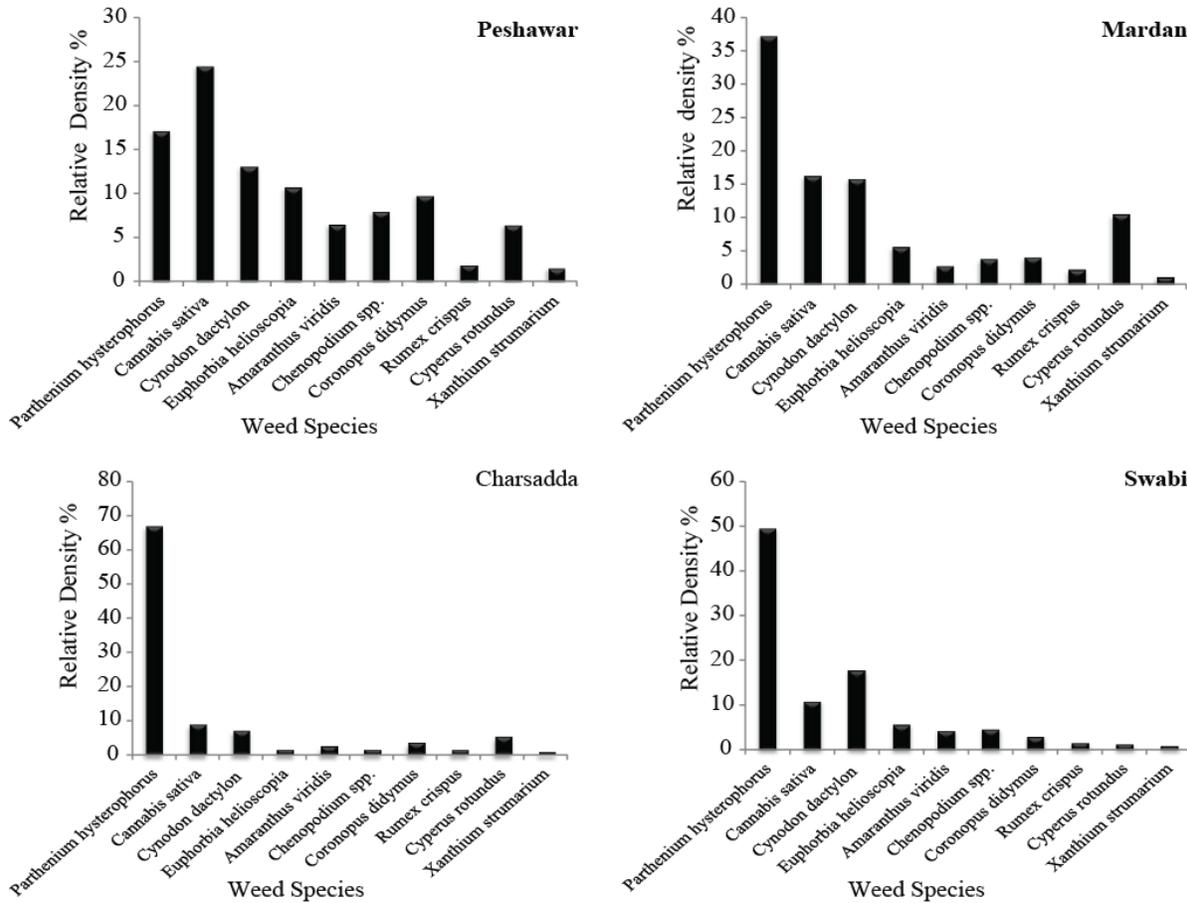


Fig. 3. Relative density % of various weed species in Peshawar, Mardan, Charsadda and Swabi district.

Table 5. Importance value (IV), average importance value (AIV), constancy and importance value constancy index (IVCI) of weed species in four districts of Peshawar valley.

Weed species	Peshawar	Mardan	Charsadda	Swabi	AIV	Constancy classes	IVCI
<i>Parthenium hysterophorus</i>	18.24	30.93	49.41	39.06	34.41	4	137.64
<i>Cannabis sativa</i>	23.52	17.38	11.69	12.62	16.30	4	65.2
<i>Cynodon dactylon</i>	13.01	15.61	9.99	15.06	13.42	4	53.6
<i>Euphorbia helioscopia</i>	8.60	5.94	3.94	9.03	6.88	4	27.52
<i>Amaranthus viridis</i>	6.51	2.97	4.47	7.91	5.46	4	21.84
<i>Chenopodium album</i>	7.24	6.56	4.74	5.24	5.95	4	23.8
<i>Coronopus didymus</i>	9.76	7.00	6.59	5.23	7.14	4	28.56
<i>Rumex crispus</i>	2.60	2.68	3.15	1.54	2.49	4	9.96
<i>Cyperus rotundus</i>	8.09	9.13	4.78	2.83	6.21	4	24.84
<i>Xanthium strumarium</i>	2.43	1.80	1.25	1.48	1.74	4	6.96

Discussion

Parthenium weed has been accidentally introduced into Pakistan and now become a weed of national significance, infesting vast areas in Khyber Pakhtunkhwa, Punjab and Islamabad. This weed is rapidly replacing our local flora due to the absence of their natural enemies. The findings of study illustrate that parthenium weed causes significant agricultural and environmental problems, such as the loss to crop productivity, fodder, biodiversity, animal

production and health problems and it has the potential to spread all over the Khyber Pakhtunkhwa, a serious menace to social, economic returns, and food security of our country. Evans (1997) reported that invasive weed species can affect crop production, animal husbandry, human health and biodiversity. Similarly, (Anon., 2004; Usman *et al.*, 2010) also confirmed that parthenium weed contributes to social and economic instability, placing constraints on sustainable development, economic growth, poverty alleviation and food security.

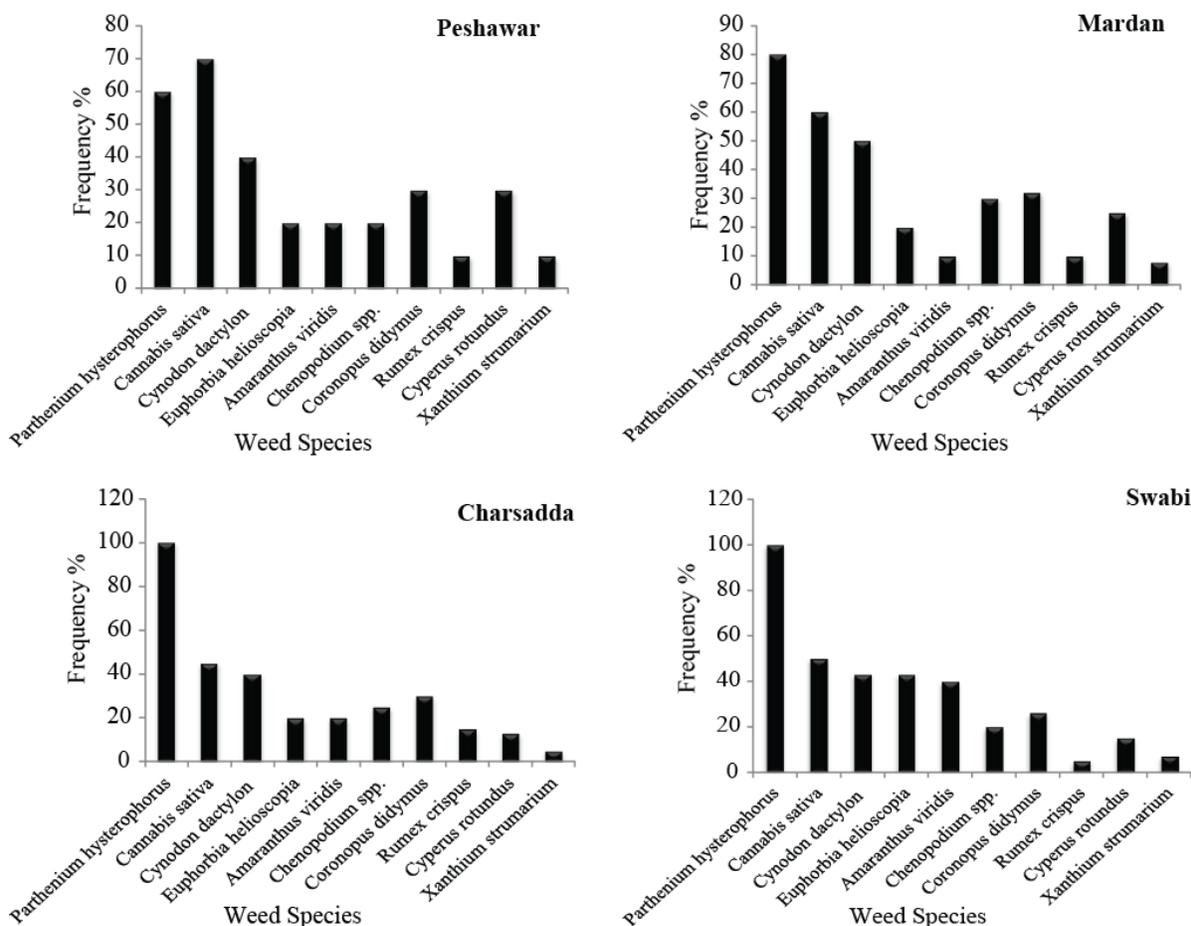


Fig. 4. Frequency % of various weed species in Peshawar, Mardan, Charsadda and Swabi district.

The survey results revealed that six weed species were common in the study area; *Parthenium hysterophorus*, *Cannabis sativa*, *Cynodon dactylon*, *Coronopus didymus*, *Cyperus rotundus* and *Euphorbia helioscopia*. It is worth mentioning that most troublesome was quite recently introduced parthenium weed. The data exhibits high relative frequency, relative density and importance value of *P. hysterophorus* (Mahadevappa, 1997; Navie *et al.*, 1996). Those workers reported that parthenium weed became the major noxious weed for the last 25 years in India and Australia, respectively. The parthenium invasion also reported from Bangladesh (Mahadevappa, 1997), Israel (Joel & Litson, 1986), Taiwan (Peng *et al.*, 1988), China & Vietnam (Navie *et al.*, 1996).

The results suggest that *P. hysterophorus* L. has become a major weed of the wasteland, road sides, orchards, waterways grasslands and municipal areas of Peshawar valley. The parthenium weed is well established in Swabi, Mardan and Charsadda districts while it is present in Peshawar district still with little and isolated infestation. In grazing lands and roadsides, one can easily observe the prominent influence of parthenium weed on the composition and importance values of other plant species. Marwat *et al.*, (2010) reported that due to the quick spread and development

parthenium weed has become one of the he most troublesome weed in KPK province.

Haseler (1976) suggested that this may be due to many factors like wider adaptation across climates, photo insensitivity, and drought tolerance. Krishnamurthy *et al.*, (1997) reported the allelopathic nature of parthenium weed and its impact on plant diversity.

Farmers in the study area believe that parthenium weed was introduced into the Peshawar valley in late 1990s. Since then it expanded at alarming rate in all directions. Farmers' view of the infestation of the habitat conforms to field observation. It was observed that parthenium weed population is high in places where the soils are disturbed constantly for purposes of construction of road, buildings, and waterways for irrigation channels. Therefore, the extensive density along roadsides in different villages might be due to the road construction and transportation of soil, sands and gravels from parthenium infested to non-infested areas (Huy & Seghal, 2004; Shabbir & Bajwa, 2006). These researchers suggest that parthenium weed invades disturbed land and it will readily colonize disturbed, bare lands along roadsides. This might have helped the dispersal of the weed thereby contributing to severe infestation and invasion of parthenium weed in the Peshawar valley.

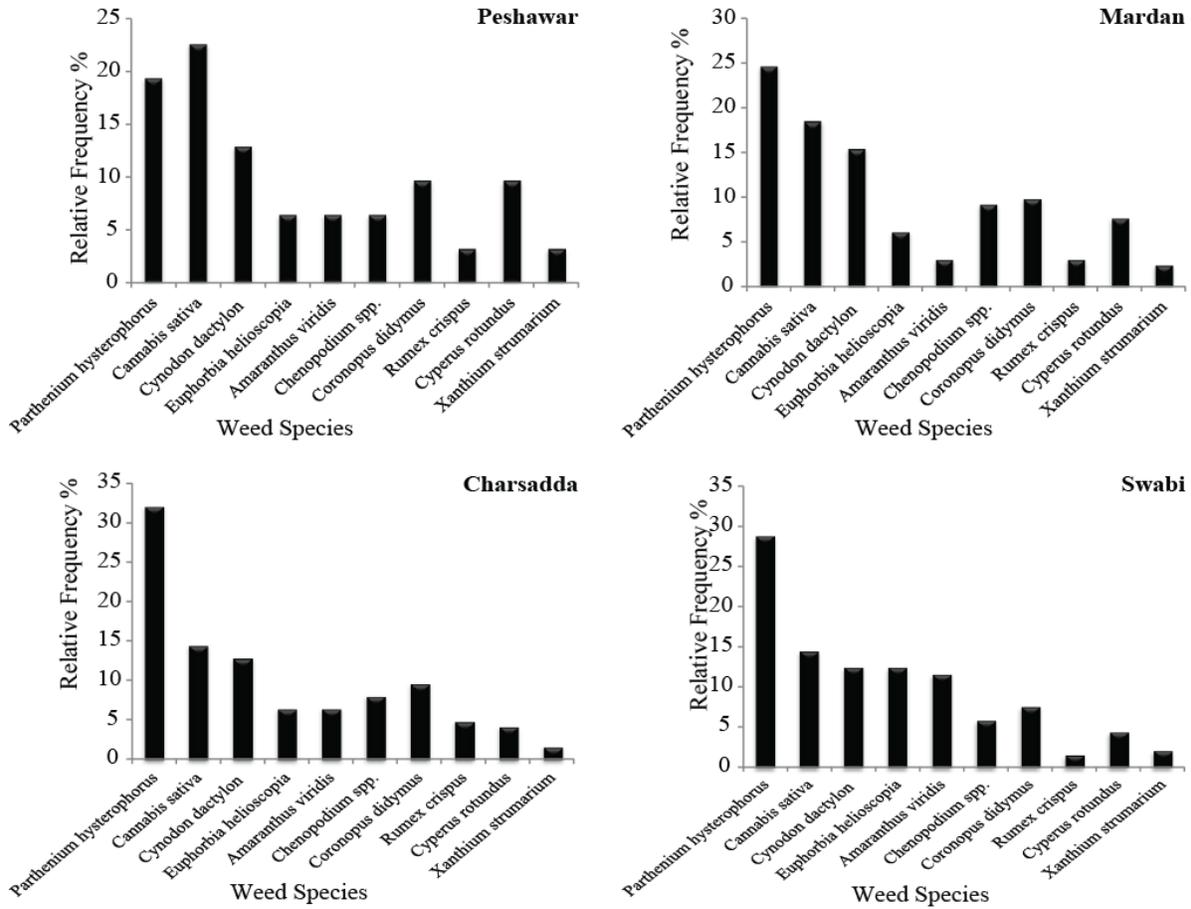


Fig. 5. Relative frequency % of various weed species in Peshawar, Mardan, Charsadda and Swabi district.

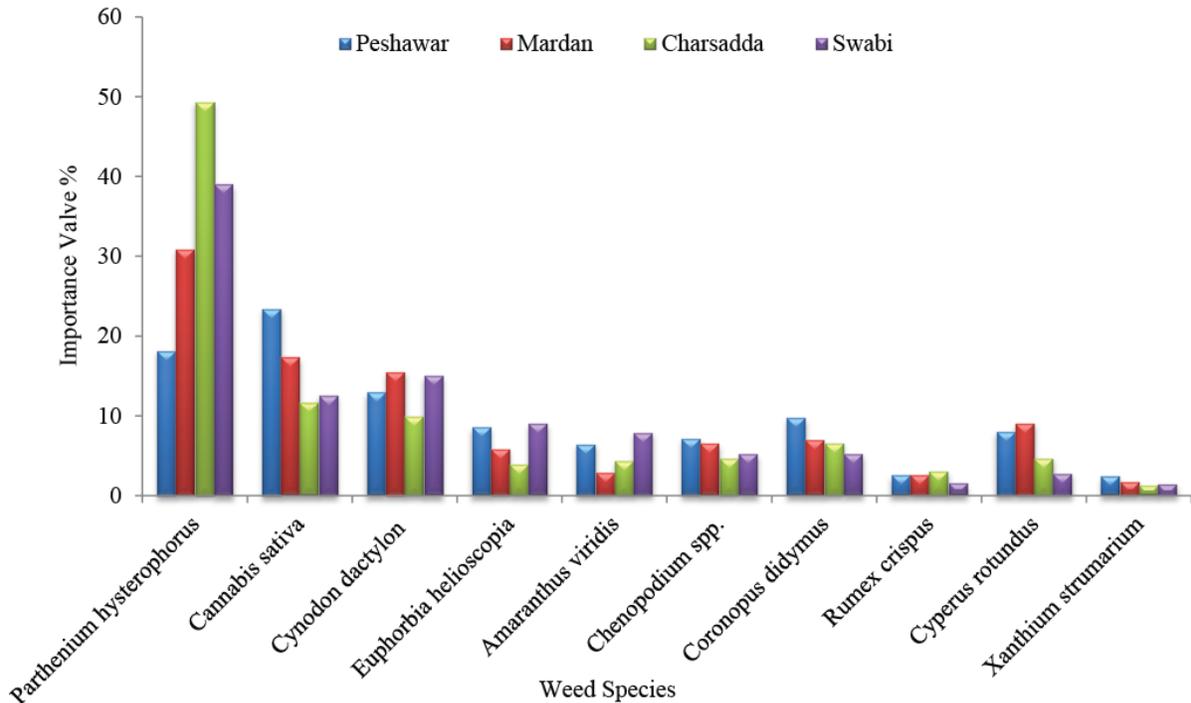


Fig. 6. Importance value % of weed species in four districts of Peshawar valley.

Parthenium weed was found in all districts showing 100% prevalence in some districts. The absolute and relative frequencies of various weed species ranged from 7.5 to 85% and 2.32 to 26.14%, respectively. Parthenium weed was the first most frequently occurring weed in the study area with mean absolute frequency of 85% and relative frequency of 26.14%, and having *Cannabis sativa* as the second ranked with 56.3% and 17.44%, respectively. Similarly parthenium weed and *Cannabis sativa* were found the two most densely populated weeds with 14.67 and 5.04 absolute densities and 42.68% and 15.17% relative density, respectively. Tamado (2002) also reported that parthenium weed is the second most frequent weed in eastern Ethiopia.

Due to its effective adaptability to varying conditions, parthenium has replaced the precious native flora of Peshawar valley and poses a strong threat to our biodiversity (Anon., 2005). They reported that invasive alien species have invaded almost every type of native ecosystem and caused hundreds of biological extinctions throughout the world. At different locations it was observed that parthenium weed is competing with *Cannabis sativa* which is not so aggressive and problematic weed. While in some areas they already replaced *Cannabis sativa*, is attributable to its invasive capacity due to its allelopathic properties, higher growth rate, rapid flowering and higher fecundity (Evans, 1997; Pandey & Dubby, 1993). It has been reported as causing a total habitat change in native Australian grasslands, open woodlands, riverbanks and flood plains (Chippendale & Panetta, 1994). A similar invasion of parthenium in national wildlife park in Southern India has also been reported (Evans, 1997).

Importance value data shows the superiority of *P. hysterophorus* at all the locations studied. The findings depict that *P. hysterophorus* was found to be the most frequent and dominant species in road sides, waste land, grazing land and around the crops. It occurred along ~100 km of motorway road, from Peshawar to Swabi. The greatest density of parthenium was recorded along the roads. Field crops attack by parthenium weed was sorghum, maize and vegetables.

Conclusion

The findings of the study revealed that the obnoxious parthenium weed grows in a wide variety of habitats and causes changes in above ground vegetation as well as in below ground soil nutrients. Parthenium weed attained the status of most frequently and densely occurring weed in Peshawar valley and expected to continue its dissemination because of the negligence not only of the farming community but also the agriculture department to control it. The parthenium weed is well established in Swabi, Mardan and Charsadda districts while present in Peshawar district with isolated infestation yet. Due to its effective adaptability to varying conditions and lack of their natural enemies, parthenium weed has replaced our precious native flora and poses a strong threat to our biodiversity. The finding of study revealed that *P. hysterophorus* causing significant agricultural and environmental problems, such as the loss to crop productivity, fodder, biodiversity, animal production and

health problems and it has the potential to spread all over Khyber Pakhtunkhwa, a serious threat to social, economic, and food security of our country. It is concluded that much has not been done for the awareness of growers from the danger of *P. hysterophorus* which has become a major pest of the grazing land, roadside, wasteland, wetland as well as cultivated land and it has the potential to cover all over the Peshawar valley. Therefore, an appropriate parthenium weed management strategy is necessary to stop potential spread and threats to biodiversity and economy of Pakistan.

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