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Full Length Research Paper

Distribution, Biology and Ecology of *Parthenium hysterophorus* L. (Congress Grass) an invasive species in the North-Western Indian Himalaya (Himachal Pradesh)

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Parthenium hysterophorus **L. is a native plant of sub-tropical America and it is rapidly invading in the North-Western Indian Himalaya (Himachal Pradesh), from last two decades onwards. Here, it is invaded up-to 2000 m altitude from mean sea level and drastically effecting native plant resources in the invaded habitats. The density and dominance of the *P. hsterophorus* has been higher in the summer and was nearly absent during the winter season in the NW Himalaya. The average height of the plants of *P. hysterophorus* was recorded up-to 2.09 0.27 m and its root system deep up-to 17.32 4.03 cm below the ground level. It produced an enormous number of seeds which will help in its invasion in to various habitats. It was measured that one single plant of *Parthenium* produced more than 7397 81.42 seeds during one season. The seeds were lighter in weight and were 2.31 0.02 mm in length and 1.03 0.01 mm in width. In the NW Himalaya *P. hysterophorus* completed its two life cycles in one year, that is,from March to June and from July to November.**

Key words: Invasive species, North-Western Himalaya, *Parthenium hysterophorus*

INTRODUCTION

Invasive plants are invading rapidly in the new habitats around the globe in the 21st century and as a result homogenization of the native plant species (Vitousek et al., 1997). The invasive plants are those which have higher densities, greater performance in their introduced habitats than their native ones and have greater effect on the native species (Blosey and Notzold, 1995; Bais et al., 2003). The invasion by invasive plants disturb the structure and composition of the native vegetation on a large extent and a as result crate pressure on the food chain and web of the ecosystem (Pimentel et al., 2000). Invasive plants now dominate many aspects of terrestrial, marine or freshwater communities throughout the world and many more introduced species remain undetected or unrecognized (Ruiz et al., 2000).

Partenium hysterophorus L., commonly known as congress grass, feverfew, ragweed parthenium or white top is a noxious weed native to tropical America. It has now naturalized in several tropical and subtropical parts of the world (Dogra et al., 2009a; Kohli et al., 2009). It is one of the most troublesome weeds and figures among the list of invasive species in the GISD (2007). It was first reported in India in 1956 growing in the outskirts of Poona (Rao, 1956). In the Shivalik hills, it has become one of the major and prominent weed during the last two decades and is still continuing to spread in the urban as well as natural habitats (Dogra et al., 2009a). *P. hysterophorus* is an annual, erect herb, reaching a height of 1.0 to 2.0 cm or more during favorable conditions. The plant had a tap root system with a number of secondary and tertiary roots. The shape of the leaves was rhomboidal and dissected and arranged alternatively on the stem. The stem of the plant remained greenish white in colour. The leaves and stem had small hair-like outgrowths called trichomes. The inflorescence in *P. hysterophorus* is capitulam type having creamy-white coloured flowers. The fruit of the plant is cypsela. The seeds are dark brown, very light in weight and often dispersed by means of air up to several kilometers.

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The weed was mostly seen in grasslands, roadsides, orchard, unattended lands, wastelands, horticulture fields and its encroachment was progressing towards the forest areas in the NW Himalaya.

METHODOLOGY

Study of distribution map

For the evaluation of distribution of *P. hysterophorus* in the North West (NW) Himalayan zones, three altitude ranges mentioned above were selected (300 to 1500 m (Sub tropical warm humid climate; 1500 to 2400 m temperate cold climate; 2400 to 3800 m temperate to alpine cold climate). Further there was no *P. hysterophorus* reported beyond the 2400 m altitude; because of this no range was selected in the alpine Himalaya. In each of the selected ranges, 3 sites were selected to calculate the ecological distribution of species. At each site 200 quadrats of size 2 × 2 m and 5 × 5 m, depending upon the area and plant species were laid (Mishra, 1968).

Study of biology, ecology and life cycle

The biology, ecology and life cycle of *P. hysterophorus* L. was studied under the natural conditions in NW Himalaya. For this, three sites were selected in the Shivalik ranges. Regular visits were made to each site after a gap of one month throughout the year from October 2008 to September 2009. Visits were repeated the succeeding year. The sites were marked properly to avoid any kind of error in the observations. At each site, 100 healthy plants were selected and their different biotic characters measured at the end of the flowering season. The leaf area, length, width, perimeter, shape factor and ratio were measured with the help of CI-251 area meter (CID, Inc., USA). For this, 100 leaves plucked from each site were put in the folds of papers and brought to the laboratory for measurement. The life cycles were studied by continuous monitoring of the invasive plant from vegetative stage to seed setting stages. Dry weights of the plants were measured after keeping the fresh plant in the oven at 80°C for 3 days.

Statistical analysis

Student t-test with two populations at 5% significance level was used for statistical analysis of data.

RESULTS

Distribution, biology, ecology and life cycle of *Parthenium hysterophorus* in the NW Himalaya

Distribution

The distribution of *P. hysterophorus* was densely in the lower Himalayas as compared to middle Himalayas and also found absent in the upper Himalayas (Figure 1). It was significantly (48.25%) more abundant between 300 and 1500 m (10.26 + 0.59) altitudes in the lower Himalaya as compared to the altitude ranging between 1500 and 2400 m (5.31 + 1.31) in the middle Himalaya (Table 1 and Figure 2). The invasive plant was most frequently established in terms of distribution between the altitudes varying from 300 to 1500 m (4.37 ± 0.83) which was 51.95% more than from 1500 to 2400 m (2.10 ± 0.59) altitudes in the middle Himalaya. The density and dominance of *P. hysterophorus* was also significantly (60.59 and 78.34%, respectively) more between the 300 and 1500 m range as compared to 1500 and 2400 m. The distribution of the invasive species in terms of IVI between the two ranges of altitude in NW Himalaya showed significant change and it was found to be 56.50% more in the lower altitude range. *P. hysterophorus* was not recorded between 2400 and 3800 m altitude. This showed that they could not invade beyond 2000 m but invaded the valleys having lower altitude situated in the middle himalayas. The invasive plant was absent both in the hilly areas as well as valleys in the upper Himalaya.

Biology and ecology

It was abundant during the summer season in the various areas/habitats of the NW Himalaya (Himachal Pradesh) up-to 2000 m altitude. The height of the invasive plant was measured around 2.09 + 0.27 m above the ground and the root system was 17.32 4.03 cm deep (Table 2). The average density of *P. hysterophorus* was 11.31 + 3.92 plants/m^2 and on an average a single plant had more than 17.30 ± 2.34 branches. On an average a mature plant had approximately 229.38 23.12 leaves and their average length 18.83 ± 2.01cm, width 6.54 ± 0.98 cm and area 26.84 ± 3.63 cm^2. The leaf perimeter, ratio and shape factor were 40.29 + 4.65 cm, 3.02 ± 0.67, 0.28 + 0.06, respectively. The trichomes on leaf and stem were very short in length. They were more on the abaxial surface than adaxial surface of the leaf. On the upper surface of leaf they were 119.23 ± 9.72 per cm^2 and 97.75 7.89 per cm^2 on the underside of the leaf. On the stem approximately 82.70 ± 12.63 trichomes per cm^2 were counted. The plant had a tap root which was 15.59 ± 1.84 cm in length having secondary and tertiary roots. The number of secondary and tertiary roots were 18.28 + 4.89 and 11.53 + 2.37, respectively. Its one plant had around 378.29 + 27.42 inflorescence heads. Single inflorescence of plant bore on an average 97.39 ± 11.89 flowers. *Parthenium hysterophorus* produced around 7397 81.42 seeds per plant. The length of the seed was measured around 2.31 0.02 mm and width 1.03 0.01 mm. The dry weight of the above ground portion of one mature plant of *P. hyaterophorus* was 8.32 1.86 g and below ground part 2.01 0.03 g, respectively.

Life cycle

Parthenium hysterophorus showed more sporadic phase of growth in the summer and rainy season but was also

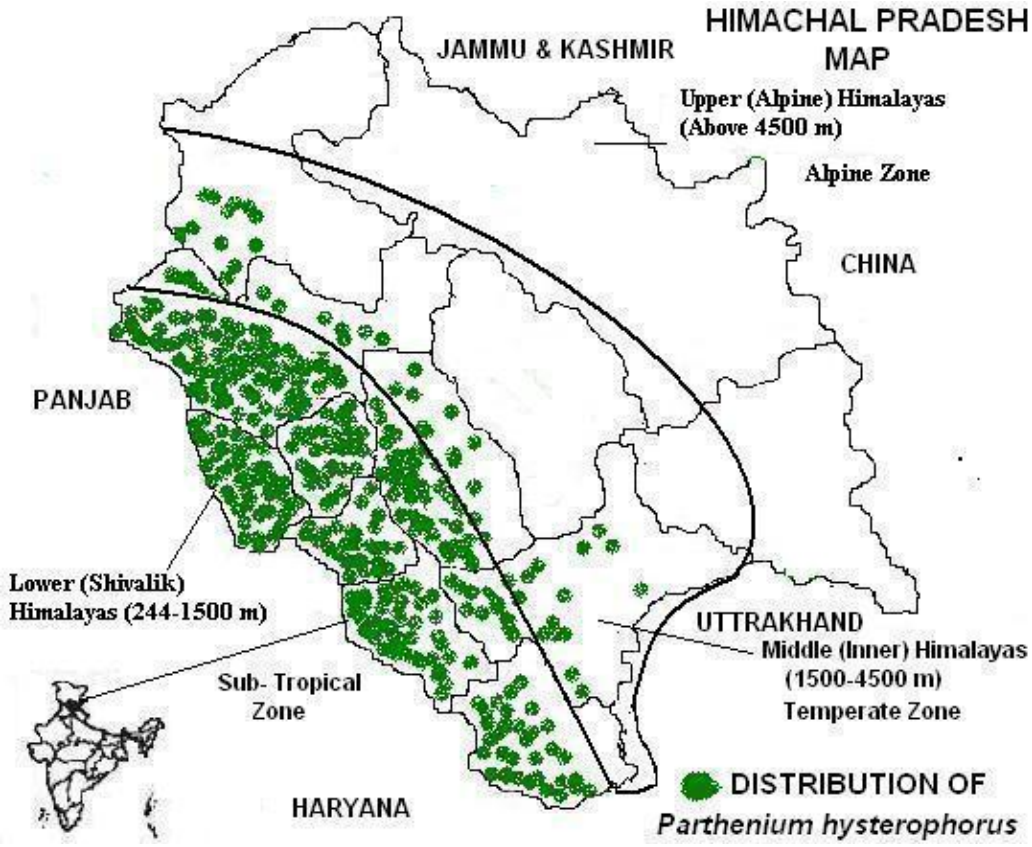

Figure 1. Distribution map of *Parthenium hysterophorus* in the NW Himalaya.

Table 1. Distribution of *P. hysterophorus* in the three altitudinal ranges in NW Himalaya.

Altitudinal ranges	Abundance	Frequency	Density	Dominance	Ivi
300 to 1500	10.26 ± 0.59*	4.37 ± 0.83*	17.43 ± 1.56*	8.17 ± 1.43*	9.77 ± 1.48*
1500 to 2400	5.31 ± 1.31	2.10 ± 0.59	6.87 ± 1.46	1.77 ± 0.46	4.25 ± 1.67
2400 to 3800	***	***	***	***	***

*** Species not recorded; * means significant at 5% level after applying student- *t* test.

seen during the winter season with lesser density. During the winter season from (November to February) the seeds remained in dormant conditions but later, in the beginning of the March, its seedlings were emerged and grew vegetatively till April. The inflorescence bearing flowers were started appearing in late April or early May. The flowering stage in some plants was lasted till June and then seed setting started. In the rainy season (July, August and September) some new seedlings emerged and they also flowered in August. In September, the seed setting was observed in most of the plants. The seeds fully ripened in the month of October and November or it completed its life cycle by that time. In the month of December, due to very cold weather the *P. hysterophorus* plants almost disappeared or were scanty with stunted height. In the later months, up-to February, it remained under dormant conditions. Here, *P. hysterophorus* completed its two life cycles in one year, that is, from March to June and other one from July to November. So, first life cycle was completed in 4 and the second one in 5 months.

DISCUSSION

Invasive species have creating havoc to the natural habitats around the world by replacing species rich areas into single species monocultures (Mack and D'Antonio, 1998) and as a result reducing diversity (Meiners et al., 2001). The cover or diversity of the invasive species was

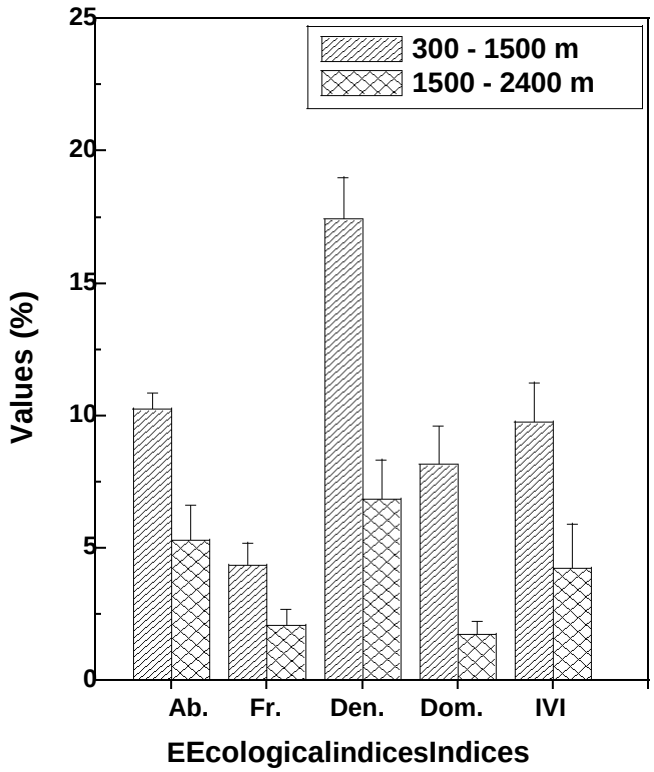

Figure 2. Comparison of ecological indices of *P. hysterophorus* between two altitudinal ranges.

Table 2. Different growth parameters of *P. hysterophorus* in NW Himalaya.

S/N.	Growth parameters	Type/number
1	Height above ground part (m)	2.09 ± 0.27
2	Height of below ground part (cm)	17.32 ± 4.03
3	Number of plants/ m^2 (Density)	11.31 ± 3.92
4	Branches/ plant	17.30 ± 2.34
5	Leaves per plant	229.38 ± 23.12
6	Leaf area (cm^2)	26.84 ± 3.63
7	Leaf length (cm)	18.83 ± 2.01
8	Leaf width (cm)	6.54 ± 0.98
9	Leaf perimeter (cm)	40.29 ± 4.65
10	Leaf ratio	3.02 ± 0.67
11	Shape factor	0.28 ± 0.06
12	Trichomes on adaxial side of leaf (Number/ cm^2)	97.75 ± 7.89
13	Trichomes on abaxial side of leaf (Number/ cm^2)	119.23 ± 9.72
14	Trichomes on stem (Number/ cm^2)	82.70 ± 12.63
16	Number of secondary roots	18.28 ± 4.89
17	Number of tertiary roots	11.53 ± 2.37
18	Primary root length (cm)	15.59 ± 1.84
19	Number of inflorescence/ plant (cm)	378.29 ± 27.42
20	Number of flowers/ inflorescence	97.39 ± 11.89
21	Seed length (mm)width (mm)	2.31± 0.021.03 ± 0.01
22	Number of seeds/plant	7397 ± 81.42
23	Dry weight of plants- above ground portion (g/ plant)	8.32 ± 1.86
24	Dry weight of plants- below ground portion (g/ plant)	2.01 ± 0.03

more in the invaded habitats as compared to their natural habitats (Dodson and Fiedler, 2006). Most plant species that are moved by humans to areas well outside their natural ranges only persist where they are cultivated, or flourish only in highly disturbed habitats. A small number of introduced species overcome many barriers to establishment and persistence and become incorporated in the biota of the new region (Richardson and Rejmanek, 2004).

The invasion of *P. hysterophorus* was relatively more in the NW Himalayan (Himachal Pradesh) of India due to the increased tourism, transportation and development in different sectors. Human beings are also responsible in one or other way for the process of invasion. Many aggressive invasive plants like *Ageratum*, *Lantana* and *Parthenium* are well established in the lower Himalaya due to suitable environmental conditions for their growth as similar to their native range (Dogra et al., 2009a; Dogra et al., 2009b).

P. hysterophorus was aggressively invaded up-to 2000 m in the NW Himalaya of India (Himachal Pradesh) and it was occasionally seen in the valleys situated in the middle Himalaya having altitude less than 2400 m. The abundance and frequency of *P*. *hysterophorus* was significantly more between 300 to 1500 m than between 1500 to 2400 m. The change in density and dominance of *P*. *hysterophorus* was also significant between the two ranges. The IVI of invasive plant was significantly more between 300 to 1500 m as compared to 1500- 2400 m range. This showed that invasive plant was abundant and well established between 300 to 1500 m as compared to the altitudinal range varying from 1500- 2400 m. The reason for their being well established in the lower range was sub-tropical and warm climate which changed to temperate and cold at higher altitudinal range. The results revealed that the tropical and sub-tropical areas were more prone to invasion than the temperate areas (Mclntyre et al., 2005). The original home of this invasive species was also in the sub-tropical areas of America as that of sub-tropical areas of NW Himalaya in India. So, it was clear that the invasive species required almost similar environmental conditions for their establishment as that of their native ones (Dogra et al., 2009a).

Introduced plants or invasive species in their new regimes showed diverse life forms, habit, morphology and reproductive biology. The life cycles of these plants are very quick and they also have the ability to survive or grow under different habitats. They produce enormous number of seeds which are very small in size and also light in weight and can survive as seed bank in soil for years. This character will help their dispersal up-to long distances and result in their rapid spread in the invaded areas. They can also reproduce vegetatively through different parts. Invasive plant species become established easily in the new area and they can out-compete and displace native species, reduce wildlife limit overall biodiversity. Although no site is immune from the chance dispersal of problem species, some sites are more predisposed than others to an invasion because of their position in the landscape. A fully established invasive species became difficult or impossible to control or eliminate due to its wide ecological amplitude (Pysek and Prach, 2003). *P. hysterophorus* has created havoc in the NW Himalaya (Himachal Pradesh) of India. It had an enormous ability to grow and establish itself in a variety of habitats like grasslands, forests, horticultural fields, roadsides, orchard, unattended and waste lands in the NW Himalaya. The soil types were not limiting for its growth and establishment. It grew fairly throughout the year except during the month of December to February in the winters under the very cold climatic conditions. During these months the plant almost disappeared. Under favorable conditions the height of plant reached more than 2 m. It completed almost two life cycles from the month of March to November. The density of the plant appeared to be more in the rainy season as compared to summer. One plant of *P*. *hysterophorus* produced a large number of leaves and branches. The number of trichomes was more on the leaves as compared to the stem. It produced 7397 + 81.42 seeds per plant which were responsible for their rapid and quick spread in the NW Himalaya (Himachal Pradesh). So, the present study revealed that *P. hysterophorus* is a well established invasive plant in the NW Himalaya of India and continuously expanding its domain in this area.

REFERENCES

Bais HP, Vepachedu R, Gilroy S, Callaway RM, Vivanco JM (2003). Allelopathy and exotic plant invasion: From molecules and genes to species interactions. Sci., 301: 1377-1380.

Blosey B, Notzold R (1995). Evolution of increased competitive ability in invasive non indigenous plants - A hypothesis. J. Ecol., 83: 887-889.

Dodson EK, Fiedler CE (2006). Impacts of restoration treatments on alien plant invasion in *Pinus ponderosa* forests, Montana, USA. J. Appl. Ecol., 43: 887-897.

Dogra KS, Kohli RK, Sood SK (2009a). An assessment and impact of three invasive species in the Shivalik hills of Himachal Pradesh, India. Int. J. Biodivers. Conserv., 1(1): 004-010.

Dogra KS, Kohli RK Sood SK, Dobhal PK (2009b). Impact of *Ageratum conyzoides* L. the diversity and composition of vegetation in the Shivalik hills of Himachal (Northwestern Himalaya), Int. J. Biodivers . Conserv., 1(5): 135-145.

Kohli RK, Batish DR, Singh HP, Dogra KS (2009). Ecological Status of some invasive plants of Shiwalik Himalayas in Northwestern India. In: Invasive Plants and Forest Ecosystem (Eds. Kohli, R., Jose, S., Batish, D. and H.P. Singh.) CRC/Taylor Press. Netherlands., pp. 143-156.

Mack MC, D'Antonio CM (1998). Impacts of biological invasions on disturbance regimes. Trends Ecol. Evol., 13: 195-198.

Mclntyre S, Martin TG, Heard KM, Kinloch J (2005). Plant traits predict impact of invading species: An analysis of herbaceous vegetation in the subtropics. Aust. J. Bot., 53: 757-770.

Meiners SJ, Pickett STA, Cadenasso ML (2001). Effects of plant invasions on the species richness of abandoned agricultural land. Ecography, 4: 633-644.

Mishra R (1968). Ecology W ork Book. Oxford and IBH Company, New Delhi, India, p. 244.

Pimentel D, Lach L, Zuniga R, Morrison D (2000). Environmental and economic costs of non indigenous species in the United States. Biosci., 50: 53-65.

Pysek P, Prach K (2003). Research into plant invasions in a crossroads region: History and focus. Biol. Invas., 5: 337-348.
Rao RS (1956). *Parthenium,* a new record for India. J. Bombay Nat. Hist. Soc., 54: 218.
Richardson DM, Rejmanek M (2004). Conifers as invasive aliens: A global survey and predictive framework. Divers. Distrib., 10: 321-331.
Ruiz GM, Fofonoff PW, Carlton JT, Wonham MJ, Hines AH (2000). Invasion of coastal marine communities in North America: Apparent patterns, processes, and biases. Ann. Rev. Ecol. Syst., 31: 481-531.
Vitousek PM, Mooney HA, Lubchenco J, Melillo JM (1997). Human domination of earth's ecosystems. Science, 277: 494-499.