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Harvesting Changes the Species Composition of *Parthenium Hysterophorus* Invaded Abandoned Cropland

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Abstract: *Parthenium hysterophorus a noxious weed is spreading and effecting the natural vegetation. In a nine year old abandoned cropland of J.P.University Chapra. Parthenium has covered almost whole campus of about 240 ha area. In 2015 the dominant species was Parthenium hysterophorus having IVI value of 106.29 and it contributed about 80.28% of the shoot biomass. However in 2016 after harvesting of Parthenium Cynodon dactylon became the dominant species having IVI value 99.33 and the IVI value of Parthenium was recorded only 44.96, Parthenium contributed only 29.56% of the total shoot biomass, species richness, species diversity and equitability values after harvesting of Parthenium in 2016 were 2.29, 0.034 and 2.36 whereas these values in 2015 were 1.45, 0.024 and 1.61.*

Keywords: *Alien species, Equitability, Importance Value Index, Phytosociology, Shoot Biomass*

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I. INTRODUCTION

When alien species are introduced unintentionally or deliberately they may spread and grow vigorously (Raghubanshi et al. 2005); and biodiversity, ecosystems, economy and human health are threatened (Evans 1997 and Levine et al. 2003). Soil physico – chemical properties are altered by invasive species such as moisture, temperature, pH, soil organic matter, carbon, nitrogen, phosphorus contents and soil microbial activities (Belnap and Phillips, 2001; Zavaleta 2000; D'Antonio 1993; Kourtev et al. 1998; Chapuis-Lardy et al. 2006; Dassonville et al. 2008; Ehrenfeld 2003; Koutika et al. 2007; Chacon et al. 2008).

Invasive species significantly affects the diversity and structure of plant communities (Chippendale and Panneta 1994; Hejda and Pysek 2006; Levine et al. 2003; Shabbir and Bajwa 2006). Invasive species are generalists, survive in wide range of climatic conditions and possess a broad habitat compatibility. These species rank second as a threat to biodiversity (McGinley and Duff 2011). They can tolerate a wide range of edaphic and climatic conditions than native species. Invasive species have wide genetic pool which enhances invasive potential. When populations of invasive species increase the populations of native species decrease and after establishment of invasive species it is irreversible. All exotic species are not harmful. Exotic species lack natural predators and diseases in new habitats. Areas disturbed by human activities become problematic due to invasive species (Sheley et al.1999) such as road building (Trombulak and Frissell 2000), residential developments, forest clearing, logging, grazing, mining, diching,mowing, erosion control, and fire control activities (Simberloff 2000). Disturbance occurring naturally such as fires, tornadoes, landslides and tree falls also pave the passage for invasion of exotic species. *Parthenium hysterophorus* a noxious weed has attained a global significance and is a major weed in all states of India and other parts of the world. It is also called as "scourge of India". *P.hysterophorus* L. is distributed worldwide such as Africa (Madagaskar, Mozambique, SouthAfrica), Amrica (Bahamas, Bermuda Cuba, Halti, Jamaica, Puerto Rico, USA, Argentina, Barbados, Bellze, Bolivia, Dominica, Guatemala, Guyana, Honduras, Paraguay, Tahiti, Trirodad, Tobago, Venuzuela, China, all states of India, Nepal, Pakistan, Taiwan, Vietnam, Australia etc. (Lakshmi and Srinivas 2017). It mainly affects the production and biodiversity of agricultural and natural ecosystems and on animal and human health. Its management is very difficult. Not a single method alone can be effective in its management although integrated management approaches have been recommended (O'Donnell and Adkins 2005). In India *Parthenium* was transported through wheat seeds under PL480 scheme.

Parthenium grows luxuriantly in wastelands, vacant lands, orchards, forest lands, flood plains, agricultural lands, shrub lands, urban areas, overgrazed pasture lands, along road sides, railway tracks etc. Reduced pasture cover and drought are favourable conditions for establishment of *Parthenium*. It can grow upto 2200 m above sea level. (Sankaran 2008). *Parthenium* grows on all types of soils but luxuriant growth takes place in black soil compared to laterite soil (Mahadevappa et al. 2001). However, Dale (1981) reported that *Parthenium* prefers to grow from alkaline to neutral clay soil or sandy to heavy clay soil (ARMCA, 2000).

Parthenium cannot grow luxuriantly in saline soil near seashore (Lakshmi and Srinivas, 2007). In acidic soil the growth of *Parthenium* is reduced (ARMCA, 2000).

A single plant of *P.hysterophorus* produces up to 100,000 seeds in one life cycle. Sankaran (2008) recorded more than 340 million seeds/ha in the surface soil. Sankaran (2008) reported that more than 70% seeds of *Parthenium* in 5cm soil surface were viable for 2 Yrs. however seed viability may be upto 20 Years. Several workers have reported the adverse effect of *Parthenium* on soil nutrient such as Kanchan and Jayachandra (1981), Bhowmik and Doll (1984) and Alam et al. (2001). However, Etana et al. (2015) have reported that pH, electrical conductivity, soil organic matter, total soil N, available P, exchangeable Na, K, Ca and cation exchange capacity (CEC) were found to be better in *Parthenium* infested site compared to non-infested site but Mg did not increased. Adkins and Sowerby (1996) have experimentally proved that *Parthenium* has allelopathic effect that reduces the growth and germination of other associated species. Timsina et al. (2011) has reported that *Parthenium* invasion has affected the growth of other species such as *Trifolium repens*, *Imperata*, *Chrysopogan aciculatum*, *Sporobolium* and *Dactyloctenium aegypticum*. Mahadevappa et al. (2001) have reported that *Parthenium* invasion reduced 90% forage production. Mahadevappa et al. (2001) have explained that *Parthenium* has no natural enemy in newly invaded site and cattle also donot feed on *Parthenium*. Thus, the biomass produced by *Parthenium* return to the soil, decompose and increase the soil organic matter in *Parthenium* infested site compared to non-infested site. Organic matter of the soil also increases the other soil nutrient. *Parthenium* absorbs large amount of nutrient even from nutrient deficient soil that results into high levels of N (3%), P (2%), K (4.3%) and other micro and macro nutrients in their leaves. Thus, *Parthenium* is used as green manure for crops (Javaid et al. 2007). *Parthenium* has two potential causes to inhibit the growth of other species such as efficient extraction of nutrient from deficient soils and its allelopathic effect.

The ecology of natural ecosystem is disrupted by invasive exotic plants. The native plant and animal species are displaced. Thus the biological resources are degraded. These invasive species reduce the amount of light, water, nutrients and space available for native species (Randall and Marinelli 1996; Hobbs and Huenneke 1992; Huenneke 1996). Such changes cause increased rate of erosion. Changes in population's genetic make up, harbour plant pathogens, contains toxins which may be lethal to humans and other animals. Fatimah and Ahmad (2012) while studying the species composition of Islamabad and Rawalpindi cities of Pakistan have recorded six major and minor communities such as *Cynodon – Brachairia - Dactyloctenium* ; *Cynodon – Parthenium – Bracharia* ; *Parthenium – Cynodon* ; *Parthenium – Cynodon – Canabis* ; and *Broussonetia – Cynodon* as major communities ; and *Cynodon – Brachairia – Digitaria* ; *Cynodon – Malvestrum – Dichanthium* ; *Cynodon – Malvestrum – Parthenium* ; *Cynodon – Ricinus* ; *Lantana – Broussonetia – Cynodon* and *Lantana – Cynodon – Parthenium* as minor communities.

The present study was conducted to know the effect of harvesting of *P.hysterophorus* on changes in species composition of the abandoned cropland because in the present study site *P.hysterophorus* was harvested in 2016, however we have already studied the phytosociology of the present study site in 2015 (Shikha and Jha 2016).

II. STUDY AREA

The present study was conducted in 2016 in rainy season in the nine year old abandoned cropland of J.P.University, Chapra campus which is spread in about 240 ha land. The study area is situated between $25^0$36'-$26^0$15' N lat. and $84^0$24'- $85^0$15' E long. The maximum temperature values ranged from 15.4^0 to 44.5^{0C}. The whole campus has been covered by invasion of *Parthenium hysterophorus* in just nine years.

III. MATERIALS AND METHODS

3.1 Phytosociological study – This study was conducted in the month of August, 2016. Ten quadrates of 50 X 50 cm^2 sizes were randomely placed in the sampling site. All herbaceous plants at the soil surface level were harvested. Harvested samples of each quadrate were kept in separate polyethylene bags. Samples were brought to the laboratory and samples of each quadrate were separated species wise and their numbers were counted. We took fresh weight using the electronic balance and were oven dried at 80^0C for 24hrs and again dry weight was taken.

The following quantitative and qualitative analyses of plants were done: frequency, density, abundance, relative frequency, relative density, relative dominance, importance value index, species richness, species diversity and equitability. Frequency, density and abundance were calculated following the formulae proposed by Curtis and McIntosh (1950). Relative frequency, relative density and relative dominance were determined following the formula of Philips (1959). The Importance Value Index (IVI) was the sum of the relative frequency (RF), relative density (RD) and relative dominance (RDo) (Curtis 1959 and Phillips 1959). Species richness was calculated following the formula of Margalef (1958). Species diversity was calculated as Shannon – Wiener 1963). Equitability (EC) was calculated following the formula of Margalef (1958):

IV. RESULTS

A total number of 20 plant species including *Parthenium* was recorded in 2016. Frequency values ranged from 100 for *P.hysterophorus, C. dactylon, C. sparsiflorus and C. rotandus* to 10 for *C. ciliaris, S. cordata, P. niruri and Z. gibbosa* (Table 1). The density value was recorded highest for *C. dactylon* (1043.6 m-2) and lowest (0.4 m-2) for *D. setigera, C. ciliaris* and *P. niruri*. The most abundant species was *C. dactylon* whereas the least abundant species were *D. annulatum, D. setigera, C. ciliaris and P. niruri* (Table 1). Relative frequency values ranged from 11.36% for *C. sparsiflorus, C. dactylon* and *C. rotandus* to 1.34% for *D. setigera, C. ciliaris, S. cordata, P. niruri and Z. gibbosa* whereas relative density values ranged from 52.19% for *C. dactylon* to 0.02% for *D. setigera*; *C. ciliaris* and *P. niruri*. Relative dominance value ranged from 33.78% for C.dactylon to 0.01% for *D.annulatum, D. setigera, Z. gibbosa* and *D. triflorum*. The highest IVI value was obtained by *C.dactylon* (97.33) and the other important species having higher IVI value (44.96) was recorded for *P.hysterophorus* and *C. sparsiflorus* having IVI value 37.65. Species richness, equitability and species diversity values were 2.29, 2.36 and 0.034 respectively (Table 2).

Table 1. Phytosociological characteristics of Parthenium invaded fallowland after nine years of abandonment.

Name of Species	**Frequency (%)**	**Density (m^{-2})**	**Abundance**	**Live Shoot Biomass (gm^{-2})**	**RF (%)**	**RD (%)**	**RDo (%)**	**IVI**
Parthenium hysterophorus	100	80.8	80.8	1187.92	1.36	4.04	29.56	44.96
Croton sparsiflorus	100	117.6	117.6	820.16	11.36	5.88	20.41	37.65
Cynodon dactylon	100	1043.6	1043.6	1357.24	11.36	52.19	33.78	97.33
Cyperus rotandus	100	491.6	491.6	276.68	11.36	24.58	6.89	42.83
Eragrostis tenella	70	71.2	101.71	59.84	7.95	3.56	1.49	13
Evolvulus alsinoides	80	60.8	76	69.32	9.09	3.04	1.73	13.86
Dicanthium annulatum	20	0.8	4	0.4	2.27	0.04	0.01	2.32
Digitaria setigera	10	0.4	4	0.28	1.34	0.02	0.01	1.37
Eleusine indica	30	4	13.33	1.44	3.41	0.20	0.04	3.65
Alysicarpus monolifer	60	28.4	47.33	22.56	6.82	1.42	0.56	8.8
Aristida adscensionis	30	8.4	28	74.04	3.41	0.42	1.84	5.67
Bothriochloa pertusa	20	18.8	94	40.32	2.27	0.94	1.00	4.21
Borreria stricta	30	44.8	149.33	72.16	3.41	2.24	1.80	7.45
Indigofera linifolia	50	13.6	27.2	18.08	5.68	0.68	0.45	6.81
Cenchrus ciliaris	10	0.4	4	1.76	1.34	0.02	0.04	1.4
Sida cordata	10	0.8	8	3.4	1.34	0.04	0.08	1.46
Phyllanthus niruri	10	0.4	4	2.88	1.34	0.02	0.07	1.43
Oxalis corniculata	20	10.8	54	8.92	2.27	0.54	0.22	3.03
Zornia gibbosa	10	1.2	12	0.56	1.34	0.06	0.01	1.41
Desmodium triflorum	20	1.2	6	0.32	2.27	0.06	0.01	2.34
TOTAL	880	1999.6	2366.5	4018.28				

Table 2. Certain selected characteristics of *Parthenium* invaded fallowlands after nine years of abandonment.

Species richness	**Species diversity**	**Equitability**
2.29	0.034	2.36

V. DISCUSSION

In the present study a total number of only 20 plant species including *Parthenium* were recorded. Karki (2009) has reported less number of plant species (19 and 23) in *Parthenium* invaded two sites compared to non-invaded sites (20 and 27). Species richness significantly decreased from *Parthenium* non-invaded to invaded sites ($p < 0.000$). When the density of *Parthenium* increased the species richness decreased significantly. The similarity index was > 77% between *Parthenium* non-invaded and invaded sites. Kumari et al. (2014) have evaluated the effect of invasion of *P.hysterophorus* on the diversity and distribution of weeds in cultivated fields of Bilaspur. A total number of 27 genera having 28 species of 16 families have been reported. In three sites the number of species ranged from 17 to 27, 14 to 28 and 15 to 28. But in the present study only 20 species were recorded. The relative density ranged from 0.77 to 22.92, 0.85 to 30.91 and 0.58 to 26.23 in three study sites Kumari et al. (2014). However the relative density of *Parthenium* in the present study was 4.04% only. Kumari et al. (2014) have reported the high similarity value between *Parthenium* non – invaded and invaded areas that indicated no radical change in species composition within the area. However, Kohli et al. (2006) have reported a decline in species richness from 25 to 12 from *Parthenium* non – invaded site to high invaded site of lower Himalaya India. The community diversity (Shannon Index) become lowered by only low infestations of *Parthenium* weed (two plants m-2). Commonly broadleaf plants are most affected by the presence of *Parthenium* weed. Medium infestation level (16 plants m-2) lowered Shannon Index (0.8) compared to no

Parthenium infestation (Shannon Index 1.6) (Adkins et al. 2010). In August 2015 when *Parthenium* was not harvested in the previous year on the same site Shikha and Jha (2016) have reported 13 total number of species and the most dominant species having highest IVI value (106.29) was *Parthenium*. Due to harvesting of *Parthenium* the total number of species increased and the species composition changed. In 2015 the dominant community was *P.hysterophorus – D.annulatum* whereas in 2016 after harvesting of *P.hysterophorus* the community *C.dactylon - P.hysterophorus* has been recorded. (Shikha and Jha 2016). In 2015 *Parthenium* has contributed 80.28(%) of the total shoot biomass which decreased to 29.56% in 2016. The shoot biomass contribution of *C.dactylon* in 2015 was 33.20% which increased to 33.78% in 2016. In 2015 the species richness, species diversity and equitability values were recorded 1.45, 0.024 and 1.6, respectively whereas in 2016 species richness value was 2.29, species diversity 0.034 and equitability value 2.36. Thus due to harvesting of *Parthenium* total number of species increased and the *Parthenium* dominated community was replaced by *C.dactylon – P.hysterophorus* community. Thus it is possible to replace the dominance of *Parthenium* by harvesting it regularly.

VI. CONCLUSION

The hervesting of *P.hysterophorus* regularly if possible can be an important method of further spread because in the present study harvesting has changed the species composition. After harvesting the dominant species *P.hysterophorus* became the Co-dominant species. The contribution of above ground biomass of *Parthenium* decreased from 3205.32 gm-2 to 1187.92 gm^{-2} from non - harvested to harvested condition.

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