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RESEARCH ARTICLE

IMPACT OF *PARTHENIUM HYSTEROPHORUS* L. INVASION ON SOIL CHEMICAL PROPERTIES OF FALLOWLAND, CHAPRA, BIHAR

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ABSTRACT

The present study was conducted in *Parthenium hysterophorus* infested fallowland in the University campus of J.P. University Chapra, Bihar in 2017. This study was aimed at determining the impact of *Parthenium* on soil chemical properties. The soil samples were collected from 0-15 cm and 15-30 cm depth of *Parthenium* infested and 0-15 cm soil depth of non-infested sites. The present study indicated that in *Parthenium* infested sites values for pH, Organic carbon, Organic matter, N, total soluble salt content, Zn, Mn and Fe were lower compared to non-infested site whereas values for K, P and Mn were higher in infested site. However the differences in soil chemical properties of *Parthenium* infested and non-infested sites were not statistically significantly different.

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INTRODUCTION

Soil physico–chemical properties such as moisture, temperature, pH, soil organic matter, carbon, nitrogen, phosphorus contents and soil microbial activities are altered by invasive species (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).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. Mahadevappa *et al.,* (2001) have explained that *Parthenium* has no natural enemy in newly invaded site and cattle also do not 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 nutrients. *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). The physical properties of soil determine the availability of oxygen in soils, the mobility of water into or through soils, ease of root penetration and in assessing the fertility of soil. Soils having slightly acidic to slightly alkaline pH provides optimum plant growth conditions because toxicity is less and nutrient availability is greater within this range. Generally plants can tolerate a pH range in their environment between 4.0 to 8.0 but outside this range, high concentrations of H^+ or OH^- ions can be directly toxic to plants. The pH of soil affects the availability of nutrients and toxic elements. Organic matter content is the best indicator of soil credibility next to particle-size distribution. Soil salinity levels of 3 to 4 mimho/cm or less are safe for most plant species but salinity levels exceeding 8 to 9 mimho/cm are unsuitable for all but the most salt tolerant plant species. The present study was aimed to collect informations on certain properties of soil at 0-15cm and 15-30cm depths of the study site infested with *Parthenium hysterophorus* such as pH, Organic carbon, Organic matter, total N, total P, total K, total soluble salt and micronutrients such as Zn, Cu, Mn and Fe.

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MATERIALS AND METHODS

Soil Sampling: Triplicate soil samples were collected randomly from ten locations of the *Parthenium* infested (I) and non-infested sites (N-I)infested with *Parthenium hysterophorus* from the upper 0-15cm and 15-30cm depths in

March 2017. The samples were mixed together of two depths separately and from these composite stocks five sub-samples were drawn for analysis. These sub-samples were analysed for pH, organic carbon, total N, P and K, and total soluble salt contents. From air-dried samples micro-nutrients such as Zn, Cu, Mn and Fe were analysed. Organic matter was calculated from the values of organic carbon.

Soil Analyses: Soil pH was determined using electrode (1:2, soil: water ratio) of electronic pH meter. Soil organic carbon was determined by Walkley and Black's rapid titration method (Jackson 1958).Total N was determined on a field moist soil by steam distillation of K_2SO_4 - extract of soil using Deverda's alloy to convert NO_3 –N to NH_4 –N (Bremner 1965).Total P was determined on field moist soil. $NaHCO_3$ extractable Pi was measured by ammonium molybdate stannous chloride method (Sparling *et al.,* 1985). Total K was analysed by flame photometer following Jackson (1958).Total soluble salt content was analysed following Jackson (1958) also.Micro-nutrients such as Zn, Cu, Mn and Fe were analysed by using Atomic Absorption spectrophotometer. All the above mentioned soil analyses were done with the help of staffs of Soil Testing Laboratory of Bihar State Government located at Chapra Bazar Semiti campus. The study was conducted in a nine year old fallowland infested with *Parthenium hysterophorus* in the newly established University campus of Chapra, Bihar in about 240 ha of land.

RESULTS

Soil pH values were recorded 7.64 and 7.66 in 0-15cm and 15-30cm soil depth, respectively in *Parthenium* infested site whereas in non-infested site this value was 9.21. The organic carbon values were 0.722 (%) and 0.56 (%), respectively, in 0-15cm and 15-30cm soil depth and organic matter values were 1.25 in 0-15cm soil depth and 0.98% in 15-30cm soil depth in infested site; and in non-infested site 0.73 (%) and 1.26 (%) were the organic carbon and organic matter values. The total P values in upper and lower soil depths were 37.8 and 40.2 kg/ha.

Table 1. Soil properties in *Parthenium* in invaded and non-invaded fallowland

	Parthenium Invaded		*Parthenium* Non-Invaded
Parameters	0-15 (cm)	15-30 (cm)	0-15 (cm)
pH	7.64 ± 1.18	7.66 ± 1.18	9.21
Organic C (%)	0.722 ± 0.54	0.56 ± 0	0.73
Organic Matter (%)	1.25	0.98	1.26
Total N (kg/ha)	221.2 ± 7.63	194.2 ± 7.03	223
Total P (kg/ha)	37.8 ± 3.47	40.2 ± 4.14	33.7
Total K (kg/ha)	2594 ± 13.63	2624 ± 13.32	2114
Total soluble salt (mimho/cm)	0.43 ± 0	0.41 ± 0	1.39
Zn (ppm)	0.84 ± 0	0.85 ± 0	1.494
Cu (ppm)	0.73 ± 0	0.68 ± 0	1.86
Mn (ppm)	3.39 ±0.77	3.24 ± 0.77	0.70
Fe (ppm)	7.34 ±1.18	7.37 ± 1.18	7.645

It was higher in lower soil depth in infested site; and in non-infested site this value was 33.7 kg/ha. Total N values were lower (194.2 kg/ha) in 15-30cm soil depth and higher (221.2 kg/ha) in upper soil depth (0-15cm) in infested site whereas in non-infested site this value was higher (223 kg/ha) than the infested site. Total K values were recorded 2594 kg/ha in 0-15 cm soil depth and 2624 kg/ha in 15-30cm soil depth in infested site and it was 2114 (kg/ha) in non-infested site. Total soluble salt values were 0.43 mimho/cm in 0-15cm soil depth and 0.41 mimho/cm in 15-30cm soil depth in infested site and this value was 1.39 (mimho/cm) in non-infested site. Total Zn, Cu, Mn and Fe values in 0-15 soil depths were 0.84, 0.73, 3.39 and 7.34 ppm, respectively and these values were 0.852, 0.652, 3.24 and 7.37 ppm in 15-30cm soil depth, respectively in infested site. In non-infested site micronutrients such as Zn, Cu, Mn and Fe values were 1.494 ppm, 1.86 ppm, 0.70 ppm and 7.645 ppm, respectively.

DISCUSSION

Mishra (2001) has reported gravel (7%), sand (49.1%), silt (29.1%) and clay (14%), bulk density (1.0 gm/c^3), water holding capacity (43.2%), moisture content (35.1%), pH 7.1, organic carbon 0.9%, organic matter 1.56%, electrical conductivity 0.21 mimho/cm, exchangeable Na 0.31 meq/100, exchangeable K 0.93 meq/100, Fe 3.62 ppm, Zn 1.26 ppm and Mn 1.66 ppm for protected grassland of Chapra without infestation of *P.hysterophorus*. In the present study soil properties such as values for pH, organic carbon, organic matter, Fe, Mn and Zn were higher than the values reported by Mishra (2001) for protected grassland of Chapra. Similarly Mahadevappa *et al.,* (2001) have reported that biomass produced by *Parthenium* return to the soil, decompose and increase the soil organic matter; and organic matter of soil also increase the other soil nutrient. It has been hypothesized that *Parthenium* invasion in a habitat changes soil properties significantly (Osunkoya and Perrett 2011; Wang *et al.,* 2015). It has been reported that the allelopathic compounds released by *Parthenium* act as defence mechanism against microbes and soil-borne predators which affect the food web and soil chemistry negatively (Adkins and Shabbir 2014; Khaliq *et al.,* 2015). Timsina *et al.,* (2011) have reported that *Parthenium* invasion increases soil pH level, N, P and K whereas Batish *et al.,* (2002) have reported decrease in pH and increase in levels of major nutrients. Similarly Khaliq *et al., (*2015) have reported decrease in pH values after invasion of *Parthenium*. No significant effect of invasion of *Parthenium* on chemistry of soil has been reported by Etana *et al.,* (2015). Thus the impact of *Parthenium* invasion on soil chemistry is influenced by complex interactions of environmental and chemical factors of the habitat and native species (Meffin *et al.,* 2010; Vila *et al.,* 2011; Hulme *et al.,* 2013; Gibbons *et al.,* 2017; Stefanowiez *et al.,* 2017).

Olusegun *et al.,* (2017) have evaluated the impact of invasion of *Parthenium* on changes in soil physico-chemical properties; functions of soil microbes in various land use types in south east Queensland, Australia. *Parthenium* commonly invade alkaline clay, loam soil to heavy clay soils (Anonymus 2006). Annapurna and Singh (2003) have reported *Parthenium* produces smaller number of larger seeds in clay rich soil and in coarser soils it produces large number of smaller seeds. Upadhyay *et al.,* (2013) have reported pH values in *Parthenium* invaded (I) and non-invaded (N-I) sites in Jaunpur, U.P. ranged from 6.9 to 7.7 and 7.2 to 7.8, respectively while electrical conductivity ranged from 9 to 23dsm^{-1}in N-I and 18 to 42dsm^{-1}in I sites. Organic C in N-I sites ranged from 2.1 to 3.4% and in I sites from 1.53 to 3.06%; and N(%) values in N-I sites ranged from 0.31% to 0.52% and in I sites 0.31 to 0.59%. These values of OC and N were not significantly different between N-I and I sites. Batish *et al.,* (2004) and Bhowmik *et al.,* (2007) have reported that *Parthenium* invasion induces changes in physical and chemical properties of soil such as soil texture, soil pH, soil organic

matter, soil nitrogen, soil potassium, soil phosphorus etc. Upadhyay *et al.,* (2013) have suggested that *Parthenium* can help to mitigate salinity in soil and can improve soil health under saline environment; and it might be of use in restoration of saline soil. Etana *et al.,* (2015) while studying the impact of *Parthenium* on soil chemical properties in Ethiopia reported that most of the soil parameters such as N, EC, Organic matter, Na, moisture content, K, P, pH, Mg, Ca and CEC values were better except Mg in *Parthenium* infested site than the non-infested site however the differences were not statistically significantly different. The biomass produced by *Parthenium* is not fed by cattle and it returns to soil and increases soil organic matter. The increase in soil organic matter influences the soil nutrients, soil moisture, electrical conductivity, cation exchange capacity, pH etc. (Winegardner 1996; Olaitan and Lombin 1984). *Parthenium hysterophorus* changes the chemical properties of soil however the changes were statistically insignificant. The effect of *Parthenium* on soil chemical properties is suggested to be evaluated on long-term basis. The soil fertility status showed a tendency of improvement. However the growth of native vegetation affected by *Parthenium* may be due to phytotoxic effects.

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