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Ecological Significance of Parthenium (*parthenium hysterophorus*) Weed in Southern Tigray, Northern Ethiopia

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Abstract—*The aim of this study was to identify the ecological significance of Parthenium (parthenium hysterophorus) weed. The study has been conducted at southern zone, Tigray, Ethiopia and mainly aimed to generate better skill and knowledge on parthenium weed encroachment and its ecological consequences in the study area. Total of 80 respondents were interviewed with formal questionnaires to understand the impact of P. hysterophorus invasion on arable land, grazing land, and human and animal health. A systematic random sample was used for vegetation and soil sampling. Alamata and Ofla Wereda are specific study sites and at each study site 25 quadrats (0.25 m2) each in arable land and grazing land were sampled. In each quadrat, presence/absence of plant species and total number of individuals of P. hysterophorus were recorded. Soil samples were collected from each sampling plot for analyzing of soil pH, organic carbon and total nitrogen. Highly invaded plots of arable land had significantly higher (P<0.05) soil organic carbon (1.51±0.19%) and total nitrogen (0.09±0.01%) than less invaded plots organic carbon (0.60±0.19%) and total nitrogen (0.04±0.01%). Less invaded plots of arable and grazing lands had significantly (P<0.05) higher plant species richness (5.52±0.45% & 6.32±0.63%), diversity (5.43±0.63% &5.73±0.55%) and evenness (0.34±0.03% & 0.34±0.02%) than highly invaded arable and grazing lands. Species richness declined (3.88±0.63%) with increasing P.hysterophorus density (41.02±7.56%) in highly invaded plots of grazing land. The diversity and evenness of species were significantly (P<0.05) different between the highly invaded P.hysterophorus area and less invaded area in both arable and grazing land. Therefore, this study confirmed that P. hysterophorus is one of the major ecological threats in the study area that has to be given serious attention by the government and the society for its effective management.*

Keywords*: Arable, Grazing, Infestation, Invaded plots, Land and Parthenium*

1. INTRODUCTION

The Invading alien species (IAS) are distinguished among the greatest threats to biodiversity and productivity. Parthenium (*Parthenium hysterophorus* L.,) is one of the IAS registered species in Ethiopia. It is an aggressive noxious weed, native to America but now widely disseminated in Africa, Asia and Australia (Evans, 1997). Parthenium hysterophorus weed was incidentally introduced into Ethiopia in the mid-1970s and first reported from Ethiopia in 1988 at Harerge, Dire-Dawa and eastern Ethiopia (Seifu, 1990). Moreover, P. hysterophorus weed has a wide range and potentially lethal impact on man's affair. There are different impacts of the weed on crop, Livestock, human as well as the biodiversity as a whole (Niguse *et al*. 2009). About 94% of farmers in the southern part of Tigray region also perceived that the test of milk obtained from cows grazing on P. hysterophorus has bitter test and changes the color of butter to yellow. It also causes different types of illness on human (Niguse *et al*. 2009). Even though there is wide coverage of P. hysterophorus, there is no scientific study conducted in the study areas. Therefore, the present study was aimed to identify the ecological significance of Parthenium (*parthenium hysterophorus*) weed in southern Tigray, Northern Ethiopia using comparison methods to know farmers' perception on the invasiveness of P.hysterophorus in arable and grazing lands.

2. MATERIALS AND METHODS

2.1 Study area

This research was done in two (2) Wereda's of Southern Tigray-Ethiopia such as Alamata and Ofla. Alamata Wereda is situated in southern zone of Tigray located 600 km north of Addis Ababa and about 180 km south of Mekelle. The total population was estimated around 128,872 in 2003/04 (IPMS-ILRI, 2005) and Altitude ranges from 1178 to 3148 m.a.s.l and 75% of it is lowland and 25% is intermediate highlands. Major crops grown in Alamata are Sorghum, Teff, Maize in the lowland and wheat, barley, pulses in highlands. Ofla is located about 160 km from Mekelle and geographically 12031'North Latitude and 39033' East Longitude. Ofla Wereda has about 133,300 ha of landmass, in which 25,275 ha arable, 24,149 ha is grazing, 44,635 ha is forest, 36,515 ha is useless and 2,726

Fig. 1: Map of the study area

ha currently not under cultivation (Kebede, 2006). Ofla Wereda has an approximated total population of 132,491 of it 51.83% are females. Agriculture is the backbone of the community where Wheat, Barley, Field pea, Faba bean, Lentil, Sorghum and Maize are most dominantly grown in Ofla Wereda and mostly rainfall dependent.

2.2 Field Data Collection

In each woredas (Alamata and Ofla) arable and grazing lands were used to assess P. hysterophorus impact on plant biodiversity. This was to compare the biodiversity of high infested area (Alamata) with the adjacent less infested area (Ofla). Ten plots each of 20X20m^2 sizes located 100m far from each other of those highly infested P. hysterophorus and less infested P. hysterophorus areas were selected. Out of the 10 plots 5 plots each from arable and grazing lands were randomly selected. Within each 400 m^2 plots, five 0.25 m^2 quadrants were randomly placed. Data on species count in the quadrates were collected to compare the diversity level between the two scenarios in arable and grazing land. The species richness and density of P. hysterophorus (pl/m^2) were determined for each quadrat sampled. The data on weed species were measured using the formula described by Taye *et al*. (1998) as depicted as F= 100*X/N: Where, F- frequency; X - number of occurrences of a weed species and N- sample number. The diversity of the species was compared using Shannon Diversity Index.

2.3. Soil Sampling and Analysis

Soil samples were collected from the four corners and middle of each plot from grazing and arable lands in both study sites at a depth of 15 cm using soil augur. Soil samples were analyzed at the soil laboratories of Mekelle University. Soil pH, organic carbon (OC) and total nitrogen (N) were analyzed using methods described by Sahlemedhin and Taye (2000). Soil pH was determined using soil water mixed of 1:2.5 ratios (one gram soil to 2.5milli litter of distilled water). Organic carbon content of the soil sample was calculated using Walkey and Black's (1934) rapid titration method. The total Nitrogen was determined using Micro-Kjeldahl (FAO, 2008).The quantitative data collected was analyzed using SPSS version 16, Microsoft Office Excel 2007, MINITAB 14 for regression, JMP 5 for matched-pair and STATA 9 for Chi-square ($\chi 2$) software.

3. RESULTS AND DISCUSSION

3. 1 Soil Characteristics

Except for soil pH, the soil organic carbon and total nitrogen were significantly higher in both highly invaded arable and grazing lands (Table 2). There was a significant difference ($P<0.05$) in soil organic carbon between the high P. hysterophorus invaded arable (1.51±0.19%) and grazing (2.05±0.19%) lands respectively and less P. hysterophorus invaded arable (0.60±0.19%) and grazing (1.12±0.19%) land respectively. This result was in agreement with the findings reported by Bidwell *et al.* (2006) denoted as increased organic carbon and organic matter in the soil invaded by P. hysterophorus. Collins (2005) also said the changes in soil nutrient pools due to invasion might require longer periods of time to show differences to native patches. This result was contradictory with the findings of Karki (2009) reported as the regular removal of biomass from invaded area might decrease carbon return to soil, because associated carbon in biomass was transferred from P. hysterophorus invaded area to other area but Kifle *et al.*(2009) suggested that C. tora and X.strumurium relatively maintain soil organic carbon as compared to P. hysterophorus and A. mexicana though soil from the later showed lower organic carbon as 1.16% and 1.39% respectively. There was a significant variation ($P<0.05$) in total nitrogen between the high and less invaded areas of arable and grazing land (Table 2). Soil total nitrogen in P. hysterophorus in high invaded site of arable (0.09±0.01%) and grazing (0.10±0.01%) was higher than in less invaded sites of arable (0.04±0.01%) and grazing (0.07±0.01%) lands. This result was alike to the findings of Bidwell *et al.* (2006) and Chen *et al.* (2008) who reported that invasion of P. hysterophorus and other invasive weeds altered soil nitrogen availability. Hence, Collins (2005) reported that changes in soil nutrient pools due to invasion required longer period of time to show differences to native patches. Similarly, Karki (2009) didn't found significant change in soil nitrogen from non-invaded to invaded plots through transition but contradicted with the findings of Kifle *et al.*(2009) suggests that P. hysterophorus and A. mexicana use more nitrogen from the soil than C. tora and X. strumarium.

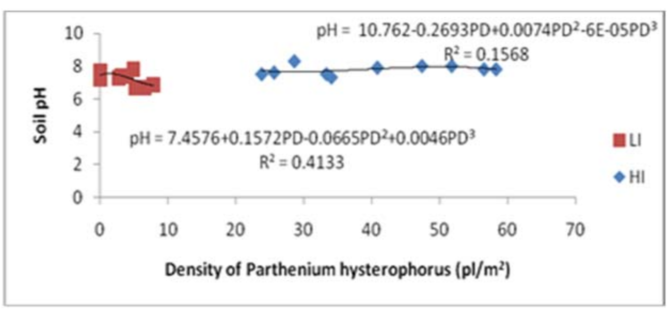

Fig. 2: Relationship between soil pH and density of P. hysterophorus in Alemata (HI) and Ofla (LI).

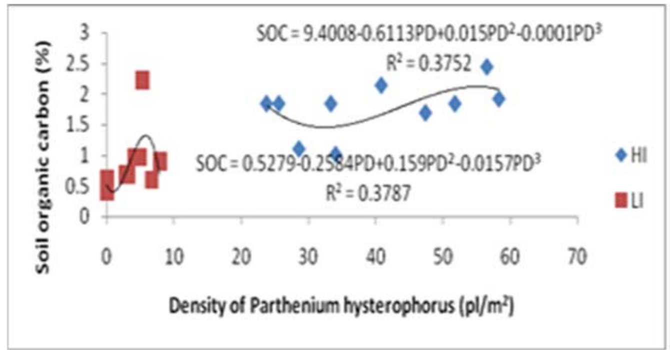

Fig. 3: Relationship between soil organic carbon and density of P. hysterophorus in Alemata (HI) and Ofla (LI).

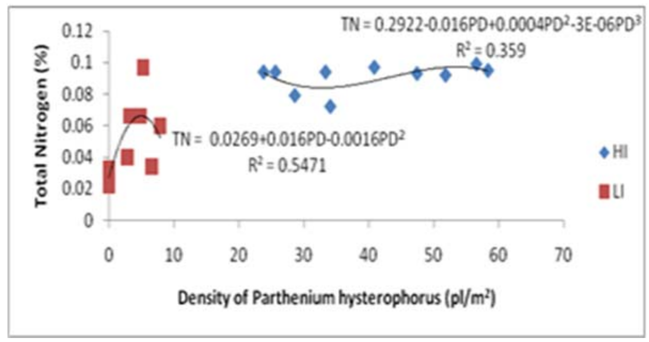

Fig. 4: Relationship between total nitrogen and density of P. hysterophorus in Alamata (HI) and Ofla (LI).

Significant increment in soil total N content from P. hysterophorus less invaded to high invaded area might be due to use of green manure from invaded site by control of P. hysterophorus through plowing at vegetation stage. 35 per cent of the interviewed farmers in Alamata site noted that P. hysterophorus was used for compost preparation through collecting P.hysterophorus before flowering stage with sorghum stalk. There was no significant difference in soil pH between less invaded and high invaded area in both arable and grazing land (Table 1 behind).

Table 1: Match paired comparison mean of P. hysterophorus density, species richness, diversity, evenness and soil attributes of P. hysterophorus invaded sites of Alamata (HI) and Ofla (LI)

Treatments	Arable Land			Grazing Land		
	HI (mean ± SE)	LI (mean ± SE)	P-value	HI (mean ± SE)	LI (mean ± SE)	P-valu
Soil pH	7.82±0.25a	7.42±0.25a	0.1806	7.72±0.24 a	7.1±0.24a	0.0579
OC (%)	1.51±0.19a	0.60±0.19b	0.008	2.05±0.19a	1.12±0.19b	0.0081
TN (%)	0.09±0.01a	0.04±0.01b	0.0031	0.10±0.01a	0.07±0.01b	0.0285
P.hysterophorus density	39.04±4.25a	1.19±4.25b	0.0009	41.02±7.58a	2.04±7.58b	0.0068
Species richness	4.56±0.45a	5.52±0.45a	0.1017	3.88±0.63b	6.32±0.63a	0.018
species diversity	3.54±0.63b	5.43±0.63a	0.0404	2.80±0.55b	5.73±0.55a	0.006
species evenness	0.236±0.03b	0.34±0.03a	0.0199	0.21±0.02b	0.34±0.03a	0.0016

HI=High infestation parthenium weed, LI =less infestation parthenium weed , SE = Standard erro

4. CONCLUSION

The total soil Nitrogen and Organic Carbon slightly increased through high invasion of P. hysterophorus in grazing and cultivated lands. Significant increase in the soil carbon content from P. hysterophorus less invaded area to high invaded area might be due to use of the weed as a green manure plowing at vegetation stage.

5. RECOMMENDATION

Further research is required to know the impact of P. hysterophorus on other soil parameter such as Phosphorus and Potassium.

6. ACKNOWLEDGEMENT

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