Distribution and Effect of *Parthenium Hysterophorus L.* In East Gojam Zone, Amhara Region, Ethiopia

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Abstract: Invasive plant species have potential to damage our environment and hence scientists, academics, leaders of industry and land managers are realizing that invasive species are serious environmental threats for the 21st century. A study was conducted in East Gojam Zone, Amhara Region Ethiopia to determine the impact and distribution status of Parthenium weed, Parthenium hysterophorus L. in the area. To collect data related with the impact of parthenium, 15 Peasant Association (PAs) were purposefully selected along the high way. A total of 140 quadrats (1 m^2 area each) from 15 PAs were selected by using stratified random sampling for herbaceous vegetation data associated with parthenium. The plant species found in each quadrat were counted, recorded and identified. The data collected from farmers' perception on the impact of parthenium weed were analyzed by using descriptive statistics. Shannon Diversity Index, evenness, species richness and Jaccards Similarity Index to determine parthenium impact on species diversity were calculated from the vegetation data. This study revealed that high infestation level of parthenium weed is confined to East Gojam Zone as. A total of 50 plant species under 20 families were recorded. The sampled PAs in Bichena town showed high infestation level with lower diversity index. Thus, it is an urgent task to draw the attention of relevant responsible bodies and public in general for managing and preventing further introduction and dissemination of the weed in this study area.
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Key words: Invasive plant species, Parthenium weed, herbaceous vegetation, infestation

1. Introduction

1.1 Background and objectives

An Invasive Alien Species (IAS) is a species that is introduced from outside its natural range of distribution (other countries or other regions of the country) by either intentional or unintentional human activity, has established self-reproducing populations in the wild and has caused obvious changes in local, artificial or natural ecosystems. Invasion is considered as the most important threat to biodiversity (Akter and Zuberi, 2009). The invasion of ecosystems by alien species is a large and growing threat to the delivery of ecosystem services (Drake *et al*. 1989). Invasive alien species are a product of the ongoing and increasing human re-distribution of species to support agriculture, forestry, mariculture, horticulture and recreation, as well as a by-product of accidental introductions. They include disease organisms, agricultural weeds, and insect pests. These species are known to erode natural capital, compromise ecosystem stability, and threaten economic productivity.

Weed and undesirable woody plants encroachment have been threatening the agricultural system and pastoral production system in the Horn of Africa, particularly Ethiopia (Amaha, 2003; Gemedo et al., 2006). Moreover, population pressure, over-stocking, overgrazing and deforestation have facilitated the disturbance of the Ethiopian ecosystem and enhanced the effect of weed invasion by threatening biodiversity of the country (EARO, 2003). Herbaceous weedy species like *Xanthium* like *Prosopis juliflora* (Sw.) DC. (Fabaceae), *Acacia mellifera* (Vahl) Benth. (Fabaceae), *Acacia nubica* (Fabaceae), *Lantana camara L* (Verbenaceae) and succulents such as *Opuntia* spp. (Cactaceae) are nowadays increasing in different regions of the country. They are responsible for a significant reduction in production of the potential of the rangelands and arable lands (SERP, 1990). Among others, *Parthenium hysterophorus* L. (Asteraceae) is a Parthenium (both are Asteraceae), woody species aggressive invasive alien weed species (Kohli et al., 2006), native to the Americas but now widely spread in Asia, Africa and Australia (Evans, 1997).

Parthenium is an annual much-branched herb of about 0.3 to 1.5 m height, native to tropical and subtropical America. Parthenium weed (*Parthenium hysterophorus* L.) is a notorious environment pollutant weed under the family Asteraceae. This weed can complete their life cycle within 4 to 6 weeks and can produce a huge number of seeds per plant.

It can spread from one place to another just like a wild fire through wind, vehecles or crop seeds. The leaf and stem of the plant contain *Sesquiterpene lactone*, which causes allergic effects to human and livestock body. Asthma, skin dermatitis, hay fever etc.

are the common diseases which may occur when the plants come in contact of body for longer time (Oudhia & Tripathy, 1998). When pollen of the flowers enters the nose respiratory problems are occurred to human body. If the plants are consumed by the livestock's allergic swelling may occur on the face and toxicity may develop in the stomach of the livestock (Chippendale & Panetta, 1994). The meat and milk of the cows become unsuitable for human consumption. When the dermatitis become severe they are very difficult to cure by medical treatments.

When plants are incorporated with the soil it releases allelo chemicals which decrease the seed germination of different crops. It may compete for nutrients and water when grow in highland crops like barley, maize, upland rice etc (R.M. Wise etal.,2007). When the pollens fall on the inflorescence of maize grain filling is reduced to a great extent. Due to its allelopathic effects it excludes other vegitation in the close proximity and damage our biodiversity. Populations of parthenium occur in north-east Africa as well as in South Africa (R.M. Wise etal. 2007). Parthenium weed was first introduced accidentally into Ethiopia in the 1970s. It was first reported from Ethiopia in 1988 at Dire- Dawa and Harerge, Eastern Ethiopia (Seifu, 1990) and subsequently found near Desse, North-eastern Ethiopia as well.

Both are major food-aid distribution centers and there is a strong assertion that parthenium weed seeds were imported from subtropical North America as a contaminant of grain food aid during the 1980s famine and distributed with the grain (Tamado et al., 2002). However, it has now emerged as one of the most aggressive weeds of both grazing land and cereal-based agriculture and crop lands (Tamado and Milberg, 2000). *P. hysterophorus* is considered as a noxious weed because of its prolific seed production and fast spreading ability (Haseler, 1976), allelopathic effect on other plants (Adkins, 1996), strong competitiveness with crops (Tamado et al., 2002) and health hazard to humans as well as animals (Chippendale and Panetta, 1994). Parthenium is so devastating that very little and sometimes no other plant species are seen in areas where it has gained dominance (Shabbir and Swhsana, 2005).

In areas where the weed occurs, the productivity of forage is reduced by 90% and the weed make lands infertile and weakens the quality of grazing land, animal health, meat and milk products, agricultural production (Rezene et al., 2005). It also poses a serious threat to the environment and biodiversity owing to its high invasion and allelopathic effect which has the capacity to rapidly replace the native vegetation (Tamado and Milberg, 2000). Parthenium exerts strong allelopathic effect and reduces the growth and reproduction of associated crops. It does these by releasing phytotoxins from its decomposing biomass and root exudates in soil. Bioassay, pot culture and field studies have revealed that all plant parts (shoot, root, inflorescence and seed) are toxic to plants (Mulatu et al., 2009).

As mentioned earlier, *P. hysterophorus* was first observed in eastern part of Ethiopia, especially in Dire-Dawa and Hararghe, Eastern Ethiopia. Currently, the weed has been distributed to different regional states of Ethiopia, eastern to Amhara Region. The local people have not yet noticed its effect on arable land, rangeland, animals and human health. The occurrence of *P. hysterophorus* is very frequent in urban, semi-urban and rural areas of East Gojam Zone, which is found in Amhara Regio. However, no data of scientific studies have been documented regarding the diversity and abundance of plant species where there is *P. hysterophorus* infestation in both arable and non-arable lands. It is imperative to identify plant species that may have the ability to resist or overcome the challenges of the weed, which is increasingly reducing the quality and quantity of the composition and biomass of the herbaceous species. Thus, major objective of this study was to determine the impact of *P. hysteroporus and* its distribution status in East Gojam Zone.

2. Materials And Methods

2.1 Description of the study area

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2.1.1.1 Geographical location

East Gojam Administrative Zone is one of the eleven Zones of Amhara National Regional State and constitutes 20 Woredas (16 rural woredas, and 4 Town administration Woredas). It is bordered on the south by the Oromia Region, on the west by Mirab Gojjam, on the north by Debub Gondar, and on the east by Debub Wollo; the bend of the Abay River defines the Zone's northern, eastern and southern boundaries. Its highest point is Mount Choqa (also known as Mount Birhan) (Figure 1).

2.1.1.2Agro-ecological zones and climatic conditions

The climate of Ethiopia is mainly controlled by the seasonal migration of the Inter-tropical Convergence Zone (ITCZ), which follows the position of the sun relative to the earth and the associated atmospheric circulation, in conjunction with the complex topography of the country (NMSA,2001). There are different ways of classifying the climatic systems of Ethiopia, including the traditional, the Köppen's, the Throthwaite's, the rainfall regimes, and the agro-climatic zone classification systems (Yohannes, 2003). The most commonly used classification systems are the traditional and the agroecological zones (AEZs). According to the

traditional classification system, which mainly relies on altitude and temperature, Ethiopia has five climatic zones.

Similar to the country the topography of the East Gojjam Zone contains four Agro-ecological zones like 'kola' (lowlands with relatively low rainfall and high temperature), *'Woina-Dega'* (middle highlands with moderate amount of rainfall and temperature), '*Dega*' (highlands with somewhat higher rainfall and cool temperature) and *'Wirch'* (highland very cold, high amount of rainfall (Table 1).

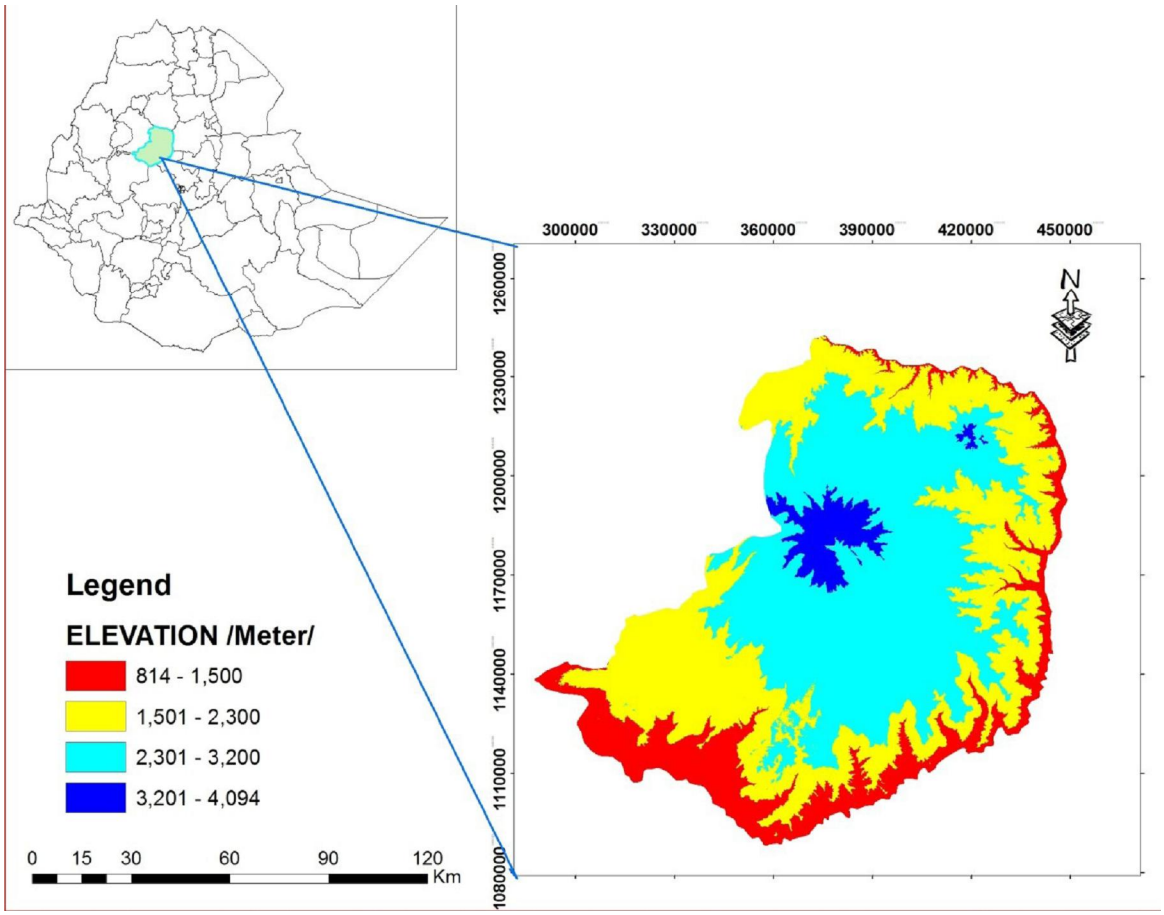

Figure 1. Geographical location of East Gojam Zone

Table 1: Traditional climatic zones and their physical characteristics

Zone	Altitude (meters)	Rainfall (mm/year)	Average annual temperature (°C)
Wurch(upper highlands)	3200 plus	900 – 2200	>11.5
Dega(highlands)	2,300 – 3,200	900 – 1,200	17.5/16.0–11.5
Weynadega(midlands)	1,500 – 2,300	800 – 1,200	20.0–17.5/16.0
Kola(lowlands)	500 – 1,500	200 – 800	27.5 – 20.0
Berha(desert)	Under 500	Under 200	>27.5

Source: MoA (2000).

2.1.1.3 Demographic Pattern and Economic Activities

Demography

East Gojjam is one of the productive and economical important crops growing area such as Teff, Wheat, Barley, Sesame, and Haricot bean etc. The total population of East Gojjam is 2,441,747 of this 286, 561 is urban population (2007 population census).

Economic Activities

The farming system in the study area is typical mixed crop and livestock system that is carried out on subsistence scale. Land and livestock are the bases of livelihood for the people and it is carried out on subsistence scale (Woldeamlack, 2003). Similar to other peoples in the country the peasants use the ox-plough farming technique, which they learned from

their parents. However, some of the peasants who have no oxen and have a piece of land give their farmland for *megazo* (share cropping) for a farmers who have oxen and economically better than them. Crop production and livestock rearing contributed to more than half of the livelihoods of the *Zone* population. Farmers mostly cultivate varieties of crops such as barely (*Hordeum Vulgant*), wheat (*Triticum Vulgare*), bean *(Vicia faba L.),* pea *(Pisum sativum L.)* oats (*Avena Sativa*) and tef (*Eragrostis tef*).

2.1.1.4 Perception of local people on the impact of parthenium weeds

Data related to peoples‟ perception about the impact of this invasive weed from urban, semi-urban and rural areas (both arable and non-arable lands) were collected from *East Gojam Zone*. From four town administrations Bichena and Mota administrative town and from 16 woredas of this zone, a total of 15 PAs were selected for this study. The researcher purposefully selected these PAs on the basis of the aggressive invasiveness of parthenium weed towards arable land following roadway. A single visit for an informal survey was conducted before the beginning of the actual research work. The survey was undertaken to observe the presence of weed, the impact of the weed on human health and to mark out the possible dispersal agents, cause of aggressiveness and the suitable seasons for the distribution of this weed in both arable and non arable lands. A total of 100 local people (farmers) and development agents at the age of above 30, unequal number of farmers from each PA were identified and selected by using purposive sampling procedure.

This selection was based on the awareness of local farmers about the aggressive colonization of *P. hysterophorus* on arable land and non-arable land (road sides) and its impact on plant biodiversity, livestock and on themselves. In order to get adequate information on the overall impact of parthenium in the study area, semi-structured interview questions were prepared. Furthermore, observations, interview, and focus group discussions was made with development agents and agricultural experts of each district.

2.2 Sampling of herbaceous vegetation cover

The field study was undertaken between January and September 2016 to collect the vegetation data depending up on the ecology of *P. hysterophorus*. Where massive growth of the weed occurs, road transect survey method was employed (Wittenberg et al., 2004) in 50 m distance to lay a quadrat. One hundred and fifty (150) quadrats (10 from each kebele) around roadsides, gardens and the farmlands of 15 sampled kebeles/PAs each measuring 1 m × 1 m (1 m2) were laid in order to collect herbaceous vegetation data and assess impact of parthenium on above ground herbaceous vegetation cover in this study area. GPS readings to record altitude, latitude and longitude for each sample site was recorded using GPS reader in order to locate the global position of each quadrat as well as the study site. The majority of the plant species collected from the quadrats was identified in the field. For species difficult to identify in the field, voucher specimen were collected, pressed and dried properly using plant presses and transported to the Addis Ababa University, National Herbarium for identification and proper naming. The nomenclature of the plant species followed the Flora of Ethiopia and Eriterea (Hedberg and Edwards, 1995). In order to investigate the relative abundance and composition of the herbaceous vegetation as impacted by parthenium, the proportion of individual species (cover and abundance of the plant species) encountered in each of the quadrats was recorded using the procedure documented by Wittenberg et al. (2004). This method involves a total estimate based on abundance and cover of the species where invasion is spatially patchy. The total estimate scale (abundance plus coverage) can be shown as follows. A plant species covers a very small area (+), cover small (1), less or equal to 5% area coverage (2), 6 to 25% area coverage (3), 26 to 50% area coverage (4), 51 to 75% area coverage (5) and 76 to 100% area coverage (6).

2.3 Data analysis

Diversity of the species for the vegetation data from the sample sites in the study areas were compared using Shannon Diversity Index. This index accounts both for the abundance and the evenness of the species in natural environment (Shannon and Wiener, 1949). It is also used to assess the impact of parthenium on the diversity of herbaceous plant species. The higher value of index of diversity indicates the variability in the type of species and heterogeneity in the community where as the lesser values point to the homogeneity in the community. Where H‟ = Shannon diversity index; Pi = the importance value of the ith species; S = total number of species in the sample quadrat.

The evenness of species will be calculated as proposed by (Hill, 1973): Where E= evenness this index explains how equally abundant each species would be in the plant community and high evenness is a sign of ecosystem health. This is because it does not have a single species dominating the ecosystem. The evenness or equitability assumes a value 0 and 1 with 1 being complete evenness and 0 a single species dominating the area. The similarity of the standing vegetation (herbaceous vegetation layer) among the sample sites in this study area was compared using Jaccard‟s coefficient of similarity (JCS**)** as shown by the equation below. This coefficient of similarity has been recognized robust and unbiased compared with other similarity indices, even with small sample size

(Ludwing and Reyonlds, 1988). Where, JSC = Jaccard"s coefficient of similarity; a = species common to quadrat 1 and 2; b = species present in quadrant 1 but absent in quadrat 2; c= species present in quadrat 2 but absent in 1 the coefficient has a value from 0 to 1, where 1 reveals complete similarity and 0 complete dissimilarity. The data collected from the respondents on the impact of parthenium were arranged and analyzed by using Microsoft office excels" for descriptive statistics (frequency and %age). Moreover, to analyze vegetation data obtained from the field on the impact of parthenium weed, R.2.14.0. package was used. The correlation of vegetation variables such as species composition, species richness, average parthenium density/sample, and average number of flower head/plant among sample sites were done to check if there is any association among and between sample sites.

3. Result and Discussion

Biological invasion by alien invasive species is now recognized as one of the major threats to native species and ecosystems (Shabbir and Bajawa, 2006). Invasive plants can have a range of impacts including, loss of biodiversity, loss of economy and ecological imbalance due to frequency and magnitude of their introduction creates by their tremendous ability to grow and proliferate (Khan et al., 2010). The phyto sociological survey of study area revealed a total of 8 weed species to be associated with P. hysterophorus (Table 1) belonging to four families. Almost.

all the selected areas of the sudy area had a heavy infestation of P. hysterophorus. *Parthenium* was found in all the five studied sites exhibiting 100 % prevalence.

Among other 7 species, Medicago polymorpha and Calyptocarpus vialis showed 64 % and 60 % prevalence respectively. The other species exhibited comparatively low prevalence i.e., 28 % which included Trifolium repens (28%), Dicliptera bupleuroides (20%), Cannabis sativa (16%), Xanthium strumarium (16%) and Taraxacum officinale (12%) (Fig 1).

Most of the range lands were found colonized by P. hysterophorus. Data collected from various localities in study area reveals that this weed was dominating the local flora with highest frequency of 92 %. The highest relative frequency (RF) of 36.54 % was exhibited by P. Hysterophorus followed by Cannabis sativa (25.23%). The rest of the weed species exhibited less than 12.15 % Relative Frequency (Table 1). The survey also showed a high relative frequency, relative density, and importance value of P. hysterophorus, however, the relative frequency of associated weed in these areas was less than 25.23 % (Table 1). The population of many grasses and medicinal plants in different watersheds might be rapidly declining because of the aggressive colonization by P. hysterophorus. The increasing infestation of this weed in study areas also poses a serious threat to the health of the inhabitants (Javaid and Anjum, 2005).

The relative density (RD) of P. hysterophorus was 62.75% which was also highest and other weed species exhibited relative density less than 14.51 % (Table 1). The domination and rapid spread of P. hysterophorus in grazing lands with gradual reduction of local flora could be attributed to its invasive capacity, allelopathic properties, high growth rate, short growth cycle and large number of seed production (Javaid and Anjum, 2005; Ayele, 2007; Dogra et al., 2011). This noxious weed can affect crop production, animal husbandry, human health and biodiversity (Shabbir, and Bajwa, 2006).

The adverse effects of this weed on human beings, livestock, crop production, and biodiversity are well-documented (Lakshmi and Srinivas, 2007; Worku, 2010).

Earlier, it was not considered a weed of orchards and forests but now it has spread rapidly into these areas (Kumar, 2012). Parthenium weed grows luxuriantly in forest due to lack of weeding.

practices in such ecosystems. In study area, *parthenium* weed has invaded the majority of pine forest in the lower elevations. The invasion of *parthenium* weed was reported in forest and grazing lands with little or no growth of any other species which results threatening of local biodiversity (Kumar, 2012).

Heavy infestation of P. hysterophorus was found along the boundaries of the agriculture fields. Furthermore, it is unable to cope with the agricultural practices and generally grows outside the agricultural fields. During surveys of various grazing pastures, it was found that cows and sheep do not graze P. hysterophorus. The spreading of *Parthenium hysterophorus* weed over the farm land for last few years has sharply increased, due to this economy of local residents has greatly affected. The people of the area are mainly dependent on the agriculture and its allied activates, especially crop cultivation is common.

4. Conclusion:

The domination and rapid spread of P. hysterophorus in farm lands with gradual reduction of local flora could be attributed to its invasive capacity, allelopathic properties, high growth rate, short growth cycle and large number of seed production. It is also responsible for creating various health problems in human and animals. Thus, *Parthenium* weed pose significant threat to the local ecosystem unless action is taken to mitigate the threat. Biological control is one

tool that forms part of an integrated management program for large-scale scattered and dense infestations. The leaf beetle Zygogramma bicolorata and the stem moth Epiblema strenuana cause the most damage. The beetle emerges in late spring and is active until autumn. Ploughing the weed in before plants reach flowering stage and then establishing pasture may be effective.

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