

Full Length Research Paper

Prevalence and distribution survey of an invasive alien weed (*Parthenium hysterophorus* L.) in Sheka zone, Southwestern Ethiopia

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Parthenium hysterophorus L, an invasive annual weed, is originated in tropical America and spread to Asia, Australia and Africa. In Ethiopia, it appeared first in Harrarghie in the 1970's and it later spread to central, northern, southeastern and southern Ethiopia. Currently, it is spreading to Southwestern Ethiopia, but its prevalence and distribution has not been assessed and documented. So, a survey on its prevalence and distribution, awareness of its effects, and control measures taken was carried out in three 'woredas' (districts) of Sheka Zone, southwestern Ethiopia. The survey was carried out in 2001 using a questionnaire completed by Agricultural professionals and visual observations. Since 1999, *P. hysterophorus* was observed mostly on market places, road sides, and arable and waste lands of some areas of Yeki Woreda but not in the other Woredas. Almost all respondents knew about its invasiveness and adverse effects, and were able to identify it from other weeds. In different woredas of the zone, different mechanical control measures, teaching of the community and reporting to higher offices were attempted so far in order to minimize its further spread and adverse effects on ecology. However, more efforts and all combinations of possible preventive measures are needed to control its further invasions in the region.

Key words: *Parthenium hysterophorus*, weed, survey, prevalence, distribution.

INTRODUCTION

Parthenium hysterophorus L. is an annual herbaceous weed native to Central America. Its reproduction is entirely by seed and its growth proceeds through a rosette stage to the flowering plant (Cock and Seier, 1999; McGuire, 2005). It is an aggressive weed and a serious problem for major crops, rangelands and wastelands. The weed is known for its allelopathic effects on other plants as well as contact dermatitis and respiratory effects on humans and livestock (Lakshmi and Srinivas, 2007). It releases phytotoxic substances into its immediate environment, which highly inhibits germination and growth of several plant species (Tadele, 2002; Mulatu et al., 2005; Maharjan et al., 2007; Mulatu, 2009; Mulatu et al., 2009). A considerable reduction in yield of crops, weight of grazing animals, and yield and quality of cow milk due to its allelopathic, competitive and skin allergy properties has also been reported (Naithani, 1987; Tamado et al., 2002; Rupschus et al., 2007). It is an alternate host for many crop pests and an inter-season

reservoir or sources of inocula. As a result, vigorous growth of many crops and grazing plants is difficult on lands invaded by *P. hysterophorus* (Labrada et al., 1994; Evans, 1997; Kassahun et al., 1999; McGuire, 2005; Janke et al., 2008). *P. hysterophorus* weed has achieved a major weed status in Australia and in India within a relatively short period of time. It is not included in the 'Weeds of Australia' of 1976 and the 'World's Worst Weeds' of 1977, but it is indicated in the 'Noxious Weeds of Australia' of 1992 (Evans, 1997). The reports from Israel (Joel and Liston, 1986), Taiwan (Peng et al., 1988), Nepal (Mishra, 1991) and Ethiopia (Medhin, 1992) were an indicator of further spreading and more prominent appearance of it in other parts of the World. Currently, it is a widely distributed and problematic weed for crops, livestock, human health and biodiversity in India, Australia, south China, The Caribbean, and in south and east Africa (Cock and Seier, 1999; McGuire, 2005). For sure, parthenium weed has come to the fore in the last 20

years in most countries, mainly based on its prolific seed production, an enormous seed bank, rapid spread and aggressive colonization (Evans, 1997). Different preventive methods that restrict the entrance of weed seed into a non-infested area and uprooting of the weed before flowering and seed setting is indicated as the most effective and less costly strategy to manage parthenium (APFISN, 2007). In addition to preventive and mechanical methods, some chemicals, biological agents and bioherbicides have also been reported promising to control parthenium and some of them are widely used in many countries, e.g. India and Australia (APFISN, 2007; Lakshmi and Srinivas, 2007; Fauzi, 2009).

P. hysterophorus invaded regions of Ethiopia are well known following its discovery in the 1970's. Its introduction to Ethiopia was probably via food grain aid from North America (Kassahun et al., 1999) and/or army vehicles during the 1976-1977 Ethio-Somalia war (Tamado, 2001). It first appeared in Harrarghie in the 1970's, and it spread later to central, northern, northwestern, southeastern and southern Ethiopia (Matiyas, 1999; Rezene et al., 2005). It has come the most dominant weed and is ranked as the worst and more frequent species of weed in areas of eastern, central and northern Ethiopia (Tamado and Milberg, 2000; Mulugeta 2006; Shashie, 2007; Adane, 2008). Due to its high reproductive and disseminative potential, as well as its prolific growth nature on non-arable lands, the weed is currently spreading at an alarmingly fast rate, colonizing large areas. It is heavily invading most areas of agricultural lands, rangelands and wastelands of eastern, southeastern and northern parts of Ethiopia. It is causing the same problem regardless of the crops grown and the preventive/control measures (e.g. mostly hand weeding and hoeing, and in some cases chemical control) (Kassahun et al., 1999; Tamado, 2001; Rezene et al., 2005; Yenealem, 2008). As previous reports indicated, the prevalence and distribution of the weed was extremely high and its problem seems to be the very fast spreading into previously un-invaded regions of the country. Its expansion to southwestern Ethiopia has also been observed along the road from Addis Ababa to the Sheka Zone and Gambela region (Rezene et al., 2005). However, knowledge on its prevalence, distribution and adverse environmental effects in southwestern Ethiopia, and in Sheka Zone in particular, were not assessed and documented. Hence, the *P. hysterophorus* prevalence and distribution, the level of knowledge to identify it from other weeds and its adverse effect on the environment, as well as the preventive measures taken so far in Sheka Zone was surveyed to provide baseline information for further work on its management.

METHODOLOGY

The study area (Sheka Zone), situated in southwestern Ethiopia, lies between 7°24' to 7°52' N, 35°13' to 35°35' E and 900 to 2700 m

asl. The zone covers about 2175.25 km², out of which 47% is covered by forest, and 56, 24 and 20% is a highland, a mid altitude and lowland, respectively. It receives high amounts of rainfall, with an average between 1800 to 2200 mm per annum. The major crops grown in the zone are maize, sorghum, millet, beans, coffee, ginger, turmeric, 'enset', wheat, barley and pea. The zone is divided into three administrative 'woredas' (districts), namely Yeki, Anderacha and Masha, each having 6 to 11 development stations, DSs. A general survey of *P. hysterophorus* prevalence and distribution, level of knowledge to identify this weed from other weeds and about its adverse effects to the environment, the areas where it is most frequently found, and the kinds of preventive or control measures attempted so far was studied in all three woredas of the zone during the main cropping season (July to September) of 2001.

The survey was conducted using a questionnaire completed by each agricultural experts, AEs, (n = 35) of each *woreda* and each agricultural development agents, DAs, (n = 16) of Yeki and Anderacha Woreda, and by direct visual observations in the market places, cultivated lands, grazing lands and wastelands, as well as along road sides in each DSs and towns of Yeki (n =13) and Anderacha (n = 6). The questionnaire, prepared in English for AEs and in Amharic (local language) for DAs, consisted of the following items: (1) whether the agricultural professionals heard about the invasiveness of *P. hysterophorus* or not, (2) whether *P. hysterophorus* is introduced in each respondent's localities or not and its time of introduction, (3) whether the respondents can identify it from other weeds or not, (4) the level of knowledge of the respondents about its adverse effect on crops or the environment, (5) the place where it is mostly localized, and (6) whether preventive or control measures were attempted or not, and if attempted, what kinds of preventive or control measures were attempted so far. Finally, the questionnaires were collected and the results of the responses and the observations were summarized in percentage. Distribution/invasion was determined as presence or absence of parthenium in the market areas, cultivated lands, grazing lands, wastelands and along road sides in each survey site. If observed, prevalence was estimated for each *woreda* separately following the method adopted by Javaid and Riaz (2007).

RESULTS

The result showed that *P. hysterophorus* has become the major weed of market areas, road sides, and arable, grazing and waste lands of Sheka area, particularly the Yeki Woreda (Table 1) with prevalence of 23.1%. All AEs and DAs in the Yeki Woreda knew *P. hysterophorus* and could identify it from other weeds (Table 2). Moreover, they pointed out that *P. hysterophorus* has been introduced in Tepi town in around 1999. However, its introduction in some rural areas of Yeki (Shuma, Fidle and Boko DSs) has been in around mid 2001 and in the Zinki areas in mid 2000. There was no *P. hysterophorus* weed in most other rural areas of this *woreda* (Yeki, Endris, Dapi Chenigawie, Michi-komi, Kubito, Gelecha and Achanie DSs) until August 2001 (Table 1). In invaded areas, it is mostly found along roadsides and in arable and waste lands. It is also observed abundantly in market areas of Tepi town and very minimal prevalence (scattered patches) in the surrounding small towns (Fidle and Zinki) of Yeki. Its growth in Yeki has been observed as robust and prosperous. Similarly, in the Masha and Anderacha Woredas, all respondents have heard about

Table 1. Summary of parthenium weed invasion, time of introduction, area of invasion and control measures taken in the Sheka Zone in 2001.

Woredas	Invasion	Time of introduction	Invasion area	Awareness of its effect	Control measures taken
Yeki (n=31)				Well know	
Tepi town	Yes	1999	Market areas, road sides, and arable, grazing and waste lands		Slashing, slashing and burning, hand pulling and burning or burying, teaching, and reporting to higher offices
Zinki DS ^a	Yes	2000			
Shuma, Beko and Fidle DSs ^a	Yes	2001			
Yeki, Endris, Dapi, Kubito, Chenigawie, Michi-komi, Gelecha and Achanie DSs	No	None until 2001	-		Teaching only
Anderacha (n=12)	No	None until 2001	-	Well know	Teaching only
Masha (n=8)	No	None until 2001	-	Well know	None

^aDS is development station and DSs are development stations.

Table 2. The percentage of agricultural professionals that can identify parthenium weed from other weeds and their awareness about its effect on environment in the Sheka Zone in 2001.

Variables	Woreda						
	Yeki			Anderacha			Masha
	DA ^b	AE	DA and DE	DA	AE	DA and DE	AE
Heard about parthenium	(n =11)	(n =20)	(n =31)	(n=5)	(n=7)	(n=12)	(n=8)
Yes	100	100	100	100	100	100	100
No	-	-	-	-	-	-	-
Identify parthenium	(n =11)	(n =20)	(n =31)	(n=5)	(n=7)	(n=12)	(n=8)
Yes	100	100	100	40	71.4	58.3	100
No	-	-	-	60	28.6	41.7	-
Awareness of parthenium adverse effects	(n =11)	(n =20)	(n =31)	(n=5)	(n=7)	(n=12)	(n=8)
Well aware	90.9	60.0	71.0	40.0	85.7	66.7	75.0
A little aware	9.1	35.0	25.8	40.0	14.3	25.0	25.0
Not aware	-	5.0	3.2	20.0	-	8.3	-

^bDA is development agent and AE is agricultural experts

this weed and most of them can identify the weed from other weeds (Table 3). Unlike in the Yeki *P. hysterophorus*, however, has not been observed both in town and in rural areas of these two woredas until this survey time, 2001.

The adverse effect of *P. hysterophorus* on the environment in general is well known by almost all DAs and AEs (71, 67 and 75% of the respondents in Yeki, Anderacha and Masha, respectively) (Table 2). Moreover, depending on the conditions of the localities, different control and/or preventive measures were attempted to restrain its further distribution in the zone. The control measures taken in the Yeki were slashing, slashing or hand pulling followed by burning or burying, teaching both urban and rural dwellers, and reporting to

higher levels. Only teaching of both urban and rural dwellers was done in Anderacha and no control or preventive measures at all was made in the Masha (Table 1).

DISCUSSION

P. hysterophorus has become a major weed of various areas of Ethiopia in a relatively short period of time. The result of the present study revealed this fact in the Sheka Zone. The weed has been found in market areas, road sides, and arable, grazing and waste lands of some areas of Yeki Woreda since 1999 (Table 1). The growth was robust and prosperous. As reported by Tamado et al. (2002) and APFISN (2007), this can be related to the

Table 3. Percentage of agricultural professionals' views about the year of parthenium introduction in their localities, the place where it was found and the control or preventive measures taken in the Sheka Zone in 2001. The figures under control or preventive measures taken do not add up to 100% because some respondents listed more than one control or preventive measures.

Variables	Woreda		
	Yeki (n =31)	Anderacha (n = 12)	Masha (n = 8)
Time of introduction			
A few months ago	16.1	-	-
A year ago	16.1	-	-
Two years ago	45.2	-	-
No parthenium until now	22.6	100	100
The place where it found	(n =31)	(n = 12)	(n = 8)
Road sides only	45.2	-	-
Also arable and waste lands	38.7	-	-
Market places	16.1	-	-
Control or preventive measures taken	(n =31)	(n =12)	(n = 8)
Slashing and burning	12.9	-	-
Hand pulling and burning	51.6	-	-
Teaching farmers and urban dwellers	61.3	100	-
Reporting to higher levels	22.6	-	-
The combination of the above	9.7	-	-
Others (slashing only/hand pulling and burying)	16.1	-	-

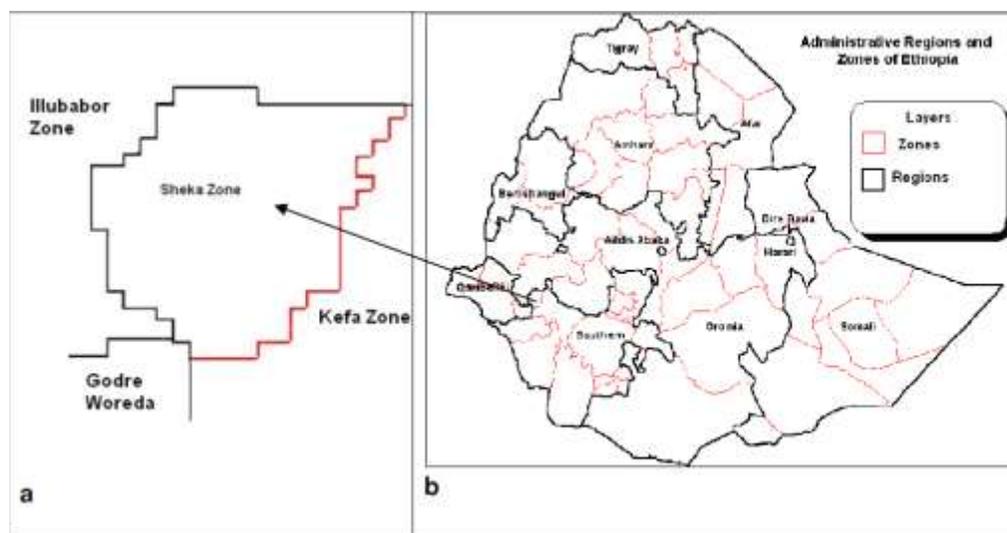


Figure 1. Maps showing (a) areas surveyed in southwestern Ethiopia and (b) other administrative zones of Ethiopia.

suitable climates (high moisture and high temperature) of the area and wider adaptability of the weed to various soil types. In addition to its seeds introducing into the region from other areas, Yeki areas can be a source of seeds for further dispersion into un-invaded areas of the zone and neighboring areas by vehicles, flood, animal feet, animal

feed and farm products. A similar area and pattern of invasion and domination of vegetation by *P. hysterophorus* was also noticed by Tamado and Milberg (2000) in Eastern Ethiopia, by Oudhia (2001) in India, and by Shabbir and Bajwa (2006) in Pakistan. This shows that *P. hysterophorus* can invade large areas

within a few years as it did in other areas unless more effort is made to control its distribution. The abundance of the weed in market areas of Tepi town and the very minimal appearance in the surrounding small towns of Yeki Woreda, and not at all in the Masha and Anderacha until 2001 might be due to higher market activities and more frequent entrance and exit of vehicles in Tepi town as compared to small towns and the later two woredas. This indicates that the most probable distribution mechanism of the seed to previously un-invaded areas of the zone are market commodities including animals brought for exchanges and vehicle bodies such as tires. According to Navie et al. (1996), most of the long - distance seed dispersal in India and Australia is through vehicles, farm machineries and flooding. Thus, at its current rate of spread, which can be accelerated by the ongoing expansion of rural roads and deforestation for agricultural land, it will definitely invade different areas within few years unless effective preventive measures, such as washing of vehicles and farm machineries before entering into non-infested areas, use of weed free cattle feeds and crop seeds, keeping of cattles in yards or small paddocks, and uprooting of the weed before flowering and seed setting (APFISN, 2007), are implemented.

The adverse effect of *P. hysterophorus* on the environment in general is well known by almost all AEs and DAs in the zone (Table 2) and they tried to take some control and/or preventive measures to restrain its further distribution in the zone. E.g. different mechanical control (slashing) and preventive measures were taken in Yeki, teaching in Anderacha but no actions in Masha (Tables 1 and 3). The latter is due to the absence of this weed in the area. However, due to its high germination and regeneration capacity, huge amount of seed production and a wide range of ecosystems' adaptability (APFISN, 2007), a single weed control measure such as mechanical methods might not be sufficient to manage this weed. Repeated ploughing during land preparation and hoeing during the early growth stages reduce its population. But, hoeing or slashing of mature plants is ineffective as it induces regrowth from crown buds (Matiyas, 1999). Various preventive measures that restrict the entrance of weed seeds into non-infested areas, and uprooting of the weed before flowering and seed setting is indicated as the most effective methods to manage parthenium (APFISN, 2007). Some chemicals (e.g. glyphosate, atrazine and metribuzin), biological agents (e.g. *Zygogramma bicolorata*, *Puccinia abrupta* and *Cassia tora*) and bioherbicides (e.g. foliar extracts of *Azadirachta indica*, *Aegle marmelos* and *Eucalyptus terteticomis*) have also been reported promising to minimize parthenium infestation (APFISN, 2007; Lakshmi and Srinivas, 2007; Fauzi, 2009). However, there is no single method used to control *P. hysterophorus* as each method has one or more limitations such as high cost, environmental safety, inefficiency and impracticability (Shashie, 2007). So, it is mandatory to use integrated

P. hysterophorus management methods that involves the use of different preventive and control options. It can be concluded that *P. hysterophorus* weed has been introduced into Sheka zone, Tepi town, in 1999. It is more serious in Yeki than in the other woredas and in market places and along road sides than in arable and waste lands. Despite the various efforts made to control its further expansion, it is still spreading very rapidly to other areas of the Yeki Woreda. It can also further spread to other woredas of the zone by movement of vehicles, livestock, market commodities, crop produce and flooding and affect the livelihood of numerous farmers in the region. So, future studies focusing on the management of this weed to control its further spread in the zone and neighboring regions are highly recommended. Use of all possible preventive options (e.g. cleaning of farm implements, use of weed free seeds, minimizing free grazing, managing of wastelands and grazing lands through uprooting weeds and growing of competitive plants) in combination with available control methods is also needed. In addition, it should be supplemented with good publicity through mass media, video, posters, field days and seminars, and organization of people's participation in uprooting the weed before flowering and seed setting.

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