# Assessment of Weed Flora Composition in Parthenium (Parthenium hysterophorus L.) Infested Area of East Shewa Zone, Ethiopia

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## ABSTRACT

Field survey on parthenium was conducted at East shewa Zone of Oromiya Regional State, Ethiopia during 2008 cropping season. The objectives of the study was to assess the weed flora composition and plant species that are growing in copetation with parthenium to use those plants as potential biological management options under field condition. Assessment of weed flora composition was carried out in five Kebeles (Farmers Association) of Boset District East Shewa Zone of Oromiya Regional State, Ethiopia. Data on the species composition were recorded and samples of weed flora compositions were collected. The result showed a total of eighty five different herbaceous plant species that were collected and recorded in 63 genera and 24 families. Poaceae (21), Asteraceae (11), Fabaceae (7) and Convolvulaceae (7) were by far the richest taxa and accounted together (55 %) of the entire flora of the study area. The major plant species having higher dominance value were *Parthenium hysterophorus* (25.6), *Cassia tora* (6.07), *Argemone mexicana* (5.83), *Xanthium strumarium* (4.53), *Digitaria abyssinica* (3.02) and *Cyperus rotundus* (2.86). Similarity index values of the species composition among different kebeles ranged from 65% to 78% which indicating that weed species compositions in these locations were similar. The diversity and evenness of species declined with increasing spread of parthenium which suggests negative influence that parthenium had on the status of species diversity in the studied area. In conclusion the selected plant species that were found competitive with parthenium based on their abundance and dominance values were *Argemone mexicana, Cassia tora,* and *Xanthium strumarium* which were suggested for detailed competition experiment in order to determine their competitiveness with *P. hysterophorus* and will be used for biological management of it.

**Key words:** Competitive, evenness, flora composition, parthenium hysterophorus, plant biodiversity, similarity index

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## INTRODUCTION

Parthenium (*Parthenium hysterophorus* L). is a herbaceous invasive alien weed belongs to the family Asteraceae. It is believed to be originated from countries around the Gulf of Mexico, and had spread throughout the Southern USA, the Caribbean and Brazil (Navie *et al.,* 2004). From its centre of origin, parthenium had spread to Africa, Australia and Asia during the last five decades (Aneja *et al.,* 1994). Now it has been widely distributed in South and East Africa. As elsewhere in the world (Evans, 1997), parthenium, an alien invasive weed has been threatening the natural and agricultural ecosystems in Ethiopia. There was no concrete evidence so far regarding the introduction of parthenium into Ethiopia. According to farmers around Dire Dawa, parthenium was introduced during the war between Ethiopia and Somalia (1976-1977), in such a way that the Somalian soldiers brought it to Dire Dawa by covering their weapons with parthenium plants and that it was first observed in Dire Dawa area (Taye, 2002).

The weed has been spreading throughout the country after it was first noticed around Dire Dawa in 1980's (Firew *et al.,* 1996; Tamado, 2001). The weed that has been widely spreading to other parts of the country at an alarming rate must have now exerted a substantial impact on the native biodiversity of rangelands and arable lands. Parthenium is so aggressive and devastating that very little and sometimes no other plant species are seen in areas where it has gained dominance (Wittenberg, 2004). Parthenium is widely spread in the range lands and in the cultivable fields of at East Show Zone of Boset district where this study was conducted and its occurrence has been negatively affecting the composition, diversity and vegetation of the area through depleting wealth and biodiversity of the natural plant species.

There is no single control method of parthenium which has been proved satisfactory as each method suffers from one or more limitations. According Bhan *et al.* (1997) single control method may be inefficient, costly, impracticable,

environmentaly unsafe and too as only temporary relief. Hence, there is need to adopt an integrated parthenium management approach by amalgamating more than one option. Integrating strong interfering competitor plants as component of integrated parthenium management is the best effective approaches. Use of strong interfering smoother crops and plants for parthenium management is practiced in different countries of the world but which, is not studied under Ethiopian condition. Singh (1997) suggested the use of *Cassia uniflora* for suppression of parthenium to be effective. Similarly, studies were done on the effect of competitive plants and their density on the growth and flowering of parthenium (Singh, 1997). They found that *Abutilon indicum* and *Cassia sericea* reduced dry matter accumulation of parthenium by 70% and parthenium population by 52% and 59.3%, respectively (Bhan *et al.*, 1997; Singh, 1997). Several other plants like *Tephrosea purpurea, Amaranthus spinosus, Hyptis savolensis, Sida latifolia, Croton sparciflorus* and other species of Cassia have been found to suppress parthenium (Singh, 1997). However, some believe that plant bio-agents are weeds and do not deserve to be encouraged and that the allergens in the plant species should also be investigated before they are recommended for parthenium control (Singh, 1997).

Management of parthenium through strong competitive plants are long term and ecologically sound management approach but this has not been given due attention in Ethiopia and no information was available with regard to plant species that grow along with parthenium. According to some observation in some parthenium infested areas of Ethiopia in 2007 of dry season plant species like *Xanthium strumarium*, *Argemone mexicana* and *Cassia tora* were abundantly growing along with parthenium and can out compete it at off season of the year (Personal communication). This observation was not scientifically proved before in our country. That is why my attention was drawn to identification and selection of competitive plant species which grow along with parthenium. Hence, identification of competitive plant species through survey and determination of competitiveness of such plant species with parthenium is an essential step to fill the existing information gap for future implementation of biological control of parthenium by using live competitive plant species for an integrated parthenium management system in Ethiopia.

Therefore, the objectives of the study were to assess the weed flora composition in parthenium infested area of Boset District in the East Shewa Zone and to determine frequency, abundance, dominances, species diversity, species richness and species evenness of herbaceous plant species that are growing in competition with parthenium to use those plants as potential biologic al management options.

## Materials and Methods

### Description of the Study Area

The study was conducted at Welenchiti, Boset district of East Shewa Zone, Oromiya Regional State, and it lies between $8^{0}25'$- $8^{0}50'$N and longitude $39^{0}25'$- $39^{0}50'$E with an altitude ranges of 1100 and 1800 m.a.s.l. It is about 125 km East of Addis Ababa, capital of the country. The climate condition of the area is semi-arid type. An average total annual rainfall is 850 mm. The highest rainfall was recorded in August (220 mm) and lowest in December (4.5 mm). The area receives mean annual rainfall 850 mm with maximum and minimum temperature of 23.3 $^{0}$C and of 18.90 $^{0}$ C, respectively (Debela *et al.,* 2004).

### Assessment of Weed Flora Composition in Parthenium Infested Area

A survey on parthenium distribution and plant species grown was carried out by selected five peasant association (PAs) of Boset district, East Showa Zone. It was conducted right after the main rainy season during September 2008 when the vegetation was to a larger extent at full flowering and vigorous growth stage. The PAs were five priori defined areas namely, Xiyo, Digelu wanga, Tsedecha, Borchota and Tiri Birretii. The Farmers Associations (FAs) were selected based on the level of infestation of parthenium and access to the main road.

For the study, area, which represent the peasant associations were selected. At each selected site, two parallel transects of each one km length and 500 m apart from each other and varying in terms of slope, drainage and soil types were established for plant data collection. In each PAs, data was collected from 40 evenly spaced 1m x 1m sample quadrants at every fifty meter from each other. This procedure was adopted for all sampling occasions in each of the five PAs. The numbers of plants were recorded per species in each $1m^2$ quadrant. The infestation of parthenium was estimated by counting the number of plants per quadrant and identifying plant species grown along with it following the method used by Yohannes and Taye (1999) with some modification (Taye, 2002).

## Data Analysis

The data on weed species was summarized using the formula described by Taye *et al.* (1998) as depicted below:

**Frequency (consistency)** is the percentage of sampling units (vegetation registrations) on which a particular weed species is found. It explains as how often a species occurs in the survey area. The frequency is calculated for all species as follows:

$$F = 100*X/N$$

Where, F= frequency; X = number of occurrences of a weed species; N= sample number

**Abundance:** population density of weed species expressed as the number of individuals of plants per unit area.

$$A = \Sigma W/N$$

Where, A = abundance; W = number of individual species/sample; N = sample number

**Dominance:** abundance of a species in relation to total weed abundance.

$$D = A*100/\Sigma A$$

Where, D = dominance; A = abundance; ∑A = total abundance (of all species)

**Similarity Index/Community Index:** is the similarity of weed communities between different locations.

$$SI = 100 * Eph/(Eph + Epa + Epub)$$

Where, SI = Similarity index; Eph = number of species found in both a and b; Epa = number of species found in a; Epub = number of species found in b.

The diversity of the species in vegetation data among the sample sites in the District of the study area were computed using Shannon Diversity Index. Abundance and evenness of the species were accounts in natural environment as shown by the equation below (Shannon and Weaver, 1963) and is 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 of the community,

$$H = \sum_{i=1}^{s} pi \ln(pi)$$

Where, H = Shannon diversity index; pi = importance value of the $i^{th}$ species, s = total number of species in the sample quadrate

The evenness of species calculated as suggested by Hill, (1973)

$$E = \exp(H)/\ln S$$

This index explains how equally abundant each species would be in the plant community and high evenness is a sign of ecosystem health.

## RESULTS AND DISCUSSION

**Weed Flora Composition in Parthenium Infested Area of Boset district**

The total of eighty-five different herb species was collected and identified from the surveyed half square kilometer area (Table 1). Of these, eighty-one species were identified on the spot at species level while the other four were differentiated only to the genus level since small seedlings were difficult to identify from closely related species at the time of data collection. These species belong to the genera of *Cassia, Chenopodium, Trifolium* and *Crotalaria*.

Among the eighty-five total herbaceous plant species recorded over different PAs , 72 species were found in Xiyoo, 69 in Digelu, 67 in Tri Biretii, 76 in Tsedecha and 70 in Borchota PAs. The herbaceous plant species recorded in different PAs were more or less similar in terms of species composition. Only 7 herbs were recorded in Tedecha, 4 in Borchota, and 1 in Digelu which were not found in other surveyed PAs. The plant species composition noted and their frequency, abundance and dominance characteristics are described (Tables 1-5).

The plant species compositions were distributed in 63 genera with in 24 families. The majority of these, 56 species, were dicotyledonous species while the other 27 species were grasses, and two were sedges (Table 1). The major families, based on the number of taxa were *Poaceae* (21), *Asteraceae* (11), *Fabaceae* (7), *Convolvulaceae* (7), *Euphorbiaceae* (5) and *Solonaceae* (5) (Table 2). These genera accounted for 66% of the total herbaceous plant species in the study area. These families were also reported to be economically important and common in different parts of the country (Taye and Yohannes, 1998; Firehun and Tamado, 2006). Moreover, these families are very rich in species diversity so it is usual that they contain many plant species. *Asteraceae, Poaceae* and *Fabaceae* were also found to be most important in other studies in the tropics (Tamado and Milberg, 2002).

Table 1: Weed Species composition in Boset district of five locations after main (long) rainy season during September 2008

| No | Scientific name | Family | LC | GH | F (%) | A (No/m²) | D (%) |
|---|---|---|---|---|---|---|---|
| 1 | Achyranthes aspera L. | Amaranthaceae | a | He | 7.5 | 0.4 | 0.38 |
| 2 | Ageratum conyzoides L. | Asteraceae | a | He | 10 | 0.46 | 0.43 |
| 3 | Agrostis alba L. | Poaceae | a | T | 12.5 | 0.36 | 0.34 |
| 4 | Amaranthus hybridus L | Amaranthaceae | a | He | 20 | 0.9 | 0.86 |
| 5 | Amaranthus spinosus L. | Amaranthaceae | a | He | 15 | 0.66 | 0.62 |
| 6 | Amaranthus deflexus L. | Amaranthaceae | a | He | 12.5 | 0.66 | 0.62 |
| 7 | Ambrosia psilostachrya DC | Asteraceae | a | He | 17.5 | 0.8 | 0.76 |
| 8 | Alternanthera sessilis L. | Amaranthaceae | a | He | 17.5 | 0.7 | 0.66 |
| 9 | Anagalis arvensis L. | Primulaceae | a | Hs | 20 | 1.9 | .86 |
| 10 | Argemone mexicana Sweet | Papaveriaceae | a | He | 47.5 | 5.1 | 5.83 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 11 | Artemisia arvensis L. | Asteraceae | a | He | 15 | 0.8 | 0.76 |
| 12 | Bidens pilosa L | Asteraceae | a | He | 17.5 | 0.8 | 0.76 |
| 13 | Cassia sp | Fabaceae | a | He | 15 | 1.06 | 1.03 |
| 14 | Cassia tora L | Fabaceae | a | He | 55 | 6.36 | 6.07 |
| 15 | Chloris inflata L | Poaceae | a | T | 17.5 | 0.64 | 0.62 |
| 16 | Chenopodium album L | Chenopodiaceae | a | He | 20 | 1.26 | 1.49 |
| 17 | Chenopodium sp | Chenopodiaceae | a | He | 20 | 0.7 | 0.66 |
| 18 | Convolvolus arvensis L | Convolvulaceae | p | Hc | 22.5 | 0.9 | 0.86 |
| 19 | Crotalaria sp | Fabaceae | a | He | 7.5 | 0.9 | 0.57 |
| 20 | Cyperus rotundus L. | Cyperaceae | p | HR | 45 | 3.3 | 2.68 |
| 21 | Cyperus esculentus L. | Cyperaceae | p | HR | 30 | 1.16 | 1.1 |
| 22 | Cynodon dactylon L. | Poaceae | p | HR | 52.5 | 4.16 | 3.97 |
| 23 | Cynodon nlemfuensis Vanderyst. | Poaceae | p | Hp | 20 | 0.66 | 0.62 |
| 24 | Datura inoxia Mill. | Solanaceae | a | He | 20 | 0.26 | 0.2 |
| 25 | Datura stramonium L. | Solanaceae | a | He | 10 | 0.3 | 0.28 |
| 26 | Desmodium adscendens DC | Fabaceae | a | He | 12.5 | 0.76 | 0.69 |
| 27 | Dinebra retroflexa Vahl | Poaceae | a | T | 12.5 | 0.76 | 0.69 |
| 28 | Digitaria abyssinica Stapf | Poaceae | p | HR | 45 | 4.35 | 4.02 |
| 29 | Digitaria horizontalis Wild | Poaceae | a | T | 20 | 0.7 | 0.66 |
| 30 | Digitaria sanguinalis L. | Poaceae | a | T | 20 | 0.6 | 0.57 |
| 31 | Digitaria ternata Stapf. | Poaceae | a | T | 32.5 | 1.06 | 1.03 |
| 32 | Digitaria velutina Forssk. | Poaceae | a | T | 15 | 0.66 | 0.62 |
| 33 | Echinochloa crusgalli L. | Poaceae | a | T | 40 | 1.6 | 1.52 |
| 34 | Echinochloa colona L. | Poaceae | a | T | 20 | 0.86 | 0.81 |
| 35 | Eleusine indica L. | Poaceae | a | T | 20 | 0.8 | 0.95 |
| 36 | Eragrostis cilianensis All | Poaceae | a | T | 35 | 1.06 | 1.03 |
| 37 | Eriochloa fatmensis Hochst | Poaceae | a | T | 20 | 0.66 | 0.81 |
| 38 | Euphorbia hetrophylla L. | Euphorbiaceae | a | He | 20 | 0.76 | 0.82 |
| 39 | Euphorbia hirta L. | Euphorbiaceae | a | Hp | 30 | 1.2 | 1.12 |
| 40 | Euphorbia indica Lam. | Euphorbiaceae | a | He | 25 | 1.2 | 1.12 |
| 41 | Euphorbia thymifolia Carter | Euphorbiaceae | a | Hp | 22.5 | 0.86 | 0.81 |
| 42 | Galansoga parviflora Cav. | Asteraceae | A | He | 20 | 1.2 | 0.74 |
| 43 | Guizotia scabra Vis | Asteraceae | a | He | 35 | 1.2 | 0.74 |
| 44 | Heliotropium cinersis DC | Boraginaceae | a | Hs | 20 | 0.86 | 0.67 |
| 45 | Indigofera spicata Forssk | Fabaceae | p | HR | 10 | 0.46 | 0.43 |
| 46 | Ipomoea acuminate L | Convolvulaceae | a | Hc | 15 | 0.5 | 0.48 |
| 47 | Ipomoea congesta L. | Convolvulaceae | a | Hp | 22.5 | 0.6 | 0.51 |
| 48 | Ipomoea cordofana (Desr) | Convolvulaceae | a | Hp | 30 | 1.06 | 1.02 |
| 49 | Ipomoea herderifolia Vatke | Convolvulaceae | a | He | 27.5 | 0.9 | 0.93 |
| 50 | Lantana camara L. | Verbenaceae | p | Hs | 32.5 | 0.76 | 0.71 |
| 51 | Leucas martinicensis (Jacq.) | Labiatae | a | He | 20 | 0.66 | 0.69 |
| 52 | Matricaria chamomilla L. | Asteraceae | a | He | 22.5 | 0.86 | 0.81 |
| 53 | Mentha arvensis L. | Labiatae | a | He | 22.5 | 0.9 | 1.01 |
| 54 | Mercurialis annua L. | Convolvulaceae | a | Hc | 17.5 | 0.76 | 0.66 |
| 55 | Nicandra physaloides L. | Solanaceae | He | HR | 12.5 | 0.66 | 0.54 |
| 56 | Oplismenus hirtellus L. | Poaceae | p | HR | 15 | 0.86 | 0.62 |
| 57 | Orobanche minor Smith | Orobanchaceae | a | | 12.5 | 0.9 | 0.77 |
| 58 | Oxalis corniculata L. | Oxalidaceae | p | HR | 15 | 0.7 | 0.59 |
| 59 | Oxygonum sinuatum Meisn | Polygonaceae | a | Hs | 30 | 1.24 | 1.19 |
| 60 | Panicum maximum Jacq. | Poaceae | p | T | 25 | 1.06 | 1.05 |
| 61 | Parthenium hysterophorus L. | Asteracae | a | He | 90 | 21 | 25.6 |
| 62 | Pinpinella abyssinica L. | Ampiliferae | a | He | 7.5 | 0.3 | 0.28 |
| 63 | Plantago lanceolata L. | Plantaginaceae | p | He | 7.5 | 0.36 | 0.30 |
| 64 | Phyllanthus amarus | Euphorbiaceae | a | He | 22.5 | 0.6 | 0.71 |
| 65 | Polygonum salicifolium Willd | Polygonaceae | a | He | 30 | 0.96 | 0.91 |
| 66 | Rhyncossia malacophylla L. | Fabaceae | a | Hc | 15 | 0.6 | 0.57 |
| 67 | Rumex abyssinicus Jacq | Polygonaceae | a | He | 10 | 0.4 | 0.43 |
| 68 | Savignya parviflora L. | Brassicaceae | a | He | 5 | 0.36 | 0.33 |
| 69 | Sonchus oleraceus L. | Asteraceae | a | He | 10 | 0.3 | 0.28 |
| 70 | Setaria abyssinica L. | Poaceae | a | T | 12.5 | 0.36 | 0.4 |
| 71 | Setaria pumila Poir. | Poaceae | a | T | 10 | 0.46 | 0.52 |
| 72 | Setaria verticillata L. | Poaceae | a | T | 7.5 | 0.4 | 0.47 |
| 73 | Sida acuta Burm.f. | Malvaceae | p | He | 15 | 0.7 | 0.78 |
| 74 | Sida alba L. | Malvaceae | p | He | 12.5 | 0.66 | 0.76 |
| 75 | Snowdenia polystachya Fresn | Poaceae | a | T | 10 | 0.6 | 0.71 |
| 76 | Solanum incanum L. | Solanaceae | a | He | 17.5 | 0.86 | 1.01 |
| 77 | Solanum nigrum L. | Solanaceae | a | He | 7.5 | 0.06 | 0.11 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 78 | Sonchus asper L. | Asteracae | a | He | 15 | 0.56 | 0.65 |
| 79 | Sorghum arundinacieum Desv | Poaceae | a | He | 27.5 | 1.06 | 1.25 |
| 80 | Spergula arvensis L | Caryophyllceae | a | He | 22.5 | 0.8 | 0.95 |
| 81 | Stellaria media L. | Caryophyllceae | a | He | 15 | 0.5 | 0.59 |
| 82 | Tribulus terrestris L. | Zygophyllaceae | a | Hp | 17.5 | 0.8 | 0.95 |
| 83 | Trifolium sp | Fabaceae | a | Hp | 12.5 | 0.7 | 0.75 |
| 84 | Trichodesma zeylanicum L. | Boraginaceae | a | He | 17.5 | 0.84 | 0.66 |
| 85 | Xanthium strumarium L. | Asteracae | a | He | 45 | 4.8 | 4.53 |

*Key: LC = life cycle; GH = growth habit; F= frequency; A = abundance; D= dominance; c = climbing; p = prostrate; a = annual; b = biennial; p = perennial; H = herb; e =erect; s = sprawling; R = rizomateous; and T = tuftted.*

Table 2: Number and proportion of plant species within the six top diverse families in five locations

| Family | Number of species | Percent flora |
|---|---|---|
| Poaceae | 21 | 25 |
| Asteraceae | 11 | 13 |
| Fabaceae | 7 | 8 |
| Convolvulaceae | 7 | 8 |
| Solanaceae | 5 | 6 |
| Euphorbiaceae | 5 | 6 |
| **Total** | 56 | 66 |

In this study, six families contributed 66 % of species to the total flora. *Poaceae, Fabaceae, Asteraceae*, and *Euphorbiaceae* were by far the species richest taxa and accounted together (55%) of the entire flora of the study area (Table 2). At the genus-level, diversity is almost two times higher than at the family level; 63 taxa have been recorded, 11 % of them include three or more species, the genus *Digitaria* and *Ipomoea* being the most diverse taxa each with five species (Table 1).

**The frequency, Abundance and Dominance of plant species**

Averaged over locations, the frequency value of the species ranged from 5–90%. The highest frequency value (90%) recorded by *Parthenium hyterophorus* followed by *Cassia tora* (55%), *Cynodon dactylon* (52.5%), *Argemone mexicana* (47.5%), *Xanthium strumarium* and *Digitaria abyssinica* (45%). Whereas, the least frequency value recorded from *Savignya parviflora* (5%) followed by *Solanum nigrum, Setaria verticillata* and *Pinpinella abyssinica* that recorded (7.5%) (Table 1). This suggests that *Parthenium hysterophorus* is the most frequent species in the study area.

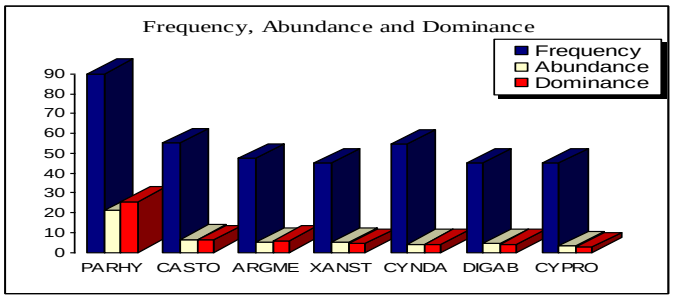
The abundance value of the species varied from 0.06 to 21 plants $m^{-2}$. The highest abundance value (21 plants $m^{-2}$) was recorded by *Parthenium hyterophorus* followed by *Cassia tora* (6.36 plants $m^{-2}$), *Argemone mexicana* (5.1 plants $m^{-2}$), *Xanthium strumarium* (4.8 plants $m^{-2}$) and *Digitaria abyssinica* (4.35 plants/$m^2$). Whereas, the least abundance value (0.06 plants $m^{-2}$) was recorded for *Solanum nigrum* followed by *Datura anoxia* (0.26 plants $m^{-2}$), *Pimpinella abyssinica, Sonchus oleraceus* and *Datura stramonium* that recorded 0.30 plants $m^{-2}$ (Table 1). This result also showed that *Parthenium hysterophorus* is the most abundant species in the study area suggesting its high competitiveness to the herbaceaous plant community in the area.

The range of dominance value of the species varied from 0.11 - 25.6%. The highest dominant species was *Parthenium hyterophorus* followed by *Cassia tora* (6.07%), *Argemone mexicana* (5.83%), *Xanthium strumarium* (4.53%) and *Digitaria abyssinica* (4.02%). The species with the least dominance value was *Solanum nigrum* (0.11%) followed by *Datura inoxia* (0.2%), *Pinpinella abyssinica, Sonchus oleraceus* and *Datura stramonium* that recorded (0.28%). Hence, the dominance values of the species composition also showed that *Parthenium hysterophorus* is to be the most competitive species in the area (Table 1).

Similar result was found from Tamado (2001) reported that if the specific plant species had higher frequency and dominance value, it indicate the economic importance of it. Taye (2002) stated that *Parthenium hysterophorus* has become a major weed of crops in northern and eastern regions of Ethiopia. Farmers in the study area reported that parthenium compete with their crop and reduce crop yields. Besides, it increases the cost of labor and other production inputs. Reports in India also indicated that parthenium significantly inhibit germination and growth of crop plants, heavy pollen deposits on nearby crop resulted in failure of seed set and caused yield loss up to 40% on maize (Navie *et al.*, 2004). Therefore, this study confirmed that parthenium is one of the major social, environmental and economic threats in the study area.

In general, there were positive and significant correlations among frequency, abundance and dominance, that is the higher the frequency of the weed species, the higher will be its abundance and dominance and vice versa. The higher frequency, abundance and dominance values of *Cassia tora, Argemone mexicana, Xanthium strumarium* and *Digitaria abyssinica* suggest that these species can grow in competition with parthenium. Moreover, the competitiveness of these species with parthenium, in the long run, might be greater and may serve as a replacement tool for the management of parthenium in the parthenium infested areas with similar ecological conditions. Hence, as a continuation of the field survey, a greenhouse study was made in order to evaluate the competitiveness of these species versus parthenium at different density proportions.

**Figure 1**: Frequency, Abundance and Dominance of the top seven plants in 2008




**Key:** PARHY = *Parthenium hysterophorus*, DIGAB = *Digitaria abyssinica*, CASTO= *Cassia tora*, ARGME = *Argemone mexicana*, XANST = *Xanthium strumarium*, CYNDA = *Cynodon dactylon*, CYPRO=*Cyperus rotundus*

**Similarity Index**

Similarity index is the similarity of plant species composition among different PAs in Boset district. The result showed a similarity index value of 65 - 78% among the PAs (Table 3). This suggests that the plant species composition among the different PAs were similar by 65-78%. As described by Yohannes and Taye (1999), if the index of similarity is below 60%, it is said that the two locations or soil types have different weed communities. Since similarity indices for the different location were greater than 60% it can be concluded that the locations exhibited similar weed community and thus, require similar management options.

**Table 3**: Similarity index of herbaceous plant community in the five PAs of Boset district

| Locations | Xiyoo | Digelu | Tri Biretii | Tsedecha | Borchota |
|---|---|---|---|---|---|
| Xiyoo | 100 | 78 | 76 | 74 | 67 |
| Digelu | | 100 | 72 | 71 | 65 |
| Tri Biretii | | | 100 | 74 | 67 |
| Tsedecha | | | | 100 | 78 |
| Borchota | | | | | 100 |

**Species diversity and evenness**

The diversity and evenness of species were not significantly different among different study sites or PAs which was analyzed by McCune and Meffored softwear 1999 (Table 4) . The highest mean number (3.73) of the diversity was obtained in Tsedecha site while the lowest mean number (2.65) was obtained at Tri briti site. The higher value of the diversity index indicates the variation in the type of species and heterogeneity in the communities where as the lesser values indicate the homogeneities of the species and the lower diversity of species. According to table 4, the high mean value of (0.87) evenness was observed at Tsedecha and least mean value of (0.65) evenness was obtained at Tri-briti site. The diversity and evenness of species were positively associated. The higher species diversity, the greater would be the evenness. The present study revealed that the diversity and evenness of species declined with increasing spread of parthenium since parthenium dominance is high at Tri-briti (37) than Tsedech (18). This suggests the negative influence that parthenium had on the status of species diversity in the studied sites of Boset district. This finding about the mean number of diversity was consistent to those revealed in the study done by Navie *et al*. (2004). In their studies, the authors pointed out that the diversity values depend on the dominance of the parthenium weed in the community and it may reduce the diversity of weed species. It is possible that the persistence infestation of parthenium in the study area might have contributed to low plant species diversity and evenness values at Tri-briti.

**Table 4**: Species diversity and evenness in different study sites

| Locations | Diversity | Evenness |
|---|---|---|
| Xiyoo | 3.03 ±0.97a | 0.72 ±0.04a |
| Digelu | 3.04 ±0.97a | 0.73 ±0.04a |
| Tri Biretii | 2.65 ±0.97b | 0.65 ±0.04b |
| Tsedecha | 3.73 ±0.97a | 0.87 ±0.04a |
| Borchota | 3.70 ±0.97a | 0.85 ±0.04a |

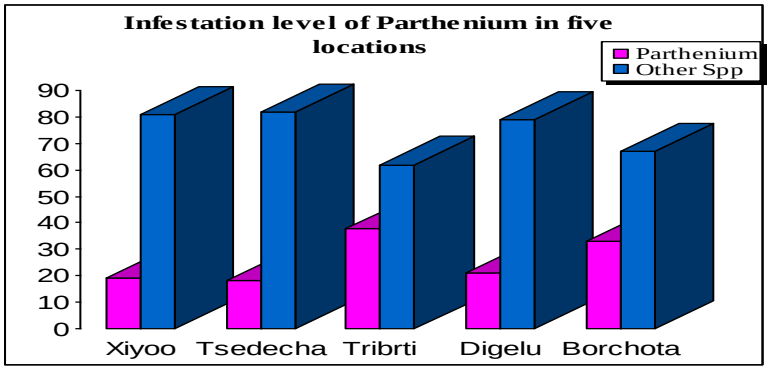
Note: - Means of the same letters are not significantly ($p<0.05$) different from each other

**Distribution and Importance of Parthenium on other Weed Species**

Parthenium showed varied level of infestation (dominance) that ranged from 18 % to 37.3 % in the surveyed five PAs in the study area. Among the study Kebles, severe infestation of parthenium was scored for Tri-bretii PAs (37.3%) followed by Borchota (33.8%) but the lowest infestation scored at Tsedech (18%) followed by Xiyoo (18.8%).

Almost all PAs were observed to be infested with parthenium. Thus, among these PAs, parthenium had a significant importance on distribution and level of native biodiversity (Figure 5). In line with this, studies conducted in different parts of the country indicated that parthenium had different distribution and importance level (Taye, 2002; Rezene, 2005; Besufekad *et al*., 2005).

**Figure 2**: Distribution and infestation level of parthenium in five PAs at Boset district




On the other hand, parthenium infestation level showed significant effect on the level of other plant species grown in the study area. In Tri-birtii PAs there is high level of parthenium infestation and low plant diversity showed as compared to Tsedecha PAs that showed low density of parthenium and high plant diversity (figure 2). This shows that there is a trend of change in plant composition as a result of parthenium dominance and it agrees with the reports of different authors that showed parthenium had a significant effect on plant diversity in a given eco-system (Jayachandra, 1971; McFadyne, 1992; Chippendale and Panetta, 1994; Evans, 1997; Taye, 2002). Hence, all the PAs in the district need to have strong preventive and control strategy and implementation in order to save existing biodiversity.

## SUMMARY AND CONCLUSION

Parthenium became a weed of economic importance in Ethiopia during the past 10-15 years. It is still spreading rapidly and has had a substantial problem on crop and animal production, biodiversity, human and animal health. Therefore, development of effective prevention and control programs are very essential to overcome its problems.

No single method of control has been proved satisfactory. Hence, there is a need to adopt an integrated parthenium management approach by amalgamating more than one option. Among these, use of strong interfering competitor plants is recommended as component of integrated parthenium management. Thus, identification and selection of strong competitive plant species which grow with parthenium and determination of their competitiveness was designed to aid future implementation of biological control of parthenium.

Based on the study, the total of eighty five different herbaceous plant species was identified. The importance of each species was determined by calculating the frequency, abundance and dominance values. The major plant species having a dominance level greater than 3% were *Parthenium hysterophoru (25.6), Cassia tora (6.07), Argemone mexicana (5.83), Xanthium strumarium (4.53), Digitaria abyssinica (3.02)* and *Cyperus rotundus (2.86).* In general, three herbaceous species, namely *Cassia tora, Xanthium strumarium* and *Argemone mexicana* had good association and grow with *Parthenium hysterophrous* in competition. They have relatively high abundance and dominance value as well as potential to compete with *P. hysterophorus* as they had large area coverage in the study site. Therefore, these species are recommended for *Parthenium* eradication.

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