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Suppressive Effect of Grasses Against Growth Of Parthenium *(Parthenium hysterophorus L.)*

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Abstract

Experiment was carried out to study the suppressive effect of some grasses on the growth and development of parthenium *(Parthenium hysterophorus L.)*. The experiment was consisted of three grasses (*Cenchrus ciliaris* L., *Pennisetum perpureum,Panicum maximum* Jacq) with their four mixture of sowing which was arranged in replacement series. From this experiment the effect of different grasses mixture significantly suppress the plant height, leaf number, and branch number, fresh and dry weight of as compared to parthenium grown alone. The tallest (76.67 cm) parthenium was recorded from 100: 0 (parthenium: grasses) whereas the shortest was recorded from *Panicum maximum* Jacq: *Parthenium hysterophorus*L. (7.67 cm) followed by *Cenchrus ciliaris* L.: *Parthenium hysterophorus*L. (12.0 cm) and *Pennisetum perpureum:* parthenium (13.0 cm) at 25:75 (parthenium: grasses) mixture however no significance difference was observed among them. Similarly, these treatments also significantly reduced leaf number, branch number, fresh and dry weight of parthenium. Moreover, the relative crowding coefficients suggested that *Panicum maxicum*Jacqwas more dominant than parthenium in plant mixture of 75:25 (Panicum: Parthenium). In this combination, P. *maxicum*Jacq had higher crowding coefficients (1.98). Aggressivity index also showed similar trends to that of relative crowding coefficients. In all seeding proportions, grasses (*Panicum maxicum* JacqC. *ciliaris* and *Pennisetum perpureum*) were all determined to be useful at out compete and displacing parthenium weed and were found to be generally more dominant. Therefore Sowing of such pasture plants in infested areas can suppress the growth of parthenium weed and provide improved fodder for stock.

Keywords: *Parthenium hysterophorus*. L; Competitive index; Grasses suppression; Management option

Introduction

Parthenium hysterophorus L. is one of the worst weeds of the world which has got a position among the list of top ten worst weeds of the world and has been listed in the global invasive species database. 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 [1]. 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. In
Queensland, cattle production has declined by approximately 4.75 animal due to this weed (Chippendale and Panetta 1994) with an associated financial loss of Aus $16.5 million per annum. Despite, various methods have been used to manage parthenium weed worldwide but most have limited effect, or need to be re-applied constantly on an annual basis as and when the weed re-emerges from the soil seed bank constant need to reapply herbicides following seasonal re-emergence of parthenium weed in sorghum (*Sorghum bicolour* L.) crops. These observations have suggested that supplementary, site-specific management strategies are now required to achieve superior management of this weed [2].

In areas where it is possible, the displacement of this weed with beneficial plants is considered to be an ideal management approach. Previously, in a glasshouse experiment, floren bluegrass (*Dichanthium aristatum* Poir.), bisset bluegrass (*Bothriochloa insculpta* cv. Bisset) and buffel grass *(Cenchrus ciliaris L.*) were all shown to be able to displace parthenium weed (O'Donnell and Adkins 2005) and to produce a quantity of fodder biomass at an appropriate level to sustain livestock production. Moreover For example in India, guinea grass (*Panicum maximum* Jacq.), tannre's cassia (*Cassia auriculata* L.) and fedogoso (*Cassia occidentalis* L.) have been used; in Ethiopia, sorghum (*Sorghum bicolor* L.) Moench and in South Africa, African love grass (*Eragrostis curvula* Nox.) have all shown significant suppressive effects upon the growth of P. *hysterophorus*L.in the field. The sowing of suppressive plants has been shown to be effective in improving the management of the weed in several countries [3]. However, in Ethiopia there no and/or no research has been done about the suppressive effect of grasses against parthenium. Therefore, the objective of this research was to evaluate the suppressive effect of different grasses sown at different combination on the growth and development of P. *hysterophorus* L.

Materials and Methods

Description of experimental site

The experiment was conducted in Ambo University Guder Campus which found in Toke kutaye district. The area is 8058' N located 37co 46'E with about 125 km western of Addis Ababa with temperature 8.25-23.4^{0}c. Altitude 2101m.a.s.l and rain fall is 800-1100 mm.

Treatment and experimental design

Pot experiment comprised of three grasses (*Cenchru sciliaris* L. *Panicum maxicum* Jacq and Pennisetum perpureum) sown different replacement series with *parthenium hysterophorus* L. (0:4, 3:1, 2:2, 1:3, 4:0) were undertaken. The experiment was arranged CBD (Complete Block Design) with three (3) replication (Table 1).

S. no	Species Name	C3/C4	Growth Habit	Palatability to livestock
1	Cenchrus ciliaris L.	C4	Erect tussock	High
2	Panicum maxicum Jacq			
3	Pennisetum perpureum	C4		High

Table 1: Test grasses description.

Cultural practices

The seeds of selected grasses were collected from ILIRI Ethiopia. Seeds of all species were sown into cell trays filled. The cell trays containing the seeds were then kept in an open air and watered to field capacity. Soil from upper surface; sand, compost and top soil was collected and sieved by using 2 mm diameter of sieve [4]. Composited soil was prepared with proportion of 2:1:1 of soil, sand and compost ratio respectively and pots (25 cm diameter) were filled this soil (air dried). The soil was then watered to saturation and allowed to drain for 24 h to reach a soil moisture content that was close to field capacity. The 10-day-old seedlings of parthenium weed and the test plant species were then transplanted into these pots as par the treatment proportion and watered to field capacity and allowed to grow together for 90 days. An replacement series experimental design was used in which seedlings were sown to a total density of 4 plants pot-1(representing 80 plants per m^{-2}), each at five combinations of parthenium weed-to-test plant species (viz. 4:0, 3:1, 2:2, 1:3, 0:4) each replicated three times [5]. Watering was done twice a day at the morning and afternoon by using water cane.

Data collection

Plant height was recorded from ground to the tip of the plant using ruler, number of branches per plant was counted and their average was computed, fresh biomass was recorded after harvested and dry biomass weight was taken by oven drying the fresh weight at 65^0c until constant weight, Ability with stand competition of grasses (AWC) was determined using

$$AWC = {}^{VI}\!/_{Vp}\, X100 \text{ (Wall, 1994)}$$

where, Vi: Yield of grass in terms of weed infested, Vp: Yield of grasses in terms of weed-free infested.

The larger the index, indicating the greater ability of crop plants for tolerance to weeds. Relative crowding coefficient for the partheenium and grasses was calculated using

$$RCCPG = \frac{DMYPG}{DMYPP - DMYPG},\ RCCGP = \frac{DMYGP}{DMYGG - DMYGP} \text{ (50:50 mixture) And}$$

Combination differed from 50:50

$$RCCPG = \frac{DMYPG(zgp)}{(DMYPP - DMYPG)zpg},\ RCCGP = \frac{DMYGP(zpg)}{(DMYGG - DMYGP)zgp}$$

Where: DMYPG = Dry Matter Yield of Parthenium mixed with any Grass DMYGP = Dry Matter Yield of any Grass mixed with Parthenium RCCPG = Relative Crowding Coefficient Parthenium mixed with any Grass RCCGP = Relative Crowding Coefficient any Grass mixed with Parthenium Zpg = the sowing proportion of parthenium with any grass Zgp = the sowing proportion of any grass with parthenium (DeWit, 1960). Aggressivity index (AI) of both grasses and the weed.

$$AIGP = \left(\frac{DMYGP}{DMYGGxzgp}\right) - \left(\frac{DMYPG}{DMYPPxzpg}\right),\ AIPG = \left(\frac{DMYPG}{DMYPPxzpg}\right) - \left(\frac{DMYGP}{DMYGGxzgp}\right)$$

Where: AIGP = Aggressivity Index of any Grass mixed with Parthenium, DMYGP = Dry Matter Yield of any Grass mixed with Parthenium DMYPG = Dry Matter Yield Parthenium mixed with any Grass zgp = the sowing proportion of any Grass with Partheniumzpg = the sowing proportion of parthenium mixed with any Grass [6]. The performance of the tested plants was determined using a competition index following Spitters (1983) and plant with Competition Index (CI) values CI>1.5, (strong) CI= 1.0-1.5 (medium) and <1.0 (poor competent).

Data analysis

All the collected data was subjected to analysis of variance following (CBD) procedure using SAS and mea separation was conducted for treatment means using least significance differences (LSD) at 5% probability level.

Result and Discussion

Plant height

According the data presented in Table 2 showed that effect of different sowing mixture of grasses was significantly reduced the height of *Parthenium hysterophorus* L. the shortest height (7.67cm) of P. *hysterophorus*L. was recorded from 75:25 (*Panicum maxicum* Jacq: *P. hysterophorus* L.) sowing combination followed by 75:25 (*Cenchrus ciliaris* L.:*P.hysterophorus* L.)(11.33 cm) followed by 50:50 (*Panicum maxicum* Jacq: P. *hysterophorus* L.) however non significance difference was observed among them whereas, the tallest (74.67cm) was recorded when P. *hysterophorus* L. allowed to grown alone (100:0). Interestingly as the sowing proportion of grasses were increased from 25:75 (grass: P. *hysterophorus* L.) to 75:25 (grass: P. *hysterophorus* L.), the height of the P. *hysterophorus* L. was significantly decreased. This height reduction may be due to sowing proportion and long period of interferences of grasses against the P. *hysterophorus* L.

Leaf number

P. *hysterophorus* L. leaves per plant was significantly affected by the sowing proportion. The maximum number leaves per plant (70.67) was observed from 100:0 (P. *hysterophorus* L.: grasses) sowing combination whereas minimum number (9.0) when P. *hysterophorus*

L. grown with *Panicummaxicum* Jacq at 75:25 (grasses: P.*hysterophorus* L) sowing mixture. This may be due the suppressive effect of the fodder grasses and their higher sowing proportion on the leave production of P. *hysterophorus* L [7].

Branch number

Like plant height and leaves number per plant, branch number of P. *hysterophorus* L. was also significantly affected by different sowing proportion. As the data presented in (Table 2) indicated that maximum number of branches per plant (22.3) was produced when P. *hysterophorus* L. was grown alone whereas the minimum number of branches per plant (6.8) was recoded from 75:25 (*Panicum maxicum* Jacq: P. *hysterophorus* L.) followed by 75:25 (*Cenchrus ciliaris* L.: P. *hysterophorus* L.) (8.7) and 75:25(*Pennisetum perpureum:P.hysterophorus* L.) sowing proportion however no significance difference was observed among them. This may be due the significant reduction of plant height and leaf number P. *hysterophorus* L. by these fodder grasses in all sowing proportion as compare to the sole grown weed [8].

Fresh biomass

As the data pertained in showed that the effect of different sowing mixture of fodder grasses were significantly reduced the fresh biomass of P. *hysterophorus*L. The highest fresh biomass per plant (84.4 g/plant) was obtained at 100:0 (P. *hysterophorus* L: grasses) sowing proportion whereas the lowest (23.1 g/plant) was recorded from 75:25 (*Panicum maxicum* Jacq: P. *hysterophorus* L.) followed by 75:25 (*Pennisetum perpureum*: P.*hysterophorus* L.) (25.4 g/plant) and 75:25(*Cenchrus ciliaris* L.:P. *hysterophorus* L.) (31.9g/plant) sowing proportion however no significance difference was observed among them. This is may be due grasses had a good tillering ability and rapid growth pattern in the field, producing an extensive root system and leaf canopy quite early after emergence from the soil. At 75: 25 sowing proportion *Panicum maxicum* Jacq, *Cenchrus ciliaris* L. and *Pennisetum perpureum* grasses were reduced the P. *hysterophorus* L fresh biomass by 72.6, 62.2 and 69.9% respectively. Similar result was also reported by Khan et al. (2010) who reported that compared to the control, purple pigeon grass, buffel grass, butterfly pea, kangaroo grass and bull Mitchell grass were all found to be good to reduce the parthenium weed biomass by 82, 74, 70, 67 and 61%, respectively.

Dry biomass

Dry biomass production of P. *hysterophorus* L. was also significantly reduced by sowing proportion of grasses. The minimum dry biomass (10.9 g/plant) was produced at 75:25 (*Panicum maxicum* Jacq: P. *hysterophorus* L.) followed by 75:25 (*Pennisetum perpureum*: *P. hysterophorus* L.) (12.4 g/plant) and 75:25(*Cenchrus ciliaris* L.:P. *hysterophorus* L.) (13.6 g/plant) sowing proportion however, no significance difference was observed among them (Table 2). At this sowing proportion, *Panicummaxicum* Jacq, *Pennisetum perpureum*, *Cenchrus ciliaris* L. were reduced the biomass production of *P. hysterophorus* L. weed by 74.4, 70.9 and 68.2% respectively. This may be attributable to the fact that these plant species are higher in sowing mixture and able to extract soil nutrients and water more efficiently and/or grow more rapidly than parthenium weed [9]. These finding was in accordance with work of Khan et al (undated) who reported that such plants are able to shade parthenium weed at an early stage of growth, resulting in suppressed growth and lower shoot biomass production in the weed where it was reported that a number of improved, introduced plant species were able to displace parthenium weed in a glasshouse study. These plants may inhibit the growth of parthenium weed through competition or through an allelopathic interference. These features of faster growth or interference may be the characteristics of these species that makes them useful for the displacement of parthenium weed [10].

Relative crowding coefficient

The relative crowding coefficients based on aboveground biomass suggested that *Panicum maxicum* was more dominant than parthenium in plant mixture of 75:25 (Panicum: Parthenium). In this combination, *P. maxicum* had higher crowding coefficients. However, as shown in (Table 3) 25:75, combinations parthenium was more dominant as indicated by higher crowding coefficients. The study showed that the biomass of parthenium was strongly inhibited by the presence of *Panicum maxicum* in 75:25 followed by *Pennisetum perpureum* 75:25 and *Panicum maxicum* 50:50 seed proportion. Interestingly as the number of grasses increased the relative crowding coefficient of grasses were also increased. Similarly as the proportion of parthenium was also increased, the relative crowding coefficients were also increased. Generally, a total biomass reduction was observed due to these plants may inhibit the growth of parthenium weed through competition or through an allelopathic interference. These features of faster growth or interference may be the characteristics of these species that makes them useful for the displacement of parthenium weed. And that *panicum* out competed parthenium at a level of combination greater or equal to 50%. This finding was in agreement reported that some grasses (*P. coloratum, Panicum maxicum* Jacq. and *Cenchrus ciliaris* L) can outcompete parthenium.

Aggressivity index of grasses

Aggressivity index also showed similar trends to that of relative crowding coefficients. In all seed proportions, grasses (*Panicum maxicum*, C. *ciliaris* and *Pennisetum perpureum*) were found to be generally more dominant. This is indicated by the positive numerical value of an aggressivity index and by the negative numerical value of parthenium the index. According to this study, the biomass of these species was strongly reduced when two species (parthenium and any grass) exist together. The reason might be due to allelopathic interaction (which is not determined) that exists between the two species.

Competitive index

The proportion of grasses increased the competitive index was increased. *Panicum maxicum*, *Pennisetum perpureum* sown in 75:25 and 50:50 combination (grasses: Parthenium) showed higher competitive index (>1.5) followed by C. *ciliaris* which were strong competitive against parthenium. Moreover *Panicum maxicum* sown in 25:75 and C. *ciliaris* sown in 50:50 proportions results moderate (1-1.5) competitive ability against the parthenium weed. These may be due to features of faster growth or interference may be the characteristics of these species that makes them useful for the displacement of parthenium weed (Table 2).

Treatments	**Sowing mixture**		
	25:75	50:50:00	75:25:00
P. perpureum +Parthenium	0.59	1.57	2.14

C. ciliaris L. +Parthenium	0.47	1.12	1.46
P. maximum Jacq +Parthenium	1.32	1.63	2.16

Table 2: Competitive index of grasses in different sowing proportion against parthenium.

Ability with stand competition of grasses

The ability to withstand competition against parthenium was significant at different density of sowing. As can be seen the greatest ability to withstand competitive (151.30) was obtained from P. maximum Jacq+Parthenium at 75:25 sowing mixture which is not statistically differ from P. perpureum+Parthenium (139.19) at the same sowing mixture whereas the lowest was recorded from C. ciliaris L. +Parthenium (42.56)at 25:75 sowing mixture. As the density of grasses increased the ability of the fodder grasses to withstand competition was also increased which indicates that keeping the grasses at higher density or reducing the grazing frequency could be option for management of parthenium in rangelands and pasture lands Table 3.

Treatments	**Sowing mixture**		
	75:25:00	50:50:00	25:75
P. perpureum +Parthenium	139.19 a	70.86 c	44.7 d
C. ciliaris L. +Parthenium	92.03 b	70.19 c	42.56 d
P. maximum Jacq +Parthenium	151.30 a	93.99 b	49.78 d
LSD	19.89		
CV	13.82		
Means with the same letters are not significantly different at P=0.05 LSD: Least Significant Difference; CV: Coefficient of Variation.			

Table 3: Effects of different sowing mixture on ability with stand competition against parthenium.

Conclusion

From this experiment it can be concluded that Sowing of *Cenchrus ciliaris* L., *Pennisetum perpureum,Panicum maximum* Jacq at different sowing density significantly suppressed plants in infested areas can suppress the growth and development of parthenium weed and provide improved fodder for stock. Keeping the grasses at higher density or reducing the grazing frequency could be option for management of parthenium in rangelands and pasture lands. However these results were obtained under non-grazing conditions and undertaken using just a single species in a plot. It is anticipated that to gain the best parthenium weed growth suppression, mixes of suppressive plants should be used and, hence future work should focus on the use of sowing mixes under grazing pressure.

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