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SCREENING OF VARIOUS GRASSES AGAINST MOISTURE STRESS UNDER RAINFED ENVIRONMENT OF FATEH JANG

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ABSTRACT

The grasses serve as biological pump because they absorb rainwater and helps in controlling soil and water erosion. Thirteen multi-purpose grasses species namely Lemon Grass (*Cymbopogon citrratus* DC), Mot grass (*Pennisetum purpureum* S), Khavvi grass (*Cymbopogon jawarncusa* L), Khabbal grass (*Cynodon dactylon* L), American grass (*Ammophila breviligulata* F), Bhabbar grass (*Eulaliopsis binata* R), Barru grass (*Sorghum halepense* L), Sireyala grass (*Heteropogon contortus* L), Pehlwan grass (*Digitaria sanguinalis* L), Miniyara grass (*Agarista ericaceae* Taub), Cheetah grass (*Acinonyx jabatus* L), Love grass (*Eragrostis superba* Per) and Dhamun grass (*Cenchrus setigerus* Vahl) were selected and tested against moisture stress. Parameters studied were Biomass (t ha^{-1}), Plant height (cm) and Plant Periphery. Results revealed that *Cymbopogon citrratus* DC showed the best performance with biomass (3.01 t ha^{-1} and 2.92 t ha^{-1}). *Heteropogon contortus* L attained maximum plant height (150 cm) while *Digitaria sanguinalis* L attained higher plant periphery (197 cm). Miniyara grass (*Agarista ericaceae* Taub), Dhamun grass (*Cenchrus setigerus* Vahl),Cheetah grass (*Acinonyx jabatus* L) and Love grass (*Eragrostis superba* Per) was not established at early stage of experiment so rejected at early stage. The general productivity, freedom from pests, high feeding value, erosion control, not too fertile soil requirement and compatibility with Rainfed area promotes the cultivation of grasses in Rainfed area for multipurpose. *Cymbopogon citrratus* DC, *Pennisetum purpureum* S, *Eulaliopsis binata* R and *Digitaria sanguinalis* L. showed great adaptability during the study in the sense that they produced maximum biomass but survive even under adverse climatic conditions. Consequently, based on the results *Cymbopogon citrratus* DC recommended for this region to be established on bunds/ marginal lands to control soil and water erosion and to achieve supplementary benefits.

Keywords: Grasses, Biomass production, Spreading ability, Moisture stress, Rainfed conditions, Pakistan.

INTRODUCTION

The grasses mainly *Tripsacum laxum*, *Pennisetum purpureum* and *Setaria splendia* found on erosion control and are major source of feed for livestock (Akyeampong and Ben 1996). It has been reported that supplementation of napier grass feed with tree fodder can improve the feed intake and animals performance (Muinga *et al.*, 1992). Pothohar plateau consists mainly of Rawalpindi, Chakwal, Attock and Jhelum districts of Punjab, covering an area of more than one million hectares (Arshadullah *et al*., 2012). Grasses are more beneficial regarding soil conservation because they are easily adapted and acclimatized under hardy climate due to their deep root system (February & Higgins, 2010). During scarcity period various grass species help to the feeding animals. Grass are cut from the field and stored as hay to cope up shortage of winter scarcity of fodder. During summer season grasses are fed to live stock several times in arid areas (Khan *et al*., 2004). Animal's performance depends on the quality and availability of fodder during the year (Hatam *et al*., 2001). The biomass of the grasses is correlated to the vegetative growth period and efficiency of biomass producer. Rainfed area can brought under cultivation considering the grass species for fodder production. Marginal lands can be used for testing new species for green fodder production even under hot and hardy climatic conditions (Anwar *et al*., 2012). The major portion of land is either uncultivated or waste land in Pakistan that contributes to pollution. Moreover, 62 % of the waste land is not covered with grasses that have potential to protect soil and having extent of green fodder production for increasing livestock population (Anwar *et al*., 2012). It is fact that drought tolerance in plants varies from species to species in almost all plants (Lin *et al*., 2006). The metabolic activities in plants are adversely affected by drought stress that ultimately affects the growth and development (Ashraf, 2004). The high Radiation Use Efficiency values of grass species (e.g., *S anceps, C. gayana* and *S. almum*) showed more biomass production and frequently multi cuts fodder for animal's nutrition under poorly fertilized soil (Anwar *et al*., 2012). Livestock sector plays an important role in the economy of Pakistan. Crude protein and digestible nutrients can affect the milk and meat production (Arshadullah *et al*., 2012).

The microbial activity in the ruminants may be depressed due less availability in the rumen (Bose and Balakarishnan 2001). The major problems in the country for food security are poor livelihood, shortage of fodder and fodder resources, depletion of vegetation cover and overgrazing of rangelands (Afzal *et al*., 2007). Many efforts regarding habitat, adaptability and spreading ability to control soil erosion have been made of the grasses of Rainfed area. Not enough work has been done about the grasses of the arid area that show great adaptability and exclusive spreading ability under very diverse ecological conditions. Therefore, this study was conducted for screening of various grasses against moisture stress and evaluating adaptability of grasses and erosion control under Rainfed region.

MATERIALS AND METHODS

Present study was conducted during 2010-2012 at Soil and Water Conservation Research Station (SAWCRS), Fateh Jang, (Attock), and Pakistan. Thirteen grass species viz. Lemon Grass (*Cymbopogon citrratus* DC), Mot grass (*Pennisetum purpureum* S), Khavvi grass (*Cymbopogon jawarncusa* L), Khabbal grass (*Cynodon dactylon* L), American grass (*Ammophila breviligulata* F), Bhabbar grass (*Eulaliopsis binata* R), Barru grass (*Sorghum halepense* L), Sireyala grass (*Heteropogon contortus* L), Pehlwan grass (*Digitaria sanguinalis* L), Miniyara grass (*Agarista ericaceae* Taub),Cheetah grass (*Acinonyx jabatus* L), Love grass (*Eragrostis superba* Per) and Dhamun grass (*Cenchrus setigerus* Vahl) were selected for study (Table 1). Rootstock of these grasses was planted on 15 February. The rootstock was collected from Kheri Moorat Animal Husbandry Farm, PMAS, Arid Agriculture University, Rawalpindi located at Fateh Jang Tehsil, District Attock. According to experimental design (RCBD) grasses were planted at Row-Row distance of 2.5 m and Plant-Plant distance of 1 m. The plot size employed for each species was 45 m^2. Three lines of each species were planted per plot. The grasses were grown under rainfed conditions. The per square meter area of each grass from the base in the month of October at maturity stage each year was harvested and biomass of each grass was calculated from the formula given by (Arshadullah *et al*., 2006). Climatically, the area falls in semi-arid with an annual rainfall 500-700 mm and divided into terraces. The soil is slightly alkaline with pH range (7.5-8.5). The rainfall was measured at study site by tipping bucket rain gauge installed at Soil and Water Conservation Research Station, Fateh Jang (Fig. 1). Data on, Plant height (cm), Plant periphery (cm) and Biomass (t ha^{-1}) were collected in monsoon at 75% flowering stage. The green biomass was derived through the following formula:

Fresh biomass (t ha^{-1}) = [Fresh biomass/area (m^2)] × 10 (Arshadullah *et al*., 2006).

The palatability test was carried out by introducing sheep & goats in the field and chopped grasses were also fed to sheep and goats and observations were noted.

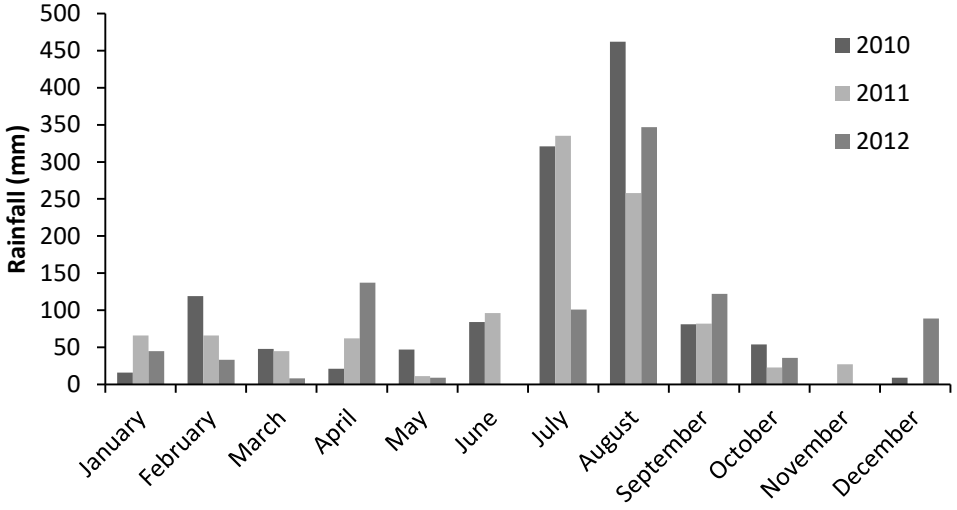

Fig.1. Rainfall Pattern in District Attock (Fateh Jang) during 2010-2012.

Table 1**.** Grasses species selected for study at Soil and Water Conservation Research Station, Fateh Jang, Distt. Attock.

Sr. No	Common Name	English Name	Botanical Name
1	Lemon grass	Fever grass	*Cymbopogon citrratus* DC
2	Mot grass	Napier grass	*Pennisetum purpureum* S
3	Khavvi grass	Camel grass	*Cymbopogon jawarncusa* L
4	Khabbal grass	Bermuda grass	*Cynodon dactylon* L
5	American grass	American beach grass	*Ammophila breviligulata* F
6	Bhabbar grass	Sabai grass	*Eulaliopsis binata* R
7	Barru grass	Johnson grass	*Sorghum halepense* L
8	Sireyala grass	Spear grass	*Heteropogon contortus* L
9	Pehlwan grass	Crab Grass	*Digitaria sanguinalis* L
10	Miniyara grass	Agarista	*Agarista ericaceae* Taub.
11	Cheetah grass	-	*Acinonyx jabatus* L
12	Love grass	Masai love grass	*Eragrostis superba* Per.
13	Dhamun grass	Bird wood grass	*Cenchrus setigerus* Vahl.

Source: Kheri Moorat Animal Husbandry Farm,Fateh Jang, PMAS, Arid Agriculture University, Rawalpindi.

RESULTS AND DISCUSSION

After about six months, grasses like Miniyara (*Agarista ericaceae* Taub), Dhamun (*Cenchrus setigerus* Vahl), Cheetah grass (*Acinonyx jabatus* L) and Love grass (*Eragrostis superba* Per) were discarded because of poor performance and less adaptability in the area of Fateh Jang. So, eliminated from the statistical analysis and was not presented. Parameters studied and discussed are as follows:

A) Plant height (cm) of grasses used for study:

Data regarding plant height (cm) of different grasses during the experiment duration presented in (Table 2) showed that maximum plant height (80 cm) was obtained by *Cymbopogon citrratus* DC in 2010 and it was statistically alike with *Pennisetum purpureum* S, *Cymbopogon jawarncusa* L, *Ammophila breviligulata* F, *Eulaliopsis binata* R, *Sorghum halepense* L and *Heteropogon contortus* L while Minimum plant height (31 cm) was obtained by *Digitaria sanguinalis* L and it was statistically alike with *Cynodon dactylon* L during the year 2010. Maximum Plant height (150 cm) during 2011 was obtained by *Heteropogon contortus* L and it was statistically alike with *Cymbopogon jawarncusa* L while minimum plant height (33 cm) was obtained by *Cynodon dactylon* L. Overall, *Cynodon dactylon* L attained minimum plant height during all the three years may be due to its spreading ability and downward growth pattern. During the year 2012 same plant height (90 cm) was obtained by *Eulaliopsis binata* R and *Digitaria sanguinalis* L while minimum plant height (44 cm) was obtained by *Cynodon dactylon* L and it was statistically alike with *Cymbopogon jawarncusa* L and *Sorghum halepense* L. A large variation in plant height was observed in every grass in different years that was may be due the variation in rainfall that affects the growth and development of grasses and ultimately the plant height of grasses. Overall, during the experiment *Cymbopogon jawarncusa* L attained more plant height as compared to all other grasses because of its vertical growth function.

B) Plant periphery (cm) of grasses used for study:

Data regarding plant periphery (cm) of different grasses during the experiment duration presented in (Table 3) showed that maximum plant periphery (56 cm) was obtained by *Cymbopogon citrratus* DC during the year 2010 while minimum plant periphery (10 cm) was attained by *Heteropogon contortus* L and it was statistically alike with *Pennisetum purpureum* S (15 cm) and *Cymbopogon jawarncusa* L (17 cm) while *Cynodon dactylon* L and *Digitaria sanguinalis* L was statistically at par with each other during the year 2010. Considering the plant periphery during the year 2011 maximum plant periphery (197 cm) was obtained by *Sorghum halepense* L and it was statistically alike with *Digitaria sanguinalis* L (195 cm) while minimum plant periphery was obtained by *Cymbopogon jawarncusa* L (38 cm) and it was statistically alike with other grass in the order *Cynodon dactylon* L (56 cm), *Pennisetum purpureum* S (55 cm) and *Ammophila breviligulata* F (40 cm). During the year 2012 maximum plant

periphery was obtained by *Digitaria sanguinalis* L (150 cm) as during 2011 and it was statistically alike with *Eulaliopsis binata* R (147 cm) while minimum plant periphery was obtained by *Cynodon dactylon* L. (21 cm) and it was statistically alike with other grasses in the order *Heteropogon contortus* L (33 cm) and *Ammophila breviligulata* F (32 cm). During the year 2012 *Cymbopogon citrratus* DCL (77 cm), *Pennisetum purpureum* S (72 cm) and *Cymbopogon jawarncusa* L (72 cm) were statistically alike with each other. Overall, maximum plant periphery was observed during the year 2011 by *Sorghum halepense L* and *Digitaria sanguinalis* L.

Table 2. Plant height (cm) of selected grasses species.

Grass Species	**2010**	**2011**	**2012**
Cymbopogon citrratus DC	80 a	100 d	63 c
Pennisetum purpureum S	75 a	120 c	70 bc
Cymbopogon jawarncusa L	70 a	148 a	45 d
Cynodon dactylon L	15 b	33 e	44 d
Ammophila breviligulata F	70 a	110 cd	84 ab
Eulaliopsis binata R	63 a	132 b	90 a
Sorghum halepense L	72 a	120 c	45 d
Heteropogon contortus L	55 a	150 a	66 c
Digitaria sanguinalis L	31 b	105 d	90 a
LSD (0.05,DNMRT)	**23.60**	**10.58**	**16.00**
SEs for Means	**7.87**	**3.53**	**5.33**

Table 3. Plant periphery (cm) of selected grasses species.

Grass Species	**2010**	**2011**	**2012**
Cymbopogon citrratus DC	56 a	165 b	77 c
Pennisetum purpureum S	15 e	55 d	72 c
Cymbopogon jawarncusa L	17 e	38 d	72 c
Cynodon dactylon L	40 bc	56 d	21 d
Ammophila breviligulata F	35 cd	40 d	32 d
Eulaliopsis binata R	28 d	115 c	147 a
Sorghum halepense L	30 d	197 a	125 b
Heteropogon contortus L	10 e	162 b	33 d
Digitaria sanguinalis L	45 b	195 a	150 a
LSD (0.05, DNMRT)	**7.03**	**17.24**	**12.79**
SEs for Means	**2.35**	**5.75**	**4.26**

C) Biomass Production (t ha^{-1}) of grasses used for study:

The results indicate that biomass production showed significant differences between the grasses and during the experiment duration. Grasses showed difference in biomass production due to difference in growth habit, spreading ability, adaptability and response against moisture stress. Data indicate that maximum biomass was produced by *Cymbopogon citrratus* DC (2.28 t ha^{-1}) and it was statistically at par with *Cynodon dactylon* L (2.05 t ha^{-1}), *Digitaria sanguinalis* L (2.01 t ha^{-1}) and *Pennisetum purpureum* S while lowest biomass was produced by *Ammophila breviligulata* F (1.02 t ha^{-1}) and it was statistically at par with *Sorghum halepense* L (1.50 t ha^{-1}),*Cymbopogon jawarncusa* L (1.37 t ha^{-1}) and *Heteropogon contortus* L during the year 2010 (table 4). Significant results also observed during the year 2011. Maximum biomass was produced by *Cymbopogon citrratus* DC (3.01 t ha^{-1}) and it was statistically alike with *Digitaria sanguinalis* L (3.00 t ha^{-1}) while minimum biomass was produced by *Ammophila breviligulata* F (1.70 t ha^{-1}) during the year 2011 (Table 4). Maximum biomass was produced by

Digitaria sanguinalis L (3.19 t ha^{-1}) and it was statistically at par with *Cymbopogon citrratus* DC (2.92 tha^{-1}), *Cymbopogon jawarncusa* L (2.84 t ha^{-1}) and *Eulaliopsis binata* R (2.35 t ha^{-1}) during the year 2012 (Table 4).

Table 4. Biomass Production (t ha^{-1}) of selected grasses species.

Grass Species	**2010**	**2011**	**2012**
Cymbopogon citrratus DC	2.28 a	3.01 a	2.92 ab
Pennisetum purpureum S	1.78 abc	1.95 de	2.15 bc
Cymbopogon jawarncusa L	1.37 cd	2.70 b	2.84 ab
Cynodon dactylon L	2.05 ab	2.00 d	2.11 bc
Ammophila breviligulata F	1.02 d	1.70 e	1.69 c
Eulaliopsis binata R	2.00 ab	2.44 c	2.35 abc
Sorghum halepense L	1.50 bcd	2.05 d	2.13 bc
Heteropogon contortus L	1.30 cd	1.90 de	1.78 c
Digitaria sanguinalis L	2.01 ab	3.00 a	3.19 a
LSD (0.05,DNMRT)	**0.54**	**0.25**	**0.79**
SEs for Means	**0.18**	**0.08**	**0.26**

D) Palatability test

Palatability depends on the taste, aroma and special characters i.e. short hairs present on the surface of leaves of grasses. The presence of short hairs and other parameters i.e. nutrient value reduces the palatability of grasses. *Pennisetum purpureum S* has short hairs on the surface leaves and culms. These short and coarse hairs cause irritation in the throat of grazing animals. Therefore, if *Pennisetum purpureum* S mixed with other grasses and chopped into small pieces it will increase the intake by animals. *Cymbopogon citrratus* DC have aroma in it so animals only intake in conditions when no other grass available in field. *Heteropogon contortus* L and *Sorghum halepense L* also cut into small pieces before intake by animals because of the presence of spines at the flowers. All other grasses studied were palatable as in the field. Also reported by other scientists that *Pennisetum purpureum S* restarts growth in February which is mostly free from hairs and this is the best time for its harvesting and stalls feeding to the animals (Arshadullah *et al*., 2012).

CONCLUSION

In the summary, *Cymbopogon citrratus* DC produces maximum biomass, performed better as compared to all other grasses and can withstand even under adverse climatic conditions. After *Cymbopogon citrratus* DC at the second place *Digitaria Sanguinalis* L and *Pennisetum purpureum* S performed better as compared to all other grass. Theses grasses recommended for Rainfed area of Fateh Jang, Distt. Attock, Pakistan for soil conservation and other purposes i.e. fodder.

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