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ASSESSMENT OF PROMISING EXOTIC FORAGE GRASSES AT FAISALABAD, PAKISTAN

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Present study assessed the suitability of six exotic grasses to local climate and evaluated their forage production and nutritional value grown at forage grass nursery, Punjab Forestry Research Institute, Faisalabad Pakistan during 2006-2007. Grass species included; Green Panic cv. Tanzania (*Panicum maximum)*, Elephant grass (*Pennisetum purpureum)*, Pangola grass (*Digitaria decumbent)s*, Finger grass *(Digitaria swazilandensis)*, Rhodes grass (*Chloris gayana)* and Vetiver grass *(Vetiveria zizanioides)* and were tested by applying randomized complete block design (RCBD). Vetiver grass *(Vetiveria zizanioides)* got the highest sprouting percentage (93%) during 1st observation, while Elephant grass (*Pennisetum purpureum*) was on top during the 2nd observation. Rhodes grass (*Chloris gayana)* produced maximum fresh biomass (9.88 t ha^{-1} and 21.53 t ha^{-1}) during spring 2006 and monsoon 2007, respectively. Dry matter yield was also higher in Rhodes grass (*Chloris gayana* i.e. 3.69 and 7.14 t ha^{-1}during the same seasons. Elephant grass (*Pennisetum purpureum)* had higher (78%) moisture contents than any other grass of this study. Crude protein percentage was higher in Elephant grass (*Pennisetum purpureum)* i.e. 6.73% followed by Rhodes grass (*Chloris gayana)* (6.67%) and Finger grass *(Digitaria swazilandensis)* (6.20%). Rhodes grass (*Chloris gayana)* attained the highest total digestible nutrients (57.82%). Based on results of the study, Rhodes grass (*Chloris gayana)* has been recommended for this region under irrigated conditions.
Keywords: Exotic grasses, Climatic suitability, Biomass production, Nutritional value, Crude protein, Total digestible nutrients.

INTRODUCTION

Livestock production in Pakistan today faces the most crucial challenge in its 60 years of experience. Prices of food of animal origin are rising, which is a phenomenon closely related and connected with energy crisis and inflation. Social and environmental problems of food production systems have thus multiplied. It isn't, therefore, surprising that food production in the country from livestock is among the nation's top research and development priorities. Currently rangelands are producing far less than their production potential. Hence, it has become imperative to recover the degraded grasslands in order to improve their grazing potential (Afzal *et al*., 2007). Under the present conditions, the pool of livestock feed is deficit by 21 percent in the country. Forage production of plant species depend on many variables such as species ecotype, age of the stand, temperature, radiation, water supply, soil fertility, leaf area, growing points (meristems) etc. (Qamar, 1999). Succulence of forages is the major determinants of digestibility of forages. Old leaves of plant tissues might contain water from 75 to 85% of fresh weight (Mengel and Kirkby, 1987). This depicts that the harvested material, in addition to green leaves, also contained previous year's old growth that reduced moisture contents level in the plant tissue (Afzal *et al*., 2007).

Rangelands in Pakistan are the main source of forage for livestock which suffer from heavy grazing and extremes of weather conditions. The fast growing human population has increased demand for animal protein that ultimately has put more pressure on grazing lands. It is evident that successful range management and improvement requires knowledge of forage calendar, nutritional value of range plant species (both qualitative and quantitative), forage palatability and preference of livestock in the region. It is estimated that existing feed resources are deficient by 29 and 33% for total digestible nutrients and crude protein (CP), respectively. Styler *et al.* (1979) reported that intake of dietary is associated with the forage digestibility, N contents and physical form of forage (fiber). Generally, forages with protein concentration above 6 - 8% have greater digestibility of required N for ruminal microbes. Hence, for providing balanced diet, the grasses should be mixed with forage legumes (Bose and Balakarishnan, 2001). Total digestible nutrients percentage is also another important determinant for feeding value. The forage digestibility is related to chemical composition, particularly of fiber, lignin and silica contents. Crude fiber mainly consists of cellulose, hemi cellulose and lignin. The lignin contents generally reduce the digestibility of forage (Afzal *et al*., 2007). The ether extract is composed of fats, oils, waxes, organic acids, pigments, sterols and vitamins A, D, E and K. Vitamins are considered of vital concern in animal breeding.

There is a need to introduce/establish new forage grasses to enhance forage production to meet animal feed requirements. Looking at the prevailing degraded condition of rangelands in the country, it is need of the time to increase their forage productivity. It is of paramount importance that high yielding and palatable grass species are established in their suitable eco-sites (Muhammad and Naqvi, 1987). Keeping this in view, some exotic grass species selected at National Agricultural Research Centre (NARC) Islamabad were established at Punjab Forestry Research Institute (PFRI) at Gatwala district Faisalabad to evaluate their forage quantity and quality under climatic conditions of that particular region. National Agricultural Research Centre is one of the research centers under Pakistan Agricultural Research Council at Islamabad, Pakistan, addressing research problems in agriculture and allied fields.

MATERIALS AND METHODS

The experiment was conducted in the forage grasses nursery of PFRI, Faisalabad during 2006-07. The soil at the nursery has sandy loam texture having the physico-chemical characteristics such as; pH=8.42, EC=0.91dSm^{-1}, organic matter=0.80 %, total N=0.04%, available P=7.43ppm, and available K=275.14ppm. During 2006, average maximum and minimum temperature was 27.53^{0}C and 12.15^{0}C, respectively having total annual rainfall of 89 mm, whereas during 2007, average maximum and minimum temperature was 25.32^{0}C and 10.54^{0}C, respectively with total annual rainfall of 122.80 mm. The grasses used in the study respectively were *Panicum maximum* Jacq. cv. Tanzania (Green Panic grass), *Pennisetum purpureum* Schum. cv. Merkeri (Elephant grass), *Digitaria decumbens* Stent. (Pangola grass), *D. swazilandensis* Stent. (Finger grass), *Chloris gayana* Kunth. (Rhodes grass) and *Vetiveria zizanioides* L. (Vetiver grass). A brief history of selected grasses under study is given in Table 1. The soil was prepared by three ploughings and one planking. No fertilizer was applied at any stage during the study. Grass tufts were planted in 3.0 x 6.0 m plots (91 slips per plot) on March 21, 2006. Row to Row and plant to plant distance was 50 cm with 05 cm depth. Water was applied through surface irrigation at planting time. Experiment was planned in single factorial randomized complete block using six varieties and three replications. Each experimental unit comprised 91 plants.

Data on sprouting of grasses were recorded on May 01, 2006 and June 02, 2006 and percentage was calculated with the help of following formula:

$$\text{Spouting (\%)} = \frac{\text{Spouted tufts slips}^{-1}}{\text{Total tufts slips}^{-1}} \times 100$$

Data on fresh and dry biomass were collected from the same plots in spring 2006 (last week of April) and Monsoon 2007 (first week of September). Three quadrates were harvested at panicle stage for fresh and dry matter determinations (Khan, 1996). The fresh biomass was calculated by using the formula:

Table 1. Basic characteristics of grass species under study

S. No.	Common name	Botanical name	Source	Brief Information
1	Green panic grass	*Panicum maximum*	Tanzania	Tufted perennial up to 3.5 m tall, very succulent and nutritious, suitable for mix seeding with legumes (Ullah *et al.*, 2006).
2	Elephant grass	*Pennisetum purpureum* cv. Merkeri	Tanzania	Tall, erect, thick stem up to 4.5 m tall, planted like sugarcane, culms having three nodes are cut into pieces and buried in the soil up to two nodes with 3rd above the ground (Ullah *et al.*, 2006).
3	Pangola grass	*Digitaria decumbens*	West Indies	Semi-erect stem up to 1.0 m tall, form open turf, stands tramping and grazing, nutritious but quality declines sharply with age (Ullah *et al.*, 2006).
4	Finger grass	*Digitaria swazilandensis*	Zimbabwe	Profusely branched stem up to 0.6 m tall, grow on poor soils, and tolerates drought, low yielding, less palatable, and good soil binder (Ullah *et al.*, 2006).
5	Rhodes grass	*Chloris gayana*	Kenya	Fine stemmed leafy prostate to erect turf forming up to 1.5 m tall, palatable for hay not for silage, drought and grazing resistant, salt tolerant (Ullah *et al*., 2006).
6	Vetiver grass	*Vetiveria zizanioides*	Kenya	Profusely branched, stem up to 0.6 m, panicle dense, suitable for mix seeding with legumes(Ullah *et al.*, 2006).

$$\text{Fresh biomass (t ha}^{-1}\text{)} = \frac{\text{Fresh biomass weight}}{\text{Area (m}^2\text{)}} \times 10$$

Plant samples were air dried until the weight of dry matter became constant. Percent moisture was calculated by the following formula:

$$\text{Water (\%)} = \frac{W_1\text{-}W_2}{W_1} \times 100$$

Where; W_1 = Fresh weight of forage (g m^{-2});
W_2=Air dry weight oven dried at 105^{O}C for 12 hours.

***Nutritive value analysis*:** All grass samples were manually harvested at panicle stage i.e. 38 days after plantation in spring season and 152 days after plantation in monsoon season. The dry matter yield (DMY) was calculated. The samples were chopped in an electric chopper, dried at 55^{o}C and ground to particles of 2.0 mm through a Wiley mill. These samples were analyzed for crude protein (CP, CF and EE) by the methods of AOAC (1994). The total digestible nutrients (TDN) of each grass sample were calculated by the equation of Wardeh (1981):

TDN (%) = -26.685 + 1.334 (CF) + 6.598 (EE) + 1.423 (NFE) + 0.967 (Pr) – 0.002 (CF)^2 – 0.67 (EE)^2 – 0.024 (CF) (NFE) – 0.055 (EE) (NFE) – 0.146 (EE) (Pr) + 0.039 (EE)^2 (Pr)

Nitrogn Free Extract was determined by difference after the analysis of all the other items in proximate analysis on dry matter percent basis by using the equation of Harris *et al.* (1970).

NFE (%) = 100 – (% crude protein + %crude fiber + % ether extract + % Ash)

The data were subjected to analysis of variance (ANOVA) and means were separated using least significant differences (Steel and Torre, 1997).

RESULTS AND DISCUSSION

Production of increased biomass of fodder is important in the developing countries in order to meet the requirements of enhancing number of livestock that is in turn necessarily desired for meeting the demands of ever increasing population. However, the quality of produced fodder is also of equal importance because balanced nutrition and protein and mineral requirements of people fed on animal products eating quality fodders meeting international standards is also of utmost importance. Therefore, higher production of fodder will only be appreciable if its quality simultaneously is acceptable as well because production of milk, meat and associated products of livestock depends upon hereditary factors by approximately 25 % while 75% is dependent on the feed quality and quantity.

The results of the study showed that *Vetiver* grass attained the highest sprouting percentage (93%) followed by Elephant grass (88%) during first observation (1st May, 2006) while on second observation (2nd June, 2006), Elephant grass got the top position with 90 percent sprouting (Table 2). On the average Elephant grass had maximum sprouting percentage (89%) followed by *Vetiver* grass (86.5%). Dry matter yield was also highest for Rhodes grass, 3.69 and 7.14 t ha^{-1} during the spring and monsoon seasons, respectively (Table 2). Grasses yielded more forage production in monsoon season as compared to spring season probably due to prolonged growth period and more rainfall (Ullah *et al.*, 2006). Elephant grass got the highest moisture contents among all grass species (78%).

The nutritive value of a forage feed is a measure of proximate composition, digestibility and nature of digested products and thereby its ability to maintain or promote growth, milk production, pregnancy or other physiological function in the animal body. The assessment of herbage quality involves an integrated evaluation of nutritive value and factors of consumption by the animal. The chemical analysis of any feed stuff is important due to having quantitative information regarding nutrients. Thus forage quality evaluation holds the key to economic livestock production. Therefore, crude protein, crude fiber, ash ether extract, nitrogen free extract, and total digestible nutrient parameters were determined in the present study. Protein is very important and the most demanded feed ingredient of ruminant rations. It is required substantially for milk or meat production as well as for reproduction. The ration deficient in crude protein depressed the microbial activity in the rumen due to lack of N. Thus, many health problems may emerge due to deficiency of CP. The nutritional composition of forage grasses showed that Elephant grass had the highest crude protein percentage (6.73%) as compared to other grasses (Table 3). However, the difference in crude protein values among Rhodes grass (6.67%), Finger grass (6.20%) and Green Panic grass (5.55%) was statistically non-significant. Green panic, Finger, Rhodes and Vetiver grasses were also statistically similar. This showed that Elephant, Finger and Rhodes grasses had more valuable forage due to high protein contents. Kutozova *et al*. (2001) described the crude protein demand in meadow fodder.

The highest crude fiber values were attained by Vetiver (43.09%) and green panic (41.34%) which was statistically at par (Table 3). The second highest value was attained by Elephant grass (36.95%) and Pangola grass (35.92%) followed by Finger grass (38.83%) and Rhodes grass (37.53) which are statistically similar. Higher value of crude fiber reduces the extent of digestion. Crude fiber value is directly correlated with growth period. As growth period increases, the crude fiber value also increases which ultimately reduces the nutritive value of the forage. Hence, the grasses should be harvested at 50 percent flowering stage. Forages are more digestible when harvested at early stage than at maturity or nearer to it due to more crude proteins, minerals and carbohydrates in composition (Bose and Balakarishnan, 2001).

Table 2. Sprouting, fresh and dry weight and moisture contents of grasses during 2006-07 (average of three replications).

Grasses	Sprouting (%) (2006)			Dry weight (t ha^{-1})		Moisture contents (%)	
	1st May	2nd June	Average	Spring 2006	Monsoon 2007	Spring 2006	Monsoon 2007
Green panic cv Tanzani	57cd	65b	61c	0.27f	0.49d	67c	65NS
Elephant grass	88a	90a	89a	0.05h	0.18ef	78a	66
Pangola grass	39de	51bc	55d	0.20f	2.58b	66c	66
Finger grass	62c	72b	67b	1.11c	2.81b	62d	65
Rhodes grass	52d	47c	49d	3.69a	7.14a	67c	66
Vetiver grass	93a	80a	86a	1.25c	2.93b	64cd	67
LSD	10.00	18.00	20.00	~~0.44~~	~~4.93~~	11.00	

Mean values followed by same letter (s) are statistically similar by LSD test

Table3. Nutritive value (%) of six grass species at 50% flowering on dry matter basis (averages of three replications and two cuttings).

Forage grasses	Dry matter	Crude protein	Crude fiber	Ash	Ether extract	Nitrogen free Extract	Total Digestible Nutrient
Green Panic cv. Tanzania	34.50c	5.55ab	41.34a	10.50a	3.50c	35.03c	50.41abc
Elephant grass cv. Merkeri	39.47b	6.73a	36.95b	7.35ab	9.80a	39.17b	45.95cd
Pangola grass	43.41a	3.32b	35.92b	6.78b	5.80b	48.18a	50.94ab
Finger grass	26.45d	6.20a	38.83ab	11.67a	4.25c	39.05b	50.41ab
Rhodes grass	27.49d	6.67a	37.53ab	6.01b	2.76de	47.03a	57.82a
Vetiver grass	25.57d	4.03b	43.09a	6.68b	4.84c	41.36b	50.22ab
LSD	3.50	3.65	6.00	4.30	3.76	6.80	3.84

Mean values followed by same letter (s) are statistically similar by LSD test

The organic carbon free substance which remains at 60^{o}C is called ash. It is the combination of essential and non-essential minerals along with plant silica. Acid soluble material is called minerals while acid insoluble is plant silica (Afzal et al.2007).The highest ash concentration (11.67%) was attained by finger grass which was statistically at par with Green Panic (10.50%) followed by Elephant grass (7.35%) (Table 3). Elephant grass contained the highest ether extract (9.80%) followed by Pingola (5.80%), Vetiver (4.84%) and Finger grass (4.25%). Pangola grass (48.18%) and Rhodes grass (47.03%) had the highest value of nitrogen free extract which were statistically similar (Table 3). Vetiver (41.36%) Elephant (39.17%) and Finger grass (39.05%) had the second highest value of nitrogen free extract and were statistically similar.

Rhodes grass attained the highest total digestible nutrients (57.82%) followed by Pangola grass (50.94%), Finger grass (50.41%), Green panic grass (50.41%), and Vetiver grass (50.22%) The results of the present study are in conformity with the findings of Afzal *et al.* (2007). Azim *et al*. (2000) observed that digestibility of NDF and hemicellulose declined non-linearly with increasing maturing stage.

***Conclusions and recommendations*:** Based on the results of this study, Rhodes grass could be recommended under surface irrigation system in Faisalabad region. The forage legumes are a rich source of proteins which is essential for milk and meat production quantitative as well as qualitative. Therefore mixing of forage legumes with grasses is also recommended.

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