J Agric. Res., 2016, Vol. 54(4):757-772
ISSN: Online: 2076-7897, Print:0368-1157
http://www.jar.com.pk

PERFORMANCE OF PALATABLE AND LOW PALATABLE GRASSES AT DIFFERENT STAGES OF THEIR PHENOLOGICAL DEVELOPMENT. II. FORAGE QUALITY

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ABSTRACT

A study was conducted during 2011 to find out forage yield and nutritive value of six palatable grasses, Blue panic grass (*Panicum antidotale*), Buffel grass (*Cenchrus ciliaris*), Elephant grass (*Pennisetum purpureum*), Tall tail grass (*Pennisetum orientale*), Rhodes grass (*Chloris gayana*) and Setaria grass (Setaria anceps) and three low palatable grasses (cotton grass, Tanglehead grass and Johnson grass) at different stages of their phenological development. Samples were analyzed for determining crude protein, acid detergent fibre (ADF), neutral detergent fibre (NDF), ash and ether extract percentages. The results revealed that yield and composition of grasses changed as these attained maturity. Generally, fresh yield increased significantly ($p < 0.05$) at full flowering stage and decreased significantly ($p < 0.05$) at maturity. Crude protein of grasses decreased significantly ($p < 0.05$) with increase in growth stages upto the final harvest stage but it did not differ significantly among the grasses. On the other hand both ADF and NDF increased significantly from pre-flowering to full flowering stage. The ash content showed mixed response for different grasses and stages.

KEYWORDS: Forage yield; phonological development; palatable grasses, Pakistan.

INTRODUCTION

Rangelands and pastures cover about 70 percent land of the world. These play a vital role in providing different goods and services needed for survival of human race (23). Rainfall in rangelands is either too low or too variable for dry crop production. Rangelands are very significant natural renewable resource of Pakistan. Rangeland are a huge part of the country which sustains livestock and wildlife populations. Pakistan has nearly two-third

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region under rangelands (38). The potential for forage production of these rangeland resources has been rigorously reduced by mismanagement and over-exploitation. Now, it is vital to re-establish their forage potential by establishing high range of most useful forage species in this vast natural resource of the country (10).

It was estimated (33) that around 60 percent (45.2 M ha) of total land of Pakistan is under rangelands. A large area of these rangelands gets less than 300 mm rainfall and is situated on rocky soil, deserts and has coarse landscape. As a result, productivity is extremely low and it is not possible to use them for permanent farming objectives. However, 93.5 M livestock heads have been partly supported by these rangelands.

Pakistan has a capital of 163.2 million heads of livestock which contribute 11.50 percent to GDP (19). Fodder crops and agro-industrial wastes mostly fulfill the nutritional requirements of these animals. However, rangelands also add considerably in providing forage to the livestock. Therefore, the sustainable use of rangelands is essential for providing forage to livestock for the progress of national economy. Currently, major problems for food safety in the country include overgrazing of rangelands, reduction of vegetation cover, deprived income of pastoral community scarcity of forage and fodder resources (1).

The main source of income in the arid areas of Pakistan is livestock. Currently, 60 percent of the feed for sheep and goats comes from rangelands (29). At the same time, horses, donkeys, and camels also get half of their feed from rangelands. The rest of their food comes from the feed resources obtained mostly from crops, fodder and agro-industrial byproducts.

Senescence starts in the herbaceous vegetation early in grazing season in many rangelands and its palatability and nutritive value decrease so fast that within a few weeks it is unable to sustain animal maintenance requirements (35). On the other hand, shrubby species during most of the grazing season consist of enough protein and phosphorus for maintenance (16) and even their introduction into *Agropyron desertorum* pasture enhances overall forage quality (36). Their occurrence also improves the production and quality of vegetation by modifying the micro-climate (20).

The decrease in nutritive value of grasses as growth reaches towards maturity is the key concern in livestock production on rangelands (27). It is essential to have awareness of nutritive value of range species and their impact on livestock production for improving productivity and forage utilization. Most of the research in the past was concentrated on quantifying the crude protein and energy content of the existing forage and just limited research was concentrated on quantifying the seasonal dynamics of minerals (24).

Heavy grazing over huge areas of rangelands has slow but unbearable pressures on land, vegetation and its residents such as wildlife, livestock and pastoral population. Increase in human and livestock populations is the major causative reason. This has resulted in an extension of dry land farming on marginal lands to gratify the rising demand for food crops, and the cutting of shrubs and trees for household fuel utilization (42). Resultantly, palatable species which earlier dominated the rangelands, have been ruined or weakened out, and it is now conquered by less palatable and less quality plants. Consequently every year, severe losses of livestock occur due to insufficient forage in the dry period, coupled with drought years (3, 22).

In the diet of ruminants, a high proportion of protein is necessary because meat, milk production and reproduction mostly depend upon protein components of diet of the animals. In animal diet, due of unavailability of nitrogen in the rumen, crude protein less than 6-7 percent might decrease microbial activity. One more reason for feeding value assessment is digestibility, which is primarily related with the total digestible nutrients (TDN) present. Grasses vary at different locations with respect to crude protein and TDN, mostly because of difference in availability of nutrients at these locations (1) but the influence of various seasons of growth and environmental conditions on the production and dietary composition of grass species is not identified.

Rangelands of the country have enough cover of many local grasses. However, all grasses are not equally palatable. Reasons vary from deposition of lignin, tannin, alkaloids, higher silica content , have thorns or even some may have toxins at different stages of their life cycle to the extent which may be lethal to the grazing livestock. Some species are palatable at certain stages while less palatable or unpalatable at other stages. Unpalatable species are usually low in nutritive value especially crude protein content. These less palatable species are abundant which include *Desmostachya bipinnata*, *Sorghum halepense*, *Sachharum munja*, *Chrysopogon aucheri*, *Cymbopogon jawarancusa* and *Heteropogon contortus*. Therefore every year, insufficient feed during the dry time, collective with drought years, causes severe losses of livestock (22; 3).

The present study was focused on evaluation of nutritive value of these palatable and unpalatable grass species at different stages of their phonological development. Range efficiency has decreased and the major portion of these areas is infested with unpalatable plants because large herds of livestock graze freely in the rangelands. Enhanced ecotypes of forage grasses have improved the range productivity for local and naturalized grasslands in many countries (44). It is of vital significance that high yielding and palatable grass species should be established in their appropriate ecosystem (34).

MATERIALS AND METHODS

This study was conducted in the field area of Forage and Forage Block. It is located at 33.43°N 73.04°E at the edge of the Pothwar at the foot of Margalla Hills in Islamabad Capital Territory. Its elevation is 507 meters (1,663 ft). Islamabad features an atypical version of a humid subtropical climate, with hot, humid summers accompanied by a monsoon season followed by cool winters. The soils of the area are alluvial, local outwash or loessic in origin. These are moderately calcareous and their lime content is uniformly distributed throughout the soil profile. The soils of the area are non-saline and non-sodic, have a slightly alkaline pH and are low in organic matter. Six pata grasses i.e, Blue panic grass (*Panicum antidotale*), Buffel grass (*Cenchrus cilliaris*), Elephant grass, (*Pennisetum purpureum*), Tall tail grass (*Pennisetum orientale*), Rhodes grass (*Chloris gayana*), Setaria grass (*Seteria anceps*) and three low polarable Cotton grass (*Imperata cylindrica*), Tanglehead grass (*Heteropogon contortus*) and Johnson grass (*Sorghum halepense*) were selected from the pasture area at Rangeland Research Institute.

The experiment was conducted in three replicates in Randomized Complete Block Design (RCBD). Three samples of each species were collected at three different stages of their phenological development i.e. vegetative, flowering and maturity. These samples were weighed with the help of 1m^2 ADC quadrats (26), oven dried at 80°C for 48 hours to obtain dried samples with minimum chemical changes and were weighed again. Then these samples were grinded and analyzed for dry matter (DM), crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), total ash (TA) and ether extract (EE) in Animal Nutrition Lab, NARC, Islamabad (2, 46).

RESULTS AND DISCUSSION

Quality of grasses at different growth stages

Crude protein of grasses decreased significantly with increase in the growth stage upto the final harvest stage (Table 1). In Buffel, Elephant and cotton grasses, the crude protein decreased significantly at full flowering stage and remained same at maturity stage while in Johnson grass, it remained same at full flowering stage and decreased significantly at maturity stage. In all other grasses, crude protein decreased significantly at all growth stages. At pre-flowering stage, the highest crude protein content was (16.94%) found in Buffel grass, 7.79 percent at full flowering stage and 6.45 percent at maturity stage. On the other hand, lowest crude protein content 8.50 percent was found in Tanglehead grass at pre-flowering stage, 6.40 percent at full flowering stage and 3.82 percent at maturity stage.

Table1. Crude protein composition of grasses (% DM) at three stages of their Phenological development.

Name of Grass	Pre flowering stage	Full flowering stage	Maturity stage	LSD
Blue panic grass	14.15[a]	7.79[b]	6.45[c]	0.34
Buffel grass	16.94[a]	8.57[b]	8.53[b]	0.08
Elephant grass	14.94[a]	7.01[b]	6.12[b]	1.13
Tall tail grass	11.55[a]	8.31[b]	6.02[c]	0.15
Rhodes grass	14.65[a]	7.84[b]	3.86[c]	0.54
Setaria grass	14.13[a]	10.57[b]	6.09[c]	0.47
Cotton grass	11.20[a]	8.20[b]	7.63[b]	1.35
Tanglehead grass	8.50[a]	6.40[b]	3.82[c]	0.54
Johnson grass	11.75[a]	11.55[a]	6.30[b]	0.33

Note. Values followed by the same letter(s) are statistically similar at P=0.05 level of significance.

Crude protein contents decline as grasses reach towards maturity. Crude protein of grasses was more at pre flowering stage. As crude protein grew to full flowering stage, it decreased and became minimum at maturity. Earlier findings (15, 46) support these results and report that grasses at three weeks of maturity usually had good crude protein contents of above 13 percent, with some as high as 19 percent. It has also been reported (31) that crude protein percentage of tropical grasses which could be increased through nitrogenous fertilizer application declines rapidly when these grasses are allowed to mature and grow to the limits of nitrogen supply. In present study, crude protein percent declined rapidly from 15-20 percent at two weeks to 10 percent at four weeks and fairly rapidly from four to thirteen weeks. Chin *et al.* (15) reported 25 percent crude protein at two weeks and 6.3 percent at seven weeks maturity. These results also supported earlier findings (18) where crude protein contents in different grass species declined with time.

Higher crude protein was possibly due to climatic conditions mainly optimum temperature which might had positive effect on total development of plant tissues and protein formation in plants. With increasing clipping interval, decreasing crude protein contents of both grasses may be due to reduced leaf to stem ratio (12) or by a dilution effect due to increased dry matter yield with less common grass clipping (17). Present results are also in conformity with those of previous studies (21, 30) who certified decline in crude protein concentration to higher cell wall contents in relatively mature grasses. Crowder and Chheda (17) reported that more regular clipping stimulated plant development and sustained biological processes, thus there was a greater demand for nitrogen. They explained that as plants reached maturity, these activities declined, resulting in low crude protein concentration in grass species.

The acid detergent fiber (ADF) significantly increased in Elephant, Rhodes, cotton and Tanglehead grasses at full flowering as well as maturity stage while in Blue panic, Buffel, Tall tail and Setaria grasses, it increased significantly at full flowering stage and remained same at maturity stage (Table 2).

Table 2. Acid detergent fiber content composition of grasses (% DM) at three stages of their phenological development.

Name of Grass	Pre flowering stage	Full flowering stage	Maturity stage	LSD
Blue panic grass	33.42[b]	38.33[a]	38.46[a]	0.53
Buffel grass	31.21[b]	35.65[a]	35.61[a]	0.62
Elephant grass	32.29[c]	43.48[b]	47.39[a]	0.72
Tall tail grass	33.40[b]	38.39[a]	38.39[a]	0.50
Rhodes grass	36.40[c]	39.45[b]	40.39[a]	0.52
Setaria grass	37.32[b]	43.32[a]	43.48[a]	0.46
Cotton grass	36.61[c]	37.60[b]	38.49[a]	0.55
Tanglehead grass	31.29[c]	33.37[b]	47.61[a]	0.29
Johnson grass	34.50[b]	34.54[b]	40.48[a]	0.56

Note. Values followed by the same letter(s) are statistically similar at P = 0.05 level of significance.

In Johnson grasses, ADF remained same at full flowering stage while increased significantly at maturity stage. ADF at pre-flowering stage was the lowest in Buffel grass (31.21%) and highest in Setaria grass (37.32%). At full flowering stage the lowest ADF was observed in case of Tanglehead grass (33.37%) and highest in Elephant grass (43.48%) while at maturity stage, the minimum ADF was recorded in Buffel grass (35.61%) and highest in Tanglehead grass (47.61%) (Table 2). The neutral detergent fiber (NDF) content increased significantly both at full flowering and maturity stage in all grasses except Tall tail grass in which NDF increased significantly at full flowering stage and remained same at maturity stage (Table 3). Forage is important in providing fiber to ruminants. Insufficient levels of dietary fiber cause low milk fat, rumen acidosis and dietary inefficiency (39). Grasses showed lowest ADF at pre flowering stage while it was maximum at full flowering stage. At maturity stage, ADF again became low. Generally grasses had the lowest acid detergent fiber at pre-flowering stage except Setaria and cotton grasses which showed maximum ADF at this stage. At full flowering stage all grasses showed maximum ADF except Tanglehead and Jhonson grass which showed minimum ADF. At maturity stage, grasses generally showed normal acid detergent fiber except Tanglehead and Jhonson grass which showed maximum ADF.

Table 3. Neutral detergent fiber content composition of grasses (% DM) at three stages of their phenological development.

Name of Grass	Pre flowering stage	Full flowering stage	Maturity stage	LSD
Blue panic grass	55.68[c]	62.35[b]	65.40[a]	0.40
Buffel grass	58.51[c]	61.54[b]	64.50 [a]	0.60
Elephant grass	62.21[c]	65.29[b]	73.51[a]	0.45
Tall tail grass	65.20[b]	66.31[a]	66.27[a]	0.39
Rhodes grass	58.24[c]	64.44[b]	69.68[a]	0.58
Setaria grass	55.36[c]	63.58[b]	64.23[a]	0.41
Cotton grass	51.38[c]	64.36[b]	70.48[a]	0.32
Tanglehead grass	63.48[c]	64.38[b]	70.49[a]	0.64
Johnson grass	57.43[c]	60.37[b]	66.44[a]	0.34

Note: Values followed by the same letter(s) are statistically similar at P=0.05 level of significance.

Generally neutral detergent fiber increased in grasses from early bloom to maturity stage except in cotton grass and Tanglehead grass, which showed maximum NDF at pre-flowering stage. The increasing trend of different cell wall components may also be attributed to the environmental temperature which is primarily associated with increased lignifications (45).

An increase in fiber and lignin contents over time had been previously reported in grasses (18). According to Cherney *et al.* (14) tropical grasses normally showed an increase in structural constituents (neutral detergent fiber, acid detergent fiber, hemi-cellulose and lignin) with increasing maturity. Bourquin *et al.* (6) reported 72.4 percent NDF and 43.8 percent ADF in orchard grass on dry matter basis. Sanderson *et al.* (40) reported a difference of 3l.4 to 66.8 percent in NDF contents of alfalfa in two different years. The neutral detergent fibre concentration ranged from 21 to 68 percent in the stem of alfalfa grass. According to another repot (13) neutral detergent fiber and acid detergent fiber tended to be lower in inflorescence than in other morphological components. The ADF was also reported higher in stem than in blade and sheath of leaves. The findings of percent study were consistent with those of Cherney *et al.* (14) who reported an increase in all fiber constituents with increasing maturity. They reported that lignin was proportionally higher in stems than other parts of the plant. It was also been reported that soil fertility could also influence grass lignin concentration (9).

The total ash decreased significantly in Setaria and Johnson grasses from early to maturity stage while in Buffel and cotton grasses, it increased significantly at full flowering stage and remained same in maturity stage (Table 4). In Elephant and Rhodes grasses, the means did not statistically different from each other (P≥0.05). In Buffel, Tall tail, Rhodes and Johnson grasses, the means are not statistically different from each other (P≥0.05).

Table 4. Total ash composition of grasses (% DM) at three stages of their phenological development.

Name of Grass	Pre flowering stage	Full flowering stage	Maturity stage	LSD
Blue panic grass	12.90[a]	12.50[a]	4.70[b]	1.19
Buffel grass	10.27[b]	13.41[a]	13.50[a]	1.28
Elephant grass	10.86[a]	27.52[a]	12.26[a]	41.97
Tall tail grass	11.09[a]	8.91[c]	10.36[b]	0.38
Rhodes grass	10.26[a]	9.98[a]	11.15[a]	1.21
Setaria grass	16.34[a]	9.22[b]	7.66[c]	0.64
Cotton grass	6.92[b]	10.79[a]	11.22[a]	0.61
Tanglehead grass	6.45[b]	7.07[a]	4.21[c]	0.18
Johnson grass	10.14[a]	8.94[b]	6.24[c]	0.73

Note. Values followed by same letter(s) are statistically similar at P = 0.05 level of significance.

Ether extract in Blue panic and Setaria grasses decreased significantly at full flowering stage while in Tanglehead grass, it increased significantly at full flowering stage and decreased significantly at maturity stage. In cotton grass, ether extract increased significantly at each growth stage while in Elephant grass, it remained same at all growth stages (Table 5). Higher ash content at pre-flowering stage was recorded in Setaria grass (16.34%) and lowest in Tanglehead grass (6.45%). At full flowering stage more ash content (27.52%) was observed in Elephant grass and lowest in Tanglehead grass (7.07%). Semilarly at maturity stage highest ash content (13.50%) was found in Buffel grass and lowest in Tanglehead grass (4.21%).

The observed decrease in the ether extract and ash content with increasing maturity was in agreement with the findings of (37) worked on eight grasses and of (7) worked on the orchard grass. Acknowledgements: The authors are thankful to Chairman, Pakistan Agricultural Research Council and Executive Director, Agricultural Linkages Project for providing funds to execute this research project.

Table 5. Ether extracts composition of grasses (% DM) at three stages of their phenological development.

Name of Grass	Pre flowering stage	Full flowering stage	Maturity stage	LSD
Blue panic grass	2.44[a]	1.69[b]	1.99[ab]	0.52
Buffel grass	2.46[a]	2.35[a]	2.48[a]	0.41
Elephant grass	2.31[b]	2.39[ab]	2.39[ab]	0.35
Tall tail grass	1.64[a]	2.05[a]	2.01[a]	1.04
Rhodes grass	2.87[a]	2.47[a]	2.50[a]	0.59
Setaria grass	3.16[a]	2.33[b]	2.69[ab]	0.65
Cotton grass	1.43[c]	1.93[b]	4.54[a]	0.22
Tanglehead grass	1.49[b]	2.07[a]	1.13[c]	0.21
Johnson grass	3.11[a]	2.71[a]	2.66[a]	0.49

Note. Values followed by the same letter(s) are statistically similar at P = 0.05 level of significance.

Proximate analysis of grasses as affected by growth stages

Pre flowering stage: The proximate composition of different grasses at pre-flowering stage revealed that crude protein of grasses ranged between 8.50 percent (Tanglehead grass*)* to 16.94 percent (Buffel grass*)* (Table 6).

Table 6. Proximate composition of grasses (% DM) at Pre flowering stage of growth.

Name of Grass	Crude protein	Ether extract	Total Ash	Acid detergent fiber	Neutral detergent fiber
Blue panic grass	14.15[c]	2.44[c]	12.90[b]	33.42[f]	55.68[f]
Buffel grass	16.94[a]	2.46[bc]	10.27[d]	31.21[h]	58.54[d]
Elephant grass	14.94[b]	2.74[abc]	10.86[c]	32.29[g]	62.21[c]
Tall tail grass	11.55[de]	1.64[d]	11.09[c]	33.40[f]	65.20[a]
Rhodes grass	14.65[b]	2.87[ab]	10.26[d]	36.40[d]	58.24[d]
Setaria grass	14.13[c]	3.16[a]	16.34[a]	37.32[c]	55.36[f]
Cotton grass	11.26[e]	1.43[d]	6.92[a]	38.49[b]	51.48[g]
Tanglehead grass	8.50[f]	1.49[d]	6.45[f]	31.29[h]	63.49[b]
Johnson grass	11.75[d]	3.11[a]	10.14[d]	34.50[e]	57.43[e]
LSD	0.38	0.42	0.44	0.46	0.48

Note: Proximate values followed by the same letter(s) are statistically similar at P = 0.05 level of significance.

Maximum EE content was observed in Setaria (3.16%) and lowest in cotton grass (1.43%). Ash content was minimum in Tanglehead grass (6.45%) and maximum concentration in Blue panic grass (12.90%). ADF content was minimum in Buffel grass (31.21%) and maximum concentration was observed in Cotton grass (39.49). All grasses differed significantly ($P<0.05$) from one another in ADF content except Blue panic (33.42%) and Tall tail grass (33.40%), Buffel grass (31.21%) and Tanglehead grass (31.29%). The highest NDF content was observed in Talltail grass (65.20%) and lowest in Cotton grass (51.48%).

Full flowering stage of growth: Proximate composition of different grasses during second stage of growth revealed that crude protein ranged from 6.40% (Tanglehead grass*)* to 11.55 percent (Johnson grass*)* (Table7). The highest EE content was observed in Johnson grass (2.71%) and lowest in Blue panic grass (1.69%). No significant difference (P<0.05) was observed among grasses except Johnson and Blue panic grasses. Means total ash also did not statistically differ from each other (P ≥0.05). ADF content was minimum (P<0.05) in Tanglehead grass (33.37%) and maximum concentration (P<0.05) in Elephant grass (43.48%). Similarly the highest NDF content was observed in Talltail grass (66.31) and lowest in Johnson grass (60.37%).

Table 7. Proximate composition of grasses (% DM) at Full flowering stage of growth.

Name of Grass	Crude protein	Ether extract	Total Ash	Acid detergent fiber	Neutral detergent fiber
Blue panic grass	7.79^{d}	1.69^{c}	12.50^{a}	38.33^{c}	62.35^{e}
Buffel grass	8.57^{c}	2.35^{ab}	13.41^{a}	35.65^{e}	61.50^{f}
Elephant grass	7.01^{c}	2.31^{ab}	27.52^{a}	43.48^{a}	65.51^{b}
Tall tail grass	8.31^{cd}	2.05^{bc}	8.91^{a}	38.39^{c}	66.31^{a}
Rhodes grass	7.4^{d}	2.47^{ab}	9.98^{a}	39.45^{b}	64.44^{c}
Setaria grass	10.57^{b}	2.33^{ab}	9.22^{a}	43.32^{a}	63.58^{d}
Cotton grass	8.20^{cd}	1.93^{bc}	10.79^{a}	37.60^{d}	64.38^{c}
Tanglehead grass	6.40^{f}	2.07^{bc}	7.07^{a}	33.37^{g}	64.38^{c}
Johnson grass	11.55^{a}	2.71^{a}	8.94^{a}	34.54^{f}	60.37^{g}
LSD	0.60	0.55	20.81	0.46	0.38

Note: Proximate values followed by the same letter(s) are statistically similar at P = 0.05 level of significance.

Maturity stage: The data (Table 8) revealed that the crude protein of grasses ranged from 3.82 percent (Tanglehead grass) to 8.53 percent (Buffel grass). EE content was maximum in Cotton grass (4.54%) and minimum in Tanglehead grass (1.13%) which differed significantly. The ash content was minimum in Tanglehead grass (4.21%) and Blue panic grass ((4.70%) and maximum in Buffel grass (13.50%). ADF content also differed significantly and it was minimum (P<0.05) in Buffel grass (35.61%) and maximum in Tanglehead (47.61%) and Elephant grasses (47.39%). The highest NDF content was observed in Elephant grass (73.29%) and lowest in Setaria grass (64.23%).

Table 8. Proximate composition of grasses (% DM) at Maturity stage of growth.

Name of Grass	Crude protein	Ether extract	Total Ash	Acid detergent fiber	Neutral detergent fiber
Blue panic grass	6.45[c]	1.99[c]	4.70[g]	38.46[d]	65.40[e]
Buffel grass	8.53[a]	2.48[b]	13.50[a]	35.61[e]	64.51[f]
Elephant grass	6.12[c]	2.39[bc]	12.26[b]	47.39[a]	73.29[a]
Tall tail grass	6.02[c]	2.01[c]	10.36[d]	38.39[d]	66.27[d]
Rhodes grass	3.86[d]	2.50[b]	11.15[cd]	40.39[c]	69.68[c]
Setaria grass	6.09[c]	2.69[b]	7.66[e]	43.48[b]	64.23[f]
Cotton grass	7.63[b]	4.54[a]	11.22[c]	38.61[d]	70.48[b]
Tanglehead grass	3.82[d]	1.13[d]	4.21[g]	47.61[a]	70.49[b]
Johnson grass	6.30[c]	2.66[b]	6.24[f]	40.48[c]	66.44[d]
LSD	0.71	0.43	0.84	0.46	0.33

Note: Proximate values followed by the same letter(s) are statistically similar at P = 0.05 level of significance.

These communities of Pothwar area face hardships in getting suitable feed for their livestock throughout the year. Although sufficient grazing material is available during summer monsoon season, however, dry months of summer and winter season face severe feed shortage.

Nutrient status of grasses: The results indicated that grasses exhibited significant differences 2.72 to 11.70 tons per hectare fresh matter yield in pre-flowering stage in fresh matter (FM) and dry matter (DM) yield. FM yield ranged from 6.00 to 12.00 tons in full flowering and 4.92 to 11.70 tons per hectare maturity stage DM yield ranged from 0.76 to 2.80 t/ha in pre flowering stage, 2.73to 5.90 tons in full flowering and 3.90 to 5.13 tons per hectare in maturity stage. This could be attributed to their genetic inheritance potential. Climatic and soil conditions also play a major role in determining yield and yield parameters. Significant differences were also obtained among grasses in DM yield. Maximum DM was attained by Johnson (2.80 t/ha) and Elephant grass (2.79 t/ha) pre flowering stage, respectively. Elephant grass also pave more DM (5.90 t/ha) followed by yielding grasses during full flowering stage were elephant and Blue panic grass (4.85 t/ha). Both Johnson grass and Elephant grass as are C_4 species.

The important difference between C_3 and C_4 modes of photosynthesis is that CO_2 partial pressure (pCO_2) at site of Rubisco is 5 to 10 times higher in C_4 than in C_3 photosynthesis. This efficiently prevents photorespiration by suppressing O_2 competition and also saturates Rubisco carboxylase activity.

Since photorespiration is a temperature- and CO_2-dependent process (8), photosynthesis is higher in C_4 than C_3 plants at high temperature and low pCO_2.

This high biomass corresponds to high leaf and stem fractions of the species. It is a recognized fact that leafy plant species allows higher interception of solar radiation (2). Therefore, high crop growth rate of species allows it to accumulate more dry matter with rather efficient consumption of resources i.e., water and light (28). The higher leaf area development of the species having all other factors e.g. soil type, nutrients and uniform growth conditions, is beneficial to yield higher biomass under climatic conditions. Genetic variation plays a key role in plant biomass production giving edge to some varieties due to their better tolerance to various stress factors (25; 41).

Forage quality parameters: Higher production of forage is considerable only if its quality is also acceptable. Livestock depends upon the feed quality and quantity for milk production, meat production and other related products by about 75% while only 25% is dependent on hereditary factors. The nutritive value of forage quality depends upon crude protein percentage and total digestible nutrients. In the feed of ruminants, crude protein is very helpful to maintain their milk, meat and other products (1). In the animal feed, due to unavailability of nitrogen in the rumen, crude protein less than 6-7% can decrease microbial activity (5). The quality of forage shows the nutrient composition level, palatability and intake, digestibility, anti nutritional factors and animal production performance. Forages comprise the main diet constituent in diets of beef cattle and forages of different feature support varying levels of production.

The majority of plant species have greater concentration of fiber in stem as compared to leaf blades. Legumes generally have less fiber than grasses. The most significant factor influencing dry matter digestibility is increase of fiber concentration with advancing plant maturity. When alfalfa (Medicago sativa L.) and red clover (Trifolium pratense L.) are at the mid-flowering stage of development, neutral detergent fiber in these species is about 25% of legume leaf-blade mass (11). This relates with 40–55% neutral detergent fiber in stems of these species. Tall fescue (Festuca arundinacea Schreb.), smooth bromegrass (Bromus inermis Leyss.), orchard grass (Dactylis glomerata L.) and other cool seasoned grasses and grasses with the C_3 photosynthetic pathway have about 70% neutral detergent fiber in stems and 50% neutral detergent fiber in leaf blades at similar maturity. Warm-season grasses with the C_4 photosynthetic pathway, such as switchgrass (Panicum virgatum L.), bermudagrass Cynodon dactylon L.) and big bluestem (Andropogon gerardii Vitman var. gerardii) have ∼70% neutral detergent fiber in leaf blades and 85% neutral detergent fiber in stems (11). Leaf sheaths are generally in the middle of leaf blades and stems in fiber concentration. As leaves contain less structural and conducting tissues than stems therefore higher fiber concentrations in stems occur in part, while mesophyll cells occupied a bigger part of leaves.

REFERENCES

1. Afzal, J. and M.A. Ullah. 2007. Assessment of productive potential and utilization of rangelands and sown pastures in Pothowar Plateau. Annual Report 2006-07. National Agricultural Research Centre, Islamabad. 10pp.
2. Akmal, M. and M.J.J. Janssens. 2004. Productivity and light use efficiency of perennial ryegrass under contrasting water and N supplies. Field Crops Research. 88: 143-153.
3. Alvi, A.S. and M. Sharif. (1995). Arid zone agriculture and research in Pakistan. Progressive Farm. 15: 5-12.
4. Anon. 1980. Official Method of Analysis. 12th Edit. Association of Official Analytical Chemists (AOAC). Washington, DC. USA.
5. Bose, M.S.C. and V. Balakarishnan. 2001. Forage Production Technologies. South Asian Publication Pvt. Ltd., New Delhi, India.
6. Bourquin, L.D., E.C. Tibgemeyer, J.V. Milgen and J.C. Fahey. 1994. Forage level and particle size effects on orchard grass digestion by steers: II Ruminal digestion kinetics of cell wall components. J.of Anim Sci. 72:759-67.
7. Bratzler, J.W., E. Keck, Jr.L.F. Marriott and J.B. Washko. 1959. Nutritive value of orchard grass as affected by level of nitrogen fertilization and stage of maturity. J. of Dairy Sei. 42:934.
8. Brooks, A. and G.D. Farquhar. (1985) Effect of temperature on the CO2/O2 specificity of ribulose-1,5-biphosphatase carboxylase/oxygenase and the rate of respiration in the light. Planta 165:397-406.
9. Brown, P.H., R.D. Graham and D.G.D. Nicholas. 1984. The effect of manganese and nitrate supply on the level of phenolics and lignin in young wheat plant. Plant Soil. 81:437-440.
10. Butt, N.M. and M. Ahmad. 1994. Production and management of Buffel grass pasture, progressive farming. 14: 30.
11. Buxton D.R., D. R., Mertens, and K. J. Moore 1995 Forage quality for ruminants: plant and animal considerations. Prof. Anim. Sci. 11:121-31.

12. Chaparro, C.J. and L.E. Sollenberger. 1997. Nutritive value of clipped 'Mott' Elephant grass herbage. J. of Agron. 89:789-794.
13. Cherney, D.J.R., J.A., Patterson and K.D., Johnson, 1990. Digestibility and feeding value of pearl millet as influenced by brown-midrib, low lignin trait. J. Anim. Sci. 68(12): 4345-4351.
14. Cherney, D.J.R., J.H. Cherney and R.F. Lucey. 1993. In vitro digestion kinetics and quality of perennial grasses as influenced by forage maturity. J. of Dairy Sci. 76:790-797.
15. Chin, F.Y., V. Raghavan and M. Noor Hashim. (1974). The yield, moisture and chemical composition of some grasses grown in Malaysia. Kajian Veterinar. 6:81-88.
16. Cook, C.W. 1972. Comparative nutritive values of forbes, grasses and shrubs. In: *Wildland Shrubs -their Biology and Utilization,* McKell, C.M., Blaudsell, J.P. and Goodin, J.R. (eds). USDA, For.Serv. Gen. Tech. Rep. INT-1.
17. Crowder, L.V. and H.R. Chheda. 1982. Tropical Grasslanad Husbandry. 1st Ed. Longman, London, New York.
18. Distel, R.A., N.G. Didoné and A.S. Moretto. 2005. Variations in chemical composition associated with tissue aging in palatable and unpalatable grasses native to central Argentina. J. Arid Envir. 62:351-357.
19. Economic Survey of Pakistan, 2011. Pakistan Economic Survey 2010-2011. Government of Pakistan, Finance Division, Economic Adviser's Wing, Islamabad, Pakistan.
20. Forti, M. 1971. Introduction of forage shrubs and their evaluation for use in semi arid areas of North-western Negev Division of Life Sciences. Negev Institute for arid zone Research, Beer Shiva, Israel. p. 12.
21. Fraser, M.D., R. Fychan and R. Jones. 2001. The effect of harvest date and inoculation on the yield, fermentation characteristics and feeding value of forage pea and field bean silages, Grass and Forage Science. 56:218.
22. Grainger, A. 1990. The Threatening Desert. Earthscan Pub. Ltd. London.
23. Holechek, J.L., R.D. Pieper and C.H. Herbel 2001. Range Management Principles and Practices. Prentice-Hall, Upper Saddle River, NJ. Pp. 274.
24. Islam, M. and M.A. Adams. 2000. Nutrient characteristics of foliage and the availability of water in a rangeland near Quetta, Balochistan, Pakistan. Pak. J. Biol. Sci. 3:2058-2062.

25. Jia, Y., X.E. Yang, Y. Feng and G. Jilani. 2008. Differential response of root morphology to potassium deficient stress among rice genotypes varying in potassium deficiency. J. Zhejiang Univ. Sci. 9(5):427-434.
26. Khan, C.M.A. 1966. New adjustable, decimal, collapsible quadrat versus three old quadrates-an evaluation. J. Range Manag. 27:71-75.
27. Kothumann, M.M. 1980. Nutrition of livestock grazing on range and pasture lands. pp. 56-90. *In:* Digestive Physiology and Nutrition of Ruminants. Vol. 3. D.C. Church. O and B Book Corvallis, Ore.
28. Long, S.P., E.A. Ainsworth, A. Rogers, and D.R. Ort. 2005. Rising atmospheric carbon dioxide: plants face their future. Annual Rev. of Pl. Biol. 55:591-628.
29. Mahmood, K. and A. Rodriguez 1991. Marketing and processing of small ruminants in highlands of Balochistan. Research report. International Center for Agricultural Research in the Dry Areas, Pp.14-19.
30. Mero, R.N. and P. Uden. 1998. Promising tropical grasses and legumes as feed resources in central Tanzania. 3. Effect of feeding level on digestibility and voluntary intake of four grasses by sheep. Anim Feed Sci. Technol. 70:79-78.
31. Milford, R. and D.J. Minson. 1966. Feeding value of tropical pastures. Tropical Pastures, DAVIS, W and C.L. SKIDMORE, Faber, London, Pp. 106-114.
32. Mirza, S.N., N. Mohammad and I.A. Qamar. 2002. Effect of growth stages on quality of forage grasses. Pak. J. Agri. Res. 17:145–147.
33. Mohammad, N. 1989. Rangeland Management in Pakistan. Published by the International Centre for Integrated Mountain Development (ICIMOD) Kathmandu, Nepal. p. 193.
34. Mohammad, N. and A.H. Naqvi. 1987. Dry matter yield of promising grasses in tropical arid rangelands of Sind, Pakistan. Trop. Agric. 61:70-71.
35. Nastis, A.S. 1982. Nutritive value of oak browse (*Quercus coccifera*) foliage for goats at various phenological stages (in Greek). Aristotelian University of Thessaloniki, Greece.
36. Otsyina., Robert, C.M. McKell, V. Epps and I.J. Gordon 1980. Fodder shrubs and crested wheatgrass proportions to meet nutrient requirements of livestock for fall and early grazing'. Abstract of paper presented at 33rd Annual Meeting of the Society for Range Management.
37. Phillips, T.G., J.T. Sullivan, M.E. Loughlin and V.G. Sprague. 1954. Chemical composition of some forage grasses. I. Changes with plant maturity. J. Amer. Soc. Agron. 46:361.

38. Quraishi, M.A.A., G.S. Khan and S. Yaqoob. 1993. Range Management in Pakistan, Kazi Publications, Lahore, Pakistan. Pp. 229.
39. Saman-Abeysekara, A.W.A. 2003. The Nutritional Value of Oat Forages for Dairy Cows.
40. Sanderson, M.A., J.S. Hornstein and W.F. Wedin. 1989. Alfalfa morphological stage and its relation to in-situ digestibility of detergent fiber fractions of stem. Crop Sci. 29:13, Pp. 15-19.
41. Shamsi, I.H., K. Wei, G.P. Zhang, G. Jilani and M.J. Hassan. 2008. Interactive effects of cadmium and aluminum on growth and antioxidative enzymes in soybean. Biologia Plantarum 52(1): 165-169.
42. Umrani, A.P, P.R. English and D. Younie. 1995. Range land in Pakistan. Asian Livestock, Bangkok, Thialand. 3:30-36.
43. Van Soest, P.J. 1994. Nutritional ecology of the ruminants. 2nd Ed. Ithaca, NY: Cornell Univ. Press. USA.
44. Walsmsley, D.V., A.L. Sergeant, and M. Dookeran. 1978. Effect of fertilizer on growth and composition of elephant grass (*Pennisetum purpureum*) in Tobago, West Indies. Tropical Agriculture. (Trinidad), 55:329-334.
45. Wilson, J.R., B. Deinum and F.M. Engels. 1991. Temperature effects on anatomy and digestibility of leaf and stem of tropical and temperate forage species. Netherlands J. Agric. Sci. 39:31-38.
46. Yusoff Sudin, M. 1994. Cattle Feeds and Feeding. Feed Technical Guide Series No. 2, Dept. Veterinary Services, Malaysia.

Received: June 10, 2014 ***Accepted: April 27, 2016***

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