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PROXIMATE ANALYSIS OF FORAGE SORGHUM CULTIVARS WITH DIFFERENT DOSES OF NITROGEN AND SEED RATE

Ahmad SHER[1], Muhammad ANSAR[2], Muhammad IJAZ[1] and Abdul SATTAR[1]*

[1] Bahauddin Zakariya University, College of Agriculture, Bahadur Campus Layyah, PAKISTAN
[2] PMAS- Arid Agriculture University Rawalpindi, Department of Agronomy, PAKISTAN
[*]Corresponding author: ahmad.sher@bzu.edu.pk

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ABSTRACT

In this study, change in proximate composition in forage sorghum cultivars as influenced by nitrogen (N) fertilization and seed rate harvested at different growth stages was planned through field experiments during consecutive years. Three forage sorghum cultivars *viz.*, JS-2002, JS-263 and Chakwal sorghum were sown under three N levels (0, 60 and 120 kg ha^{-1}) by using three seed rates i.e. 75, 100 and 125 kg ha^{-1}. Results showed that all individual effect of treatments had a variable influence on quality of sorghum cultivars. JS-2002 had higher crude protein content (CP), crude protein yield (CPY), crude fibre (CF), crude fibre yield (CFY), ether extractable fats (EE), total ash content (TA) and organic matter (OM) whilst JS-263 produced greater nitrogen free extract (NFE) than other cultivars. Increasing N rates (0 to 120 kg ha^{-1}) raised all above mention bio-chemical attributes but not NFE. Similarly, increased seed rate enhanced accumulation of CP, CF, EE, TA, CPY and CFY while caused reduction of OM and NFE. Genotypic variations may have influenced the accumulations of these traits however, differences were not significant. In conclusion, sorghum cultivar JS-2002 seeded at 75 kg ha^{-1} with 120 kg N ha^{-1} application produced better quality forage under sub-tropical conditions

Keywords: Forage sorghum cultivars, seed rate, N levels, proximate quality, growth stages, sub-tropical conditions

List of Abbreviations: a.s.l, Above sea level; ANOVA, analysis of variance; C, cultivar; CP, crude protein; CF, crude fibre; EE, ether extractable fats, DAE, days after emergence; K, potassium; N, nitrogen; NFE, nitrogen free extract; OM, organic matter; P, phosphorus; SNK, Scott –Newman-Keuls; TA, total ash content; Y, year.

INTRODUCTION

Livestock is an integral part of farming system in Pakistan and its population going to be increasing day by day. This increase in change between 1996 to 2006 is about 29% but area under fodder production decreases about 8.07% between this era (GOP, 2007). There is severe shortage of forage during winter months because of shortage of rainfall and about 60% of livestock feed on wheat straw, dry stalks of maize, sorghum and millet during winter months. Farmer grows wheat and brassica as a green fodder crops for winter feeding to their livestock (Kumar and Thakur, 2006).

Sorghum is an important summer season crop sown both for fodder and grain purposes. Average fodder yield at present under local conditions is less than the potential of 50-100 tons per hectare. Sorghum can resist drought and hot weather and can be successfully grown on all types of soil except water logged and saline (Chaudhry et al., 2006). Forage shortage during the scarcity period can be reduced by the introducing the high yielding cultivars (Chohan et al., 2006). Different sorghum cultivars vary in fodder yield as well as quality of fodder (Sarfraz et al., 2012; Bilal et al., 2001; Chohan et al., 2006).

The introduction of high yielding crop varieties is the most suitable option to fulfill forage shortage (Bilal et al., 2001). Significant differences in the results have been observed among the different sorghum cultivars for quality attributes (Ashraf et al., 1995; Sarfraz et al., 2012).

Nitrogen (N) fertilizer plays a key role in increasing sorghum forage yield with good nutrition value especially in rainfed regions of the world. It is very important agricultural utility in various developed and developing countries. The use of heavy doses of N to achieve increased fodder has become a custom as it not only increases the yield but protein also (Mohammed and Hamed, 1988). With the increased use of N, crude fibre contents are reduced (Patel et al., 1994). Increase in N levels also increases the protein and digestibility of dry matter. This practice may change the canopy architecture by increased size of foliage. High concentration of N results in succulent growth and dense canopy of plants. High usage of N may increase the vegetative growth and maturity duration of the plants and has affected the quality of the sorghum forage (Rana et al., 1990).

Population density and N application have great influence on quality of sorghum forage. The input of any physical resource below the optimum level, change the growth of plant and yield (Clipson and Edwards, 1994).

In the light of the above mentioned facts, an investigation was undertaken to study the changes in proximate composition in forage sorghum cultivars as influenced by nitrogen fertilization and seed rate.

MATERIALS AND METHODS

Site description

Field experiment was carried out during the summer 2008 and 2009 at National Agricultural Research Centre (NARC; 33°43' N; 73°04' E; 518 m a.s.l), Islamabad. Figure 1 shows meteorological data of the experimental area during the growing season, with monthly average temperature and monthly total rainfall. Soil of the experimental area is clay-loam with neutral pH. Total N and organic matter contents were low, particularly in the layers to below given depth. There was poor phosphorus and potassium status in the soil.

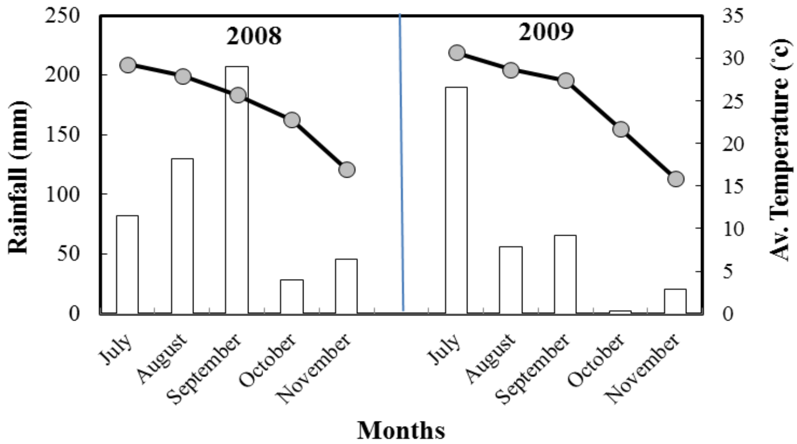

Figure 1. Rainfall, av. temperature and relative humidity recorded during crop growth period

Plant material and experimental design

Three forage sorghum cultivars: two cultivars i.e. JS-2002 and Chakwal sorghum were approved by Punjab Seed Council in collaboration with Seed Certification & Registration Department and one landrace (JS-263). The cultivar JS-2002 is the late variety which remains green for a longer period with small/compact panicle and yellow grain for irrigated areas and is developed by Fodder Research Institute, Sargodha. Chakwal Sorghum is a medium cycle cultivar for rainfed areas, resistant to drought with loose panicle and whitish grain and is being developed by Barani Agricultural Research Institute, Chakwal. JS-263 seed was collected from farmers of Rawalpindi surrounding rainfed area; is a medium-high genotype, semi-resistant to drought, with loose panicle, bold and whitish grain. These cultivars were grown each with 75, 100 and 125 kg ha^{-1} seeding rates, and under 0, 60 and 120 kg ha^{-1} nitrogen (N) levels. Sorghum cultivars, seed rates and N rates were allocated in main plots, sub-plots and sub-sub plots, respectively. This experiment comprised of 27 treatment combinations under randomized completely block design arranged in split-split plots with three replications.

Crop husbandry

Crop was sown on 20th August, 2008 and 1st August, 2009 with same area of treatment plots size was 4 m × 1.2 m during two years, respectively. Planting of crop was done by maintaining 30 cm of row to row distance with hand drill. At the time of seed bed preparation, applied 30 kg ha^{-1} of phosphorus as triple super phosphate. The N was applied in the form of urea through broadcasting as per treatment. All other cultural practices were kept uniform as recommended for sorghum forage crop during both seasons.

Forage quality analysis and calculations

The proximate composition *viz.*, crude protein, CF, EE, TA, NFE and OM were determined for all samples. Nitrogen concentrations were determined by the Kjeldahl procedure and crude protein concentration was calculated by the formula of N concentration × 6.25 (AOAC, 2002). Crude protein and fibre yield is estimated to multiply crude protein percentage and crude fibre with dry matter yield, respectively and then dividing it by 100.

The data collected were subjected to analysis of variance using the CoStat 6.3 software (CoHort Software, Monterey, CA, USA) to determine significance of the tested factors (cultivar, seed rate and N level) with sorghum traits. Means of significant effects were separated using the test at 5% level of significance.

RESULTS

Crude protein

Amongst cultivars, JS-2002 gave maximum crude protein (CP) than JS-263 (Table 1). JS-2002 produced CP 43.8 and 31.3% at pre-booting, 36 and 31.5% at booting, 26.1 and 25.9% at 50% heading stage in 2008 and 2009, respectively; which is higher than JS-263. Increase in seed rate gradually decreased crude protein. Lower seed rate produced highest CP at pre-booting, booting and 50% heading stage during both the years. Nitrogen rate is linearly related with the value of crude protein. Higher dose of N (120 kg ha^{-1}) resulted maximum CP, while minimum was found from zero N application at three successive growth stages during both years of study. Almost similar trend was found during both years; however, overall CP in all the treatments was better during 2009 than 2008.

Crude protein yield

Statistically analysis of crude protein yield (CPY) revealed that means comparison of sorghum cultivars indicate that JS-2002 produced significantly higher CPY (t ha^{-1}) than JS-263 and Chakwal sorghum (Table 2). Increasing seed rates decreased the CPY (t ha^{-1}). Higher CPY (t ha^{-1}) was recorded at lower seed rate (75 kg ha^{-1}) than at higher seed rate at three successive growth stages in the two consecutive years. Regardless of seed rate, N application rate showed direct relation with CPY (t ha^{-1}). Maximum CPY (t ha^{-1}) at pre-booting, booting and 50% heading stage was recorded at higher rate 120 kg N ha^{-1} during both years.

Crude fibre

Statistical analysis of data revealed that individual effect of sorghum cultivars, seed rate and N application significantly ($\leq$0.05) affected the crude fibre (CF). JS-2002 produced significantly higher contents of crude fibre at all stage (Table 1). Contrarily, JS-263 contained minimum CF at all three succeeding growth stages during both years of study. Seed rate inversely affect CF values. Maximum CF was recorded at lower seed rate (75 kg ha^{-1}) than higher rate (125 kg ha^{-1}). Increasing nitrogen level increased the CF. The highest CF at pre-booting, booting and 50% heading stage was recorded with higher dose (120 kg N ha^{-1}) during two years.

Crude fibre yield

Data revealed that individual effect of sorghum cultivars, seed rate and N application significantly ($\leq$0.05) affected the crude fibre yield (CFY). JS-2002 produced significantly higher crude fibre yield at all stages (Table 2). Seed rate inversely affect CFY values. Maximum CFY was recorded at lower seed rate (75 kg ha^{-1}) than higher rate (125 kg ha^{-1}). Increasing N level increased the CFY. The highest CFY at pre-booting, booting and 50% heading stage was recorded with higher dose (120 kg N ha^{-1}) during two years.

Ether extractable fats

Among the sorghum cultivars, maximum ether extracts (EE) at pre-booting, booting and 50% heading stage were recorded in JS-2002, whereas minimum EE was observed in JS-263 at three successive growth stages during two consecutive years (Table 3). Increasing seed rates increased the EE. Maximum EE were observed with seed rate of 75 kg ha^{-1} during both the years. Increasing N levels increased the EE concentration. The highest EE was recorded with application of 120 kg N ha^{-1}.

Total ash content

Means comparison of sorghum cultivars indicate that JS-2002 produced significantly more total ash content (TA) than JS-263 and chakwal sorghum (Table 3). Increasing seeding rates increased the TA. Maximum TA was recorded at higher rate (125 kg ha^{-1}) at three successive growth stages in the two consecutive years. Regardless of seed rate, N application rate showed direct relation with TA. Maximum TA at pre-booting, booting and 50% heading stage was recorded at higher rate 120 kg N ha^{-1}. In contrast, minimum TA was observed in control plots (0 kg N ha^{-1}) during both years.

Nitrogen free extract

Amongst cultivars, JS-263 contained higher nitrogen free extract (NFE) as compared to JS-2002 (Table 4). Increased seed rates resulted in progressive increase of NFE. Maximum NFE was recorded at seed rate 125 kg ha^{-1} than 100 and 75 kg ha^{-1} seed rate during 2008 and 2009 at respective growth stages. The N rate showed inverse relationship with NFE. Highest NFE was recorded from treatment without N application when compared with high dose (120 kg N ha^{-1}) at three successive stages during two consecutive years.

Organic matter

Statistical analysis of data showed that JS-2002 produced maximum organic matter (OM) value compared to JS-263 at pre-booting stage during 2008 and 2009 respectively, while booting and 50% heading stage during 2009 only (Table 4). Higher seed rates gave higher OM. Maximum OM was recorded at higher seed rate (125 kg ha^{-1}) in comparison to lower rates (100 and 75 kg ha^{-1}). Likewise, N application enhanced organic matter at pre-booting, booting and 50% heading stage during both years with 120 kg N ha^{-1}.

Table 1. Interactive effect of Cultivar, Seed rate and Nitrogen application of sorghum forage at different growth stages during 2008 and 2009

Treatments	Crude protein (%)						Crude fibre (%)					
	Pre-booting		Booting		50% heading		Pre-booting		Booting		50% heading	
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
Cultivar (C)												
JS-2002	11.5 a	13.0 a	10.2 a	12.1 a	8.7 a	10.7 a	41.9 a	39.4 a	31.3 a	29.2 a	27.8 a	25.9 a
Chakwal sorghum	8.9 b	10.9 b	8.0 b	9.9 b	7.5 b	9.2 b	39.1 b	37.3 b	29.2 b	27.0 b	27.0 a	25.0 b
JS-263	8.0 c	9.9 c	7.5 c	9.2 c	6.9 c	8.5 c	35.4 c	33.6 c	25.8 c	23.6 c	25.1 b	23.1 c
LSD	0.528	0.343	0.369	0.400	0.331	0.362	0.770	0.622	0.919	1.309	0.792	0.753
Seed rate (S) (kg ha^{-1})												
75	10.4 a	12.4 a	9.5 a	11.6 a	8.6 a	10.5 a	41.1 a	38.6 a	30.6 a	28.2 a	28.6 a	26.5 a
100	9.7 b	11.4 b	8.6 b	10.5 b	7.7 b	9.4 b	38.8 b	36.8 b	28.9 b	26.7 b	26.6 b	24.6 b
125	8.3 c	10.0 c	7.5 c	9.2 c	6.9 c	8.5 c	36.4 c	35.0 c	26.8 c	24.9 c	24.6 c	22.8 c
LSD	0.528	0.343	0.369	0.400	0.331	0.362	0.770	0.622	0.919	1.309	0.792	0.753
Nitrogen level (N) (kg ha^{-1})												
0	8.5 c	10.0 c	7.5 c	9.1 c	6.4 c	8.2 c	36.4 c	34.4 c	27.3 c	25.1 c	25.1 c	23.5 c
60	9.6 b	11.4 b	8.5 b	10.3 b	7.7 b	9.4 b	28.8 b	37.0 b	28.8 b	26.6 b	26.5 b	24.5 b
120	10.2 a	12.5 a	9.6 a	11.8 a	9.0 a	10.7 a	41.1 a	38.9 a	30.2 a	28.1 a	28.3 a	26.0 a
LSD	0.528	0.343	0.369	0.400	0.331	0.362	0.770	0.622	0.919	1.309	0.792	0.753
C × S	<0.006*	<0.001**	0.052 ns	<0.001**	0.215 ns	0.139 ns	0.773 ns	0.106 ns	0.476 ns	0.089 ns	0.207 ns	0.789 ns
C × N	0.778 ns	<0.043*	0.252 ns	0.100 ns	0.708 ns	0.950 ns	0.924 ns	<0.027*	0.721 ns	0.498 ns	0.884 ns	0.349 ns
S × N	0.893 ns	<0.029*	0.754 ns	0.706 ns	0.586 ns	0.177 ns	0.969 ns	0.196 ns	0.878 ns	0.949 ns	0.737 ns	0.091 ns
C × S × N	0.982 ns	0.338 ns	0.859 ns	0.600 ns	0.357 ns	0.493 ns	0.717ns	<0.005*	0.973 ns	0.531 ns	0.976 ns	0.863 ns
C.V. (%)	10.1	5.5	7.8	7.0	7.8	6.9	3.6	3.1	5.8	8.9	5.4	5.3

ns, non-significant; *, significant at $P \leq 0.05$; **, $P \leq 0.01$

Different letters indicate statistically significant-difference among the values in each column and individual factors (SNK test; $P \leq 0.05$)

Table 2. Interactive effect of Cultivar, Seed rate and Nitrogen application of sorghum forage at different growth stages during 2008 and 2009

	Crude protein yield (t ha^{-1})						Crude fibre yield (t ha^{-1})					
Treatments	**Pre-booting**		**Booting**		**50% heading**		**Pre-booting**		**Booting**		**50% heading**	
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
Cultivar (C)												
JS-2002	1.42 a	1.02 a	1.76 a	1.13 a	2.09 a	1.97 a	5.14 a	3.06 a	5.34 a	2.66 a	6.62 a	4.75 a
Chakwal sorghum	0.75 b	0.58 b	1.13 b	0.78 b	1.32 b	1.05 b	3.24 b	1.95 b	4.05 b	2.09 b	4.70 b	2.79 b
JS-263	0.44 c	0.32 c	0.77 c	0.41 c	0.91 c	0.65 c	1.93 c	1.07 c	2.62 c	1.04 c	3.24 c	1.74 c
LSD	0.187	0.084	0.299	0.111	0.303	0.345	0.729	0.236	0.876	0.268	0.950	0.749
Seed rate (S) (kg ha^{-1})												
75	1.11 a	0.88 a	1.62 a	1.03 a	1.62 a	1.45 a	4.29 a	2.66 a	5.06 a	2.47 a	5.73 a	3.79 a
100	0.88 b	0.63 b	1.20 b	0.74 b	1.39 b	1.18 b	3.39 b	1.99 b	3.92 b	1.84 b	4.66 b	2.95 b
125	0.61 c	0.42 c	0.86 c	0.55 c	1.13 c	1.03 c	2.62 c	1.42 c	3.02 c	1.47 c	4.17 c	2.53 c
LSD	0.092	0.056	0.106	0.077	0.084	0.096	0.299	0.124	0.245	0.175	0.300	0.279
Nitrogen level (N) (kg ha^{-1})												
0	0.59 c	0.40 c	0.74 c	0.49 c	0.88 c	0.73 c	2.39 c	1.31 c	2.63 c	1.34 c	3.44 c	2.07 c
60	0.86 b	0.64 b	1.16 b	0.76 b	1.34 b	1.17 b	3.39 b	2.02 b	3.84 b	1.92 b	4.60 b	2.98 b
120	1.15 a	0.89 a	1.77 a	1.07 a	2.10 a	1.76 a	4.52 a	2.75 a	5.53 a	2.52 a	6.52 a	4.24 a
LSD	0.054	0.038	0.087	0.034	0.117	0.100	0.148	0.102	0.271	0.113	0.260	0.217
C × S	<0.015*	<0.001*	<0.004*	<0.001*	0.116 ns	0.062 ns	0.075 ns	<0.001*	0.169 ns	<0.007*	0.051 ns	<0.047*
C × N	<0.002*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.003*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*
S × N	<0.022*	<0.001*	<0.002*	<0.001*	0.681 ns	<0.028*	<0.023*	<0.001*	<0.004*	0.941 ns	0.353 ns	0.059 ns
C × S × N	0.502 ns	0.192 ns	0.713 ns	0.258 ns	0.889 ns	0.066 ns	0.400 ns	0.129 ns	0.673 ns	0.172 ns	0.996 ns	0.088 ns
C.V. (%)	11.3	10.7	12.9	8.1	14.7	14.9	7.8	9.1	12.3	10.6	9.7	12.7

ns, non-significant; *, significant at $P \leq 0.05$; **, $P \leq 0.01$
Different letters indicate statistically significant-difference among the values in each column and individual factors (SNK test; $P \leq 0.05$)

Table 3. Interactive effect of Cultivar, Seed rate and Nitrogen application of sorghum forage at different growth stages during 2008 and 2009

	Ether extractable fat (%)						**Total ash content (%)**					
Treatments	**Pre-booting**		**Booting**		**50% heading**		**Pre-booting**		**Booting**		**50% heading**	
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
Cultivar (C)												
JS-2002	3.0 a	1.9 a	2.8 a	1.7 a	2.6 a	1.5 a	8.1 a	7.4 a	8.5 a	7.9 a	9.5 a	8.6 a
Chakwal sorghum	2.7 b	1.7 b	2.6 b	1.5 b	2.4 b	1.3 b	7.6 b	6.7 b	8.0 b	7.4 b	8.8 b	7.9 b
JS-263	2.2 c	1.1 c	2.1 c	1.0 c	1.9 c	0.83 c	6.7 c	6.0 c	7.3 c	6.7 c	7.9 c	7.2 c
LSD	0.194	0.065	0.131	0.079	0.141	0.075	0.311	0.339	0.378	0.265	0.363	0.238
Seed rate (S) (kg ha^{-1})												
75	3.0 a	1.9 a	2.7 a	1.7 a	2.6 a	1.4 a	6.8 c	6.1 c	7.5 c	7.0 c	8.2 c	7.3 c
100	2.6 b	1.5 b	2.4 b	1.4 b	2.3 b	1.2 b	7.5 b	6.7 b	8.0 b	7.4 b	8.7 b	7.9 b
125	2.4 c	1.3 c	2.2 c	1.2 c	2.1 c	1.0 c	8.0 a	7.3 a	8.3 a	7.6 a	9.3 a	8.5 a
LSD	0.194	0.065	0.131	0.079	0.141	0.075	0.311	0.339	0.378	0.265	0.363	0.238
Nitrogen level (N) (kg ha^{-1})												
0	2.2 c	1.1 c	2.0 c	0.99 c	1.9 c	0.84 c	6.7 c	5.9 c	7.2 c	6.4 c	8.0 c	7.0 c
60	2.8 b	1.7 b	2.6 b	1.5 b	2.4 b	1.3 b	7.6 b	6.8 b	7.9 b	7.3 b	8.8 b	8.1 b
120	3.0 a	1.9 a	2.8 a	1.7 a	2.7 a	1.5 a	8.1 a	7.4 a	8.7 a	8.2 a	9.5 a	8.6 a
LSD	0.194	0.065	0.131	0.079	0.141	0.075	0.311	0.339	0.378	0.265	0.363	0.238
C × S	0.944 ns	0.645 ns	0.999 ns	0.226 ns	0.782 ns	0.578 ns	<0.006*	0.188 ns	0.679 ns	0.996 ns	0.862 ns	0.852 ns
C × N	0.558 ns	<0.001**	0.104 ns	<0.001**	<0.036*	<0.001**	0.729 ns	0.797 ns	0.540 ns	<0.015*	0.956 ns	0.205 ns
S × N	0.722 ns	<0.003*	0.863 ns	0.284 ns	0.852 ns	0.363 ns	0.921 ns	0.913 ns	0.984 ns	0.965 ns	0.641 ns	<0.016*
C × S × N	0.989 ns	0.183 ns	0.973 ns	0.941 ns	0.961 ns	0.622 ns	0.975 ns	0.623 ns	0.999 ns	0.983 ns	0.975 ns	0.815 ns
C.V. (%)	13.3	7.6	9.7	10.2	11.0	11.3	7.6	9.2	8.6	6.6	7.5	5.5

ns, non-significant; *, significant at $P \leq 0.05$; **, $P \leq 0.01$
Different letters indicate statistically significant-difference among the values in each column and individual factors (SNK test; $P \leq 0.05$)

Table 4. Interactive effect of Cultivar, Seed rate and Nitrogen application of sorghum forage at different growth stages during 2008 and 2009

	Nitrogen free extract (%)						**Organic matter (%)**					
Treatments	**Pre-booting**		**Booting**		**50% heading**		**Pre-booting**		**Booting**		**50% heading**	
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
Cultivar (C)												
JS-2002	35.6 c	38.3 c	47.3 c	49.0 c	51.4 c	53.4 c	23.9 a	17.1 a	27.4	19.1 a	34.4	29.1 a
Chakwal sorghum	41.8 b	43.4 b	52.3 b	54.2 b	54.2 b	56.5 b	16.8 b	12.7 b	27.2	15.0 b	31.5	26.3 b
JS-263	47.7 a	49.4 a	57.4 a	59.5 a	58.2 a	60.4 a	15.3 c	10.2 c	23.6	12.1 c	32.0	27.0 b
LSD	1.050	0.712	1.126	1.386	0.831	0.892	0.811	0.525	0.067 ns	0.623	0.133 ns	0.763
Seed rate (S) (kg ha^{-1})												
75	38.7 c	41.0 c	49.6 c	51.6 c	52.0 c	54.2 c	16.4 c	11.5 c	23.8 c	14.2 c	30.6 c	24.5 c
100	41.4 b	43.5 b	52.1 b	54.1 b	54.7 b	56.9 b	18.6 b	13.3 b	25.9 b	14.9 b	31.8 b	26.6 b
125	44.9 a	46.4 a	55.1 a	57.1 a	57.2 a	59.2 a	21.0 a	15.3 a	28.4 a	17.2 a	35.4 a	31.3 a
LSD	1.050	0.712	1.126	1.386	0.831	0.892	0.811	0.525	0.960	0.623	0.934	0.763
Nitrogen level (N) (kg ha^{-1})												
0	46.1 a	48.6 a	56.0 a	58.3 a	58.6 a	60.4 a	16.3 c	11.2 c	23.2 c	13.2 c	30.4 c	25.5 c
60	41.3 b	43.2 b	52.2 b	54.2 b	54.7 b	56.7 b	18.5 b	13.6 b	26.2 b	15.6 b	32.4 b	26.9 b
120	37.7 c	39.2 c	48.7 c	50.1 c	50.6 c	53.2 c	21.3 a	15.4 a	28.8 a	17.4 a	35.0 a	30.0 a
LSD	1.050	0.712	1.126	1.386	0.831	0.892	0.811	0.525	0.960	0.623	0.934	0.763
C × S	0.143 ns	<0.038*	0.647 ns	0.585 ns	0.589 ns	0.811 ns	<0.009*	<0.001**	0.467 ns	<0.008*	0.503 ns	<0.001**
C × N	0.997 ns	0.434 ns	0.517 ns	0.549 ns	0.871 ns	0.557 ns	0.483 ns	0.203 ns	0.400 ns	<0.033*	<0.001**	<0.001**
S × N	0.989 ns	<0.036*	0.874 ns	0.904 ns	0.540 ns	0.087 ns	0.233 ns	<0.001**	0.489 ns	<0.023*	0.341 ns	0.088 ns
C × S × N	0.810 ns	<0.006*	0.999 ns	0.541 ns	0.873 ns	0.656 ns	0.186 ns	<0.004**	0.278 ns	<0.006*	0.844 ns	0.070 ns
C.V. (%)	4.6	3.0	3.9	4.6	2.6	2.8	7.9	7.1	6.5	7.3	5.2	5.0

ns, non-significant; *, significant at $P \leq 0.05$; **, $P \leq 0.01$

Different letters indicate statistically significant-difference among the values in each column and individual factors (SNK test; $P \leq 0.05$)

DISCUSSION

The nutritive value of forage is a measure of proximate composition, digestibility and nature of digested products and thereby its ability to maintain or promote growth, milk production or other physiological function in the animal body. The forage digestibility is related to change in chemical composition and to some extent crude protein (Sher et al., 2014; Bose and Balakarishan, 2001). Therefore; forage containing high crude protein content is considered of good quality. Current study indicates that forage sorghum cultivars influenced the proximate compositions at different developmental stages. Cultivar JS-2002 appeared to be more nutritious for animals as it contains high protein in comparison with other two cultivars, it might be due to its genetic potential (Celen and Akdemir, 1998). Shobha et al. (2008) found that crude protein between 8 and 13% of sorghum genotypes that was in line with present study having the crude protein 7-13%. Aruna et al. (2015), Rana et al. (2014), Sarfraz et al. (2012), Ayub et al. (2010), Abusuwar and Hala (2010), Mahammed and Moataz (2009) and Carmi et al. (2006) have also reported significant differences among the sorghum cultivars for crude protein. Likewise; Ayub et al. (2012) found the variation in protein contents among the various sorghum cultivars. In contrast Eltelib and Eltom (2006) and Mahmud et al. (2003) did not find any significant differences in protein contents among various sorghum cultivars.

However, increasing the seed rates decreased crude protein of sorghum forage. Similar results were found by Ayub et al. (2003) who examined that crude protein decreased by increasing seed rate, while Iptas et al. (2002) found contradictory results that no statistically significant association was observed in seed rate and crude protein.

The current studies showed that application of N significantly enhanced the crude protein in sorghum forage, which might be due to high concentration of amino acids, because N directly involved in synthesis of amino acid (Sher et al., 2016). Our results are supported by many researchers who reported that crude protein content increased with increasing N levels (Glamoclija et al., 2011; Almodares et al., 2009; Iptas and Brohi 2003; Iptas et al., 2002). Crude protein was found 8-13% at NP fertilizer, 7-9% at N-K_2O rates, 4-8% and 5-8% at NPK fertilizer (Mahmud et al., 2003; Pholsen and Sornsungnoen, 2004; Pholsen and Sukrsi, 2004; Azam et al., 2010) whereas in our experiment 6-13% was recorded which is similar to previous investigations. Protein is one of the most costly supplements for livestock; the total amount of protein produced per unit area is one of the most important quality characteristics as suggested by many researchers (Assefa and Ledin, 2001; Lithourgidis et al., 2006; Atis et al., 2012). The result of the current study was in line with finding of Kim et al. (2006) and Bhilare et al. (2007) who also reported that application of N increased the crude protein yield while some studies showed the contradictory results (Iqbal et al., 2013; Iptas and Brohi 2003) who reported that no significant differences were found by the application of N rate.

The intake, palatability and digestibility of forage is inversely related to crude fibre percentage i.e. the forage containing low crude fibre content is better in quality and vice versa. Therefore, in present investigations, cultivar JS-2002 produced low contents of crude fibre in comparison with other two cultivars that might be due to the genetic makeup the of the cultivars. Rana et al. (2014), Abusuwar and Hala (2010), Ayub et al. (2010; 2012), Shobha et al. (2008), Nabi et al. (2006) also supported our finding and confirmed that there was a significant difference among sorghum varieties regarding crude fibre. In case of seed rate, it was found that crude fibre contents were decreasing with increasing the seed rate. Almost similar results have been reported by Ayub et al. (2003) who also found that crude fibre decreased with the increasing of seed rate while Abusuwar (1994) found the contradictory results. Good quality forage has less crude fibre and in case of higher crude fibre percentage digestibility will be reduced. Increased N levels increased the crude fibre (Eltelib and Eltom, 2006; Mahmud et al., 2003) whereas current study revealed that higher crude fibre was recorded with the application of NP while Almodares et al. (2009) found the contradictory results with current study.

In current study, there is variation among the cultivars of sorghum for EE. This might be due to their genetic characters. Ayub et al. (2002, 2010), Mahammed and Moataz (2009) and Shobha et al. (2008) also found the significant difference in EE of various cultivars. In addition; concentration of EE is increased with increasing the dose of N which might be due to higher production of glycerol contents which lead to an increased fats percentage. According to our findings, results were consistent with the results of Azam et al. (2010), Ayub et al. (2002) who reported that EE increases with an increase in N levels.

In our results it was observed that ash percentage varied among the sorghum cultivars which might be due to genetic potential and rooting array to absorb nutrients from soil (Rana et al. 2014; Ayub et al. 2012). An increasing trend for total ash content was observed and our results are consistent with the results of Ayub et al. (2003) who found that total ash content increased with increasing seed rate. Similarly, nitrogen has direct relationship with total ash content in present study. Ayub et al. (2002) found that increased level of fertilizer increased the total ash content. Mahmud et al. (2003) observed maximum total ash content at the highest rate of NP fertilizer levels (100-100 kg ha^{-1}), whereas in our experiment the maximum total ash content was recorded with the application of NP (120-30 kg ha^{-1}).

Glamoclija et al. (2011) reported significant differences for NFE in different cultivars. However, in our experiment sorghum cultivar JS-263 seemed well adapted under local climate and utilized the available resources efficiently as compared to other two cultivars. The N rate has inversely proportional for NFE. Similar results are reported by Rakic et al. (2013) and Glamoclija et al. (2011) who found that NFE decreased with increasing N levels. Our results presents that highest OM was observed from JS-2002 compared to JS-263. Increased seed and N rates gradually increased the OM. It was higher in 2009 than 2008 indicating some sessional effects on cultivars.

CONCLUSION

The JS-2002 indicate more efficiency in CP, CPY, CF, CFY, TA, EE, OM while JS-263 in NFE than Chakwal sorghum. The proximate composition would be affected by the variation of seed rate at the given developmental stages. In this study, high fodder quality was expressed by the forage sorghum cultivars JS-2002 at 75 kg ha^{-1} seed rate and N fertilization of 120 kg ha^{-1}. Moreover; these treatments are suitable to harvest at 50% heading stage and recommended best for livestock feeding.

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