Mycopath (2014) 12(1): 59-62 **Research Article**

Morphological and chemical changes in three cultivars of sorghum under dry conditions in Pakistan

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Abstract

A field study was carried out during 2010-11 to quantify fodder and yield qualityin three sorghum [*Sorghum bicolor* (L.) Moench] cultivars viz., JS-2002, Chakwal Sorghum and Local Cultivar at different growth stages i.e. 3rd leaf stage (GS_1), prebooting (GS_2) and 50% heading (GS_3). Experiment was laid out in randomized complete block design with three replications. Cultivar JS-2002 showed the maximum plant height (196.1 cm), number of leaves per plant (11.3), leaf area per plant (535.9 cm^2), stem thickness (1.7 cm), green fodder yield (63.3 t ha^{-1}) and dry matter yield (18.9 t ha^{-1}) followed by Chakwal Sorghum and Local Cultivar. Cell wall components viz., acid detergent fiber (ADF), neutral detergent fiber (NDF), hemicellulose, cellulose and silica contents were higher (72.90%, 41.91%, 34.3%, 27.77% and 3.5) in local cultivar i than rest of two cultivars. Higher contents of cell wall components indicated the inferior quality and poor digestibility of the fodder. Overall, JS-2002 sorghum cultivar provides better yield and quality among the tested cultivars. Although at GS_3, maximum fodder yield was observed but at this stage nutritional value decreased. So, GS_2 is good stage for feeding to livestock with higher nutritional value and digestibility.

Keywords: ADF, Crude Protein, Hemicellulose, Growth stages, Green Fodder Yield, NDF, Nutritional Value.

Introduction

In Pakistan, most of the large ruminant animals such as buffalos and cattle are traditionally raised on farm grown fodder and crop remaining. These fodders are rich with protein, carbohydrates and minerals. Importance of any fodder depends upon the nutrients concentration in the fodder as well as fodder intake by the animals. Nutrients play a vital role in body maintenance and various productive functions depending upon the efficiency with which the animals utilized these nutrients. The major summer fodders in the Pakistan are maize, sorghum and millet. Sorghum (*Sorghum bicolor*. Moench) belongs to the family Poaceae is becoming an increasingly important forage crop in many regions of the world (Zerbini and Thomas, 2003). It holds promise for food, feed and fodder for human, poultry and cattle, respectively. It is one the most important cereal crop which is largely cultivated throughout world during summer and monsoon seasons to meet out both green as well dry fodder requirements of the livestock. Proper identification of growth stages, adequate fertilization, suitable and low HCN content are among the major factors limiting the fodder production of sorghum (Sing *et al.,* 2008).

This is important to note that the most digestible parts of sorghum is young green leaves and shoots. Whereas, in the hot areas, forages have more contents of lignin as compare to cooler areas due to which food value and digestibility decreased rapidly as plant matures. Therefore, a study was designed with the objective to identify the appropriate cultivar as well as better growth stage of sorghum to obtain good yield and nutritious forage quality.

Materials and Methods

The experimental field soil was loamy with available phosphorous (P) 12.15 mg kg^{-1}, available potassium (K) 160 mg kg^{-1} and pH 7.5. The experimental field as per farm record was prepared after wheat harvesting with two cross cultivation followed by planking to make the seedbed firm for uniform seed germination. Fodder Research Institute, Sargodha provided the seeds of JS-2002

and seeds of Chakwal sorghum were got from Barani Agricultural Research Institute, Chakwal while the seed of local sorghum cultivar was purchased from local market. The cultivars were sown in lines 30 cm apart on August 1, 2010 in randomized complete block design with three replications. Each block consisted of 6 m long rows and 3 m apart thus having a block size of 18 m. Seed at 75 kg ha^{-1} of each cultivar and fertilizer @ 60 kg ha^{-1} nitrogen in the form of urea, 35 kg ha^{-1} P_2O_5 in the form of single super phosphate were applied at the time of seed bed preparation.

Top fully expanded leaves samples were taken at three growth stages viz., GS_1 i.e. 3rd leaf (10 days after germination), GS_2 (Pre-booting-40 days after germination) and GS_3 (50% heading-70 days after germination) from each block. These growth stages were chosen initially based on the data presented by Vanderlip and Reeves (1972). All the samples were saved in bags for further analysis. Agronomic parameters viz., stem thickness (cm), green fodder yield (t ha^{-1}) and dry fodder yield (t ha^{-1}) were taken in a randomly selected 1 m^2 areas of each block at different growth stages. For chemical composition of the fodder, samples were dried in hot air oven at 60 ^oC. Dried samples were ground in a laboratory mill and sieve through 4 mm sieve. These samples were used for further analysis viz., neutral detergent fiber (NDF), acid detergent fiber (ADF), cellulose, hemicellulose and silica. The statistical analysis of the data was carried out by using MSTATC program.

Results and Discussion

Stem thickness in different cultivars at three growth stages

Stem thickness is considered as an important characteristic of the plant that produces more above ground biomass. Plants with thicker stems can bear more loads and thus can stand firmly on the ground. Mean stem thickness of the three sorghum cultivars recorded at three different growth stages is presented in Table 1. At GS_1, all the three cultivars namely JS-2002, chakwal sorghum and local cultivar showed non-significant difference. At GS_2, JS-2002 was statistically significant in comparison with local cultivar and statistically non-significant with chakwal sorghum whereas chakwal sorghum and local cultivar showed significant results with each other. At GS_3, JS-2002 chakwal sorghum and local cultivar was statistically significant with each other. These results are in lines with the finding of Nabi *et al.* (2006), who reported that the maximum 512.15 cm^2 leaf area $plant^{-1}$ was in JS-88 of tested sorghum cultivars.

Green fodder yield in different cultivars

Green fodder yield at a particular time is a function of fresh plant weight of number of plants present in a unit area. Cultivars with more crop growth rate give more fodder yield. The data pertaining to mean green fodder yield (t ha^{-1}) of sorghum cultivars at three different growth stages is presented in Table 2. At GS_1, all three cultivars i.e. JS-2002, Chakwal sorghum and local cultivars showed non-significant results. At GS_2 and GS_3, JS-2002 was statistically significant in comparison with local cultivar and statistically non-significant with Chakwal sorghum whereas Chakwal sorghum and local cultivar showed significant results with each other. These results are in agreement with the findings of Nabi *et al.* (2006); Khan *et al.* (2007) and Singh *et al.* (2008) who reported that higher yield in different cultivars could be attributed to positive contribution of fodder yield components.

Dry matter yield in different cultivars at three growth stages

Dry matter yield at a particular time is a function of dry plant weight of total number of plants in a unit area. Cultivars with more crop growth rate give more dry matter yield. The data pertaining to mean dry matter yield (tons ha^{-1}) at three different growth stages of sorghum cultivars is presented in Table 2. At GS_1, all three cultivars i.e. JS-2002, Chakwal sorghum and local cultivars showed non-significant results. These results are in agreement with the findings of Nabi *et al.* (2006) and Malik *et al.* (2007) who reported that maximum dry matter yield (17.11 tons ha^{-1}) in JS-88 sorghum cultivar.

Quality of sorghum fodder

Quality fodder is needed for better performance of animals. The parameters used to describe forage quality were NDF, ADF, cellulose, hemicellulose and silica contents The information on chemical composition of sorghum cultivars is deficient, specifically on the changes occurring in chemical composition of different fractions of the plant with advancing growth stages. The results of the chemical composition of three different sorghum cultivars at three stages are presented in Table 3.

The result of NDF in three sorghum cultivars at three different stages was shown in Table 3. At GS_1, all three cultivars i.e. JS-2002,

Chakwal sorghum and local cultivar were showed statistically significant difference among each other. At GS_2, JS-2002 showed significant difference with the Chakwal sorghum while non-significant with the local cultivar whereas Chakwal sorghum was statistically significant in comparison with JS-2002 and local cultivar. All three cultivars showed the statistically significant results among each other at GS_3. The results indicated that with increasing the growth stages NDF increased in each cultivars and maximum contents was found in local cultivar while minimum content was recorded in JS-2002. Rashid and Iqbal (2011) reported that ADF and NDF are structural components of the carbohydrate of plants. The decrease in ADF and NDF is an indication in improvement of the quality of fodder. Otherwise, high values of both the parameters indicate digestibility due to more lignification. Our finding was in accordance with the finding of Firdous and Gilani (2001) who concluded that with the advancement of the growth stages the NDF contents were increased in crop age and contents vary cultivar to cultivar.

The results of ADF in three sorghum cultivars at three different stages were shown in Table 3. All three cultivars i.e. JS-2002, Chakwal sorghum and local cultivar were showed statistically significant ($\leq$0.05%) difference among each other. At GS_2, GS_3, JS-2002 showed significant difference with the Chakwal sorghum and local cultivar whereas chakwal sorghum and local cultivar were found statistically non-significant. The results indicated that with increasing the growth stages NDF increased in each cultivars and maximum contents was found in local cultivar while minimum content was recorded in JS-2002. Dabo *et al*. (1988) reported that consequent to advancing maturity the changes in ADF were less marked in leaves than in stem. Some cultivars differences were also observed with respect to ADF content of whole sorghum plant. Results of above reported work support the finding of present study.

Cellulose in sorghum cultivars at different stages

The result of cellulose in three sorghum cultivars at three different stages was shown in Table 3. At GS_1, Chakwal sorghum was showed statistically significant ($\leq$0.05%) difference in comparison with JS-2002 and local cultivar while JS-2002 and local cultivar was found non-significant with each other. At GS_2 and GS_3, JS-2002 showed significant difference with the Chakwal sorghum and local cultivar whereas Chakwal sorghum and local cultivar were found statistically non-significant. The study on maturity and cultivars effects on chemical composition of sorghum was carried out by Firdous and Gilani (2001) is in accordance with the present study.

Hemicellulose in sorghum cultivars at different stages

The result of hemicellulose in three sorghum cultivars at three different stages was shown in Table 3. At GS_1, all three cultivars showed statistically non-significant ($\leqq$0.05%) difference among each other. At GS_2, local cultivar was statistically significant in comparison with JS-2002 and Chakwal sorghum while Chakwal sorghum and JS-2002 showed significant non-difference with each other. All three cultivars showed statistically significant difference among each other. The results are in accordance with finding of Rashid and Iqbal (2011) and Firdous and Gilani (2001).

Silica percentage in sorghum cultivars at different stages

The results of silica in three sorghum cultivars at three different stages are shown in Table 3. At GS_1, GS_2 and GS_3, JS-2002 showed statistically significant ($\geq$0.05%) difference in comparison with Chakwal sorghum and local cultivar while Chakwal sorghum and local cultivar was found non-significant with each other. The results were supported by the finding of Ashraf *et al*. (1995).

Conclusion

Nutritional value of fodder plays a critical role on its utilization and consumption by large ruminants and nutritional value depends upon the critical growth stages and cultivars. The present study concludes that JS-2002 performed best among the tested cultivars both for yield and quality. From this study, it is observed that better yield was obtained at GS_3 but at this stage digestibility and value nutrition of the fodder declined. So the best stage for feeding the forage to livestock is GS_2 i.e. prebooting with good quality parameters.

Table 1. Morphological parameters of three sorghum cultivars at different growth stages.

Cultivars	Stem thickness (cm)			Green Fodder Yield (t/ha)			Dry matter Yield (t/ha)		
	GS_1	GS_2	GS_3	GS_1	GS_2	GS_3	GS_1	GS_2	GS_3
JS-2002	0.5de	1.3b	1.7a	1.1d	46.5b	63.3 a	0.4f	15.8c	21.3a
Chakwal Sorghum	0.3e	1.2b	1.2b	1.1d	43.3b	60.67a	0.4f	14.1d	18.9b
Local cultivar	0.3e	0.7d	0.9c	0.9d	38.1c	45.67b	0.3f	12.6e	15.6c
LSD ($P \leq 0.05$)	0.226			3.25			1.417		

Similar letters indicate non-significant difference at $P \leq 0.05$.

Table 2. Chemical composition of three sorghum cultivars at different growth stages (GS).

Cultivars	Neutral detergent Fiber (%)			Acid detergent fiber (%)		
	GS_1	GS_2	GS_3	GS_1	GS_2	GS_3
JS-2002	39g	48.93d	67.37b	21.33g	29.43d	38.77b
Chakwal Sorghum	43.43f	54.26c	71.53a	24.43f	31.8c	41.5a
Local Cultivar	46e	53.27d	72.90a	26.66e	33.26c	41.93a
LSD ($P \leq 0.05$)		2.2			1.77	

Similar letters indicate non-significant difference at $P \leq 0.05$.

Table 3. Chemical composition of three sorghum cultivars at different growth stages (GS).

Treatments	Cellulose			Hemicellulose			Silica		
	GS_1	GS_2	GS_3	GS_1	GS_2	GS_3	GS_1	GS_2	GS_3
JS-2002	17.1e	21.5d	27.6b	17.17f	23.83e	27.77c	1.37f	1.77e	2.9b
Chakwal Sorghum	17.5f	24.5c	30.0a	18.43f	25.5de	31.5b	1.87de	2.13cd	3.43a
Local Cultivar	18.03e	24.83c	30.83a	19.00f	27.20cd	34.3a	1.77e	2.3c	3.57a
LSD ($P \leq 0.05$)	1.53			2.2			0.27		

Similar letters indicate non-significant difference at $P \leq 0.05$.

References

Ashraf Y, Gilani AH, Nagra SA, 1995. Effect of harvesting interval and varieties on the chemical composition of indigenous fodder 1: Proximate composition. *J. Agric. Res.,* **33**: 31-43.

Dabo SM, Taliaferro CM, Coleman SW, Horn FP, Claypool PL, 1988. Chemical composition of old world bluestem grasses as affected by cultivar and maturity. *J. Range Manage..*, **41:** 40-48.

Firdous R, Gilani AH, 2001.. Changes in chemical composition of sorghum as influenced by growth stages and cultivar. *J. Anim. Sci*., **4**: 935-940.

Khan M, Khan M. Idrees M, Muhammad N, Hassnain M, 2007. Screening of sorghum lines for grain and fodder yields under rainfed conditions of Kohat. *Life Sci. Int. J.,* **1:** 421-424.

Malik A FM, Manzoor H, Shahid IA, 2007. Yield response of fodder sorghum (*Sorghum bicolor*) to seed rate and row spacing under rain-fed conditions. *J. Agric. Soc. Sci.*, **3**: 95-97.

Nabi GC, Raiz M, Ahmed G, 2006. Comparisons of some advanced lines of *sorghum bicolor* L. moench for green fodder/ dry matter yield and morpho-economic parameters. *J. Agric. Res*., **44**: 191-197.

Rashid, M, Iqbal M, 2011. Response of sorghum (*Sorghum bicolor* L.) fodder to phosphorus fertilizer on torripsamment soil. *J. Anim. Plant Sci.,* **21**: 220-225.

Singh H, Pushpendra S, Sumerhya HK, 2008. Effect of fertility levels on fodder yield and HCN content of fodder sorghum [*Sorghum bicolor* (L.) Moench] genotypes. *Int. J. Trop. Res*., **26**: 417-420.

Vanderlip RL, Reeves HE, 1972. Growth stages of sorghum [*Sorghum bicolor*, (L.) Moench.]. *Am. J. Agron*., **64**: 13-16.

Zerbini E, Thomas D, 2003. Opportunities for improvement of nutritive value in sorghum and pearl millet residues in south Asia through genetic enhancement. *Field Crop Res.*, **84**: 3-15.