STUDIES ON FODDER YIELD AND QUALITY OF SORGHUM GROWN ALONE AND IN MIXTURE WITH GUARA UNDER DIFFERENT PLANTING TECHNIQUES

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A study on fodder yield and quality of sorghum grown alone and in mixture with guara under different planting techniques was conducted at the Agronomic Research Area, University of Agriculture, Faisalabad during summer 2007. The experiment was laid out in randomized complete block design (RCBD) with three replications. Experimental treatments comprised of sorghum alone sown by broadcast method, guara alone sown by broadcast method, sorghum alone sown in 30cm apart rows, guara alone sown in 30 cm apart rows, blended seed of sorghum and guara sown by broadcast method, blended seed of sorghum and guara sown in 30 cm apart rows, sorghum sown in 30 cm apart rows and guara in between the rows and sorghum sown in 30 cm apart rows and intercropped with guara in crossed rows. Planting techniques significantly affected the growth, yield and qualitative characteristics of fodder sorghum. Sorghum sown in 30 cm apart rows and guara in between the rows produced highest green and dry matter yield due to greater plant density, plant height and number of leaves per plant. Guara sown alone either by broadcast method or in 30 cm apart rows produced significantly higher crude protein percentage and lower crude fibre and ash percentages than all other treatments. Keeping in view both quality and quantity fodder sorghum must be sown in 30 cm apart rows and guara in between the rows.
Keywords: Sorghum, guara, planting technique, forage yield and quality

INTRODUCTION

Sorghum is intensively grown in Pakistan but mainly under rainfed conditions both for forage and grain purposes. It ranks fourth among the major cereals after wheat, rice and maize. With the introduction of high yielding hybrids, the crop has also gained importance in the irrigated areas as well. Although the soil and climatic conditions of Pakistan are favorable for sorghum production but it's per hectare average forage yield is very low and is also considered inferior in quality due to low protein contents and presence of hydrocyanic acid (Hingra *et al*., 1995). It is therefore imperative to improve both forage yield and quality of sorghum.

Due to rapid increase in population and reduction in cultivated area, horizontal increase in fodder production is not possible, but the only way is to increase its yield on per unit basis. Non-legume intercropped with legume significantly increased the total mixed green forage yield, and crude protein content of mixed forage (Iqbal *et al*., 2006). Growing legumes and non-legumes together also improves the fodder palatability and digestibility (Chaudhary and Hussain, 1985). Mixed cropping of cereal with legumes fodder is a good option to increase the quality of cereal fodder (Khandaker, 1994). While mixed cropping also ensures against the total crop failures under adverse environmental conditions or pest epidemics and increases total productivity per unit land area and judicially utilizes land resources and farming inputs including labour (De and Sing, 1979).

The development of sustainable and economically viable intercropping system largely depends on planting pattern of the crop grown in association with each other. The interaction between planting geometry and associated legumes culture has great importance in crop productivity. Hussain *et al*. (1999) reported that sorghum inter cropped with guara or cowpea gave the highest fresh and dry matter yield of sorghum when two rows strips of sorghum were intercropped with three rows of guara. Superior intercropped sorghum yield and land use efficiency were obtained when component crops were arranged in alternate rows at 90 cm spacing but no yield benefit was observed when crops were arranged in an alternate row pattern at narrow row spacing of 45 cm (Ayisi *et al*., 2001).

Keeping in view the above facts, the present study was, therefore, designed to evaluate the impact of different planting techniques on fodder yield and quality of sorghum when sown alone and in mixture with guara.

MATERIAL AND METHODS

Field studies to ascertain the effect of different planting techniques on growth, yield and quality of forage sorghum when grown alone and in mixture with guara were carried out at the Agronomic Research Area, University of Agriculture, Faisalabad. The experimental treatments comprised of sorghum alone sown by broadcast method, guara alone sown by broadcast method, sorghum alone sown in 30cm apart rows, guara alone sown in 30 cm apart rows, blended seed

of sorghum and guara sown by broadcast method, blended seed of sorghum and guara sown in 30 cm apart rows, sorghum sown in 30 cm apart rows and intercropped with guara in between the rows and sorghum sown in 30 cm apart rows and intercropped with guara in crossed rows. The experiment was laid out in randomized complete block design, using three replications and having a net plot size of 1.8 x 6m. Sorghum and guara were sown at seed rate of 80 and 62 kg ha^{-1}, respectively. Same seed rates were combined in case of sowing with blended seed. Sowing was done in second week of June. The nitrogen and phosphorus were applied in the form of Urea and Diammonium Phosphate at the rate of 250 and 125 kg ha^{-1}, respectively. Full dose of phosphorus and half dose of nitrogen were applied at sowing and remaining half dose of nitrogen was applied with first irrigation. All other agronomic practices except those under studies were kept normal and uniform for all the treatments. Ten plants were selected at random from each plot for recording individual plant observations like plant height, stem diameter and number of leaves $plant^{-1}$ of sorghum. Stem diameter was measured with the help of vernier caliper from the base, middle and top position and averages were recorded. Quality parameters like crude protein, crude fibre and crude ash were determined using the standard methods of analysis (AOAC., 1984). The data on growth, yield and quality parameters were analyzed by Fisher's analysis of variance technique and least significant test at 0.05 probability level was employed to compare the treatment means (Steel *et al*., 1997).

RESULTS AND DISCUSSION

Plant density (m^{-2})

Significant differences in plant population were observed among different geometrical patterns (Table-1). Maximum plant population ($277m^{-2}$) was recorded when sorghum was sown in 30 cm apart rows and intercropped with guara in between the rows and it was significantly higher than all other treatments. Cross sowing and sowing in 30cm spaced rows with blended seed produced statistically similar plant population. The minimum plant density (m^{-2}) was obtained when guara was broadcasted alone and was statistically similar with sowing of blended seed by broadcast method. Significant difference of sowing techniques on plant population has also been reported by Singh and Singh (2004). The reason of obtaining low plant density in case of broadcast method might have been the unequal depth of sowing. Some seeds might have gone too deep in the soil and may not be able to emerge out of the soil and some seeds might have been taken away by ants and birds because they may have not been properly covered by the soil.

Plant height of sorghum (cm)

The data given in Table 1 showed that sorghum plant height was significantly affected by the planting techniques. The sorghum sown alone by broadcast method produced taller plants and was significantly different from all the other treatments except sorghum sown alone in 30 cm apart rows where the height of plants were statistically similar. The differences between treatment of blended seed sown in 30 cm apart rows (T_6) and sorghum sown in 30 cm apart rows and guara in between the rows (T_7) were also not significant. The minimum plant height of sorghum (174.66cm) was observed when sorghum was sown in 30 cm apart rows and guara cross the rows but was statistically similar with (T_5). The maximum plant height in case of sole crop of forage sorghum may be due to

Table 1. Growth characteristics of sorghum as influenced by different planting techniques and mix sowing with guara

Treatment	Total plant density (m^{-2})	Plant height of sorghum (cm)	No. of leaves $plant^{-1}$ of sorghum	Stem diameter of sorghum
T_1 (Sorghum sown alone by broadcast method)	76.67 d	206.30 a	10.99 a	0.93 ab
T_2 (Guara sown alone by broadcast method)	41.00 e			
T_3 (Sorghum sown alone in 30 cm apart rows)	199.70 c	204.36 ab	10.88 a	0.98 a
T_4 (Guara sown alone in 30 cm apart rows)	208.00c			
T_5 (Blended seed sown by broadcast method)	60.67 de	181.30 cd	9.22 b	0.84 bc
T_6 (Blended seed sown in 30 cm apart rows)	232.00 b	186.91 c	10.44 a	0.75 c
T_7 (Sorghum sown in 30 cm apart rows, and guara in between rows)	277.00 a	193.08 bc	11.33 a	0.82c
T_8 (Sorghum sown in 30 cm apart rows and guara cross the rows)	252.00 b	174.66 d	9.44 b	0.78 c
LSD	22.15	11.34	0.88	0.94

Any two means not sharing a letter in common differ significantly at 5% probability level (LSD).

better penetration of light, circulation of air and comparatively more nutritional area available to sole corp. similarly decrease in plant height of sorghum in mixture intercropping and cross sowing with guara may be due to the competition offered by intercrop for different environmental resources which suppressed the growth of companion sorghum crop. The results are quite in line with those of Ahmed *et al.* (2007).

Number of leaves of sorghum plant^{-1}

Leaves play a positive role in the yield of forage crops. Sorghum sown in 30 cm apart rows and intercropped with guara in between the rows produced the maximum number of leaves plant^{-1} (11.33) but it remained at par when sorghum alone sown by broadcast method, sorghum alone sown in 30 cm apart rows and sowing of blended seed in 30cm apart rows. Minimum numbers of leaves (9.22) were obtained when blended seed was sown by broadcast method and it was statistically similar to sorghum sown in 30cm apart rows and intercropped with guara in crossed rows. The reason for having lower number of leaves in these treatments might have been due to poor air circulation that might have resulted in more competition for CO_2. Keerio and Singh (1985) have also reported significant effect of intercropping on number of leaves plant^{-1}.

Stem diameter of sorghum (cm)

Stem diameter has inverse relationship with quality. The sorghum sown alone in 30 cm apart rows produced significantly thicker stems (0.98 cm) than all the remaining treatments except the sorghum sown alone by broadcast method. The difference between sorghum sown alone by broadcast method and blended seed sown by broadcast method was not significant. The minimum stem diameter (0.75 cm) was noted when blended seed was sown in 30 cm apart rows. The reason for having thicker stems in case of sorghum sown alone either by broadcast method or line sowing can be attributed to less competition and better air circulation. Significant effects of sowing techniques on stem diameter have also been reported by Hong *et al*. (1987).

Forage yield (t ha^{-1})

The planting technique significantly affected the green forage yield (Table-2). Sorghum sown in 30 cm apart rows and intercropped with guara in between the rows remaining at par with blended seed sown in 30 cm apart rows produced significantly higher forage yield than all other treatments. The difference between blended seed sown in 30cm apart rows and sorghum sown in 30cm apart rows and guara cross the rows were not significant. The minimum green forage yield was obtained when blended seed was sown by broadcast method and it remained at par to sorghum sown alone by broadcast method. The higher yield obtained in case of sorghum sown in 30 cm apart rows and guara cross the rows can be attributed to higher plant density m^{-2}. Significant effects of sowing techniques on forage yield have been reported before by Yadav and Solanki (2002) and Ahmed *et al*. (2007).

Dry matter yield (t ha^{-1})

The effect of different planting techniques on dry matter yield was almost similar as was observed for green fodder yield (Table-2). Sorghum sown in 30 cm apart rows and intercropped with guara in between the rows and blended seed sown in 30 cm apart rows produced statistically similar dry matter yield but was significantly higher than the remaining treatments. The sorghum sown in 30 cm apart rows and guara across the rows occupied the third position regarding dry matter yield. The minimum dry matter yield was recorded when sorghum was sown alone by broadcast method and it was statistically similar to guara sown alone by broadcast method. The results are quite in line with those of Ahmad *et al*. (2006) who reported that intercropping significantly affected the forage yield of sorghum but these results are contradictory to those of Khot *et al*. (1992). They reported that maize sown in pure stand produced higher dry matter yield than in mixed stand. These contradictory results can be attributed to differences in soil fertility, climatic conditions and crop traits.

Crude protein (%)

Protein content which is considered one of the most important parameter affecting the palatability and nutritional value of forage crops. The treatments containing guara produced significantly higher crude protein contents than the sorghum sown alone either by broadcast method or in 30 cm apart rows. Guara sown alone by broadcast method produced significantly higher crude protein contents (20.32 %) than all other treatments and it was followed by guara sown alone in 30 cm apart rows, which produced protein contents of 17.82 %. The sorghum sown alone by broadcast method or in 30 cm apart rows produced statistically similar crude protein percentage but significantly lower than all other treatments. The reason of higher crude protein contents in those treatments having guara either alone or in mixture with sorghum sown by any technique than the sole sorghum is simply due to the leguminous nature of the guara. The leguminous crops generally have higher crude protein contents. Higher crude protein contents from mixture of non-legume and legume have been reported by Reddy *et al*. (1986).

Table-2. Yield and quality parameters of fodder sorghum as influenced by different planting technique and mix sowing with guara

Treatment	Green fodder yield (t ha^{-1})	Dry matte yield (t ha^{-1})	Crude protein (%)	Crude fibre (%)	Ash %)
T_1 (Sorghum sown alone by broadcast method)	27.12 f	8.07 e	11.08 e	20.95 bc	10.39 a
T_2 (Guara sown alone by broadcast method)	32.57 e	9.14 e	20.32 a	14.22 e	8.23 f
T_3 (Sorghum sown alone in 30 cm apart rows)	60.09 c	18.21 c	11.05 e	19.03 d	10.06 b
T_4 (Guara sown alone in 30 cm apart rows)	47.67 d	13.31 d	17.82 b	14.01 e	8.05 g
T_5 (Blended seed sown by broadcast method)	26.22 f	19.47 c	12.38 d	21.45 ab	9.39 e
T_6 (Blended seed sown in 30 cm apart rows)	78.27 ab	24.87 a	12.82 d	21.51 ab	9.50 d
T_7 (Sorghum sown in 30 cm apart rows, and guara in between rows)	80.70 a	25.78 a	13.98 c	21.77 a	9.63 c
T_8 (Sorghum sown in 30 cm apart rows and guara cross the rows)	75.44 b	23.46 b	13.71 c	20.48 c	9.43 de
LSD	4.619	1.372	0.446	0.645	0.072

Any two means not sharing a letter in common differ significantly at 5% probability level (LSD).

Crude fibre (%)

The planting techniques significantly affected the crude fibre contents (Table 2). The sorghum sown in 30 cm apart rows and intercropped with guara in between the rows (T_7) remaining at par with blended seed sown either by broadcast method or in 30 cm apart rows produced significantly higher crude fibre contents than all other treatments. The guara sown alone by broadcast method or in 30 cm apart rows produced statistically similar crude fibre contents but significantly lower than all other treatments. The maximum crude fibre contents (21.77 %) were observed when sorghum was sown alone in 30 cm apart rows and intercropped with guara in between the rows. The crude fibre contents are mainly influenced by growth stage at harvest time. The significant differences indicated that there might have been differences in growth stage among the treatment at the time of harvest. The treatments having higher crude fibre contents might have been in more advanced stage than those treatments having less crude fibre contents. The low crude fibre percentage in legumes than in cereal-legumes mixtures and cereal alone has been reported by Ibrahim *et al*. (2006).

Ash (%)

The ash contents were influenced significantly by the treatments under study (Table 1). The treatments containing guara sown by any technique produced significantly lower ash percentage than all other treatments. While sorghum sown alone by broadcast method produced significantly higher ash percentage than all other treatments and it was followed by sorghum sown alone in 30cm apart rows. These results indicated that sorghum sown alone by any technique have better ability to absorb nutrients than sown in mixture with guara by using any sowing technique. The results are contradictory to those of Ayub *et al*. (2004). These contradictory results might have been due to differences in legume species or variation in soil fertility status.

CONCLUSION

Based on the present studies it can be concluded that for obtaining higher forage yield of good quality, sorghum should be sown in 30 cm apart rows and intercropped with guara in between the rows.

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