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FORAGE YIELD AND QUALITY OF NEWLY EVOLVED GENOTYPE CHINESE SWEET SORGHUM GROWN ALONE AND IN ASSOCIATION WITH COWPEA

Asif Iqbal, Muhammad Umer Chattha*, Imran Khan, Muhammad Umair Hassan [1], Muhammad Bilal Chattha [2], Amina Iftikhar [1] and Mina Kharal [3]

[1] Department of Agronomy, University of Agriculture, Faisalabad, [2] Institute of Agricultural Sciences, University of the Punjab, Lahore,
[3] Department of Management Sciences, National Textile University, Faisalabad, Pakistan.
*Corresponding author e-mail: umer1379@gmail.com

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ABSTRACT

A field experiment was conducted in the Department of Agronomy, University of Agriculture, Faisalabad, Pakistan to study the forage yield and quality of newly evolved Chinese sweet sorghum genotype grown alone and in association with cowpea. Chinese sweet sorghum was grown alone and in combination with cowpea in 30 cm apart rows as intercrop, mixed cropping, 2:1 lines of Chinese sweet sorghum and cowpea, 50:50 seed ratio and 75:25 seed ratio of Chinese sweet sorghum and cowpea, respectively and also by broadcast method. The results revealed a significant effect of sowing techniques on the forage yield and quality. The intercropping of sorghum and cowpea performed relatively better than the sowing of sole crops. However, blended seeds of Chinese sweet sorghum+cowpea sown in 30 cm apart rows produced maximum total green forage yield (47.23 t ha^{-1}), total dry matter yield (6.40 t ha^{-1}), protein percentage (27.08%) and less fibre contents as compared to the rest of treatments. In conclusion, blended seeds of Chinese sweet sorghum+cowpea sown in 30 cm apart can be a preferable practice for the farmers of semi-arid regions to get maximum forage and dry matter yield.

KEYWORDS: *Sorghum bicolor; Vigna unguiculata;* sorghum; cowpea; mixed cropping; feed crop; yield; quality; Pakistan.

INTRODUCTION

In Pakistan, forage shortage is continuously on rise and area under fodder crops is decreasing @ 2% per decade (Sarwar *et al.,* 2002). If the total available feed from all sources is compared with the normal appetite of the animals, inescapable conclusion is that on an average the animals are undernourished. The deficit is estimated at 30 to 50% of their requirement in terms of nutrients (Anon., 1996). The shortage in quality and quantity of animal feed causes low reproductive and production performance of animals (Malede, 2013). Most important restraining reason in favor of a prosperous production of livestock is fodder insufficiency. In Pakistan, existing feed production is about 52-54% which is less than the actual requirement of livestock (GOP, 2013).

Intercropping would be an advantageous method for crop production. It can be defined as the raising of two or more crops at the same time on same land area (Usman *et al.,* 2006). Its most important advantages are enhanced land use efficiency, maximum green forage total yield (Dhima *et al.,* 2007), improved consumption of nutrients and light and water (Javanmard *et al.,* 2009). Similarly, consistency of yield in cropping scheme (Lithourgidis *et al.,* 2007) offers an improved exploitation of labour and natural resources, against collapse of single crop. It also provides protection and gives higher return on unit area basis and superior yield (Usman *et al.,* 2006). Weed and pest control (Banick *et al.,* 2006; Vasilakoglon *et al.,* 2008) can also be achieved by intercropping systems particularly in cereals and legume intercropping. Monocultures are often associated with risks of crop failure that can be lowered by adopting cereal-legume intercropping (Tsubo *et al.,* 2005). Land equivalent ratio (LER) shows more proficient utilization of space by intercrops than sole cropping. Intercropping also results in more competent consumption of soil moisture by intercrops than monoculture of crops (Sani *et al.,* 2011).

Sorghum (*Sorghum bicolor* L.) is a summer season crop. It is a short-day, annual and with C_4 photosynthetic pathway plant (Balole and Legwaila, 2006). It comparatively grows best in radiance environment and high temperature (Dahlberg, 2000). Sorghum can be grown successfully throughout Pakistan both under irrigated and rainfed conditions (Khan *et al.,* 2013). In Pakistan, it is grown on an area of 0.197 million hectares with annual production of 0.122 million tons (Govt. of Pakistan, 2013).

Cowpea (*Vigna unguiculata* L.) is an important legume all over tropics as well as subtropics, including Asia, Africa, Central and South America. It is cultivated mainly in rainfed areas, however it can also be grown in irrigated planes. It is mainly used as livestock feed. Cowpea is the only accessible higher quality legume used for hay making for livestock feed in most of the areas of world. Moreover, it is used at the same time as a nitrogen fixing crop, green manure and also cultivated to control erosion. Almost 70–350 kg N ha^{-1} can be fixed by cowpea from the atmosphere in association with nodule bacteria (*Bradyrhizobium* spp.) and 40–80 kg N ha^{-1} per year soil is replenished by it, that makes it a rich forage, potent soil amendment, green manure and cover crop (Muhammad, 2011).

Sorghum grown in combination with cowpea provided the highest dry matter percentage, fresh weight per plant and total green fodder yield alongwith protein content (Abbas, 2005). Intercroping of sorghum and cowpea gave the highest green forage and dry matter yield. It also provided maximum land equivalent ratio, cost benefit ratio and net returns, when grown in five different combinations of sorghum and cowpea monocultures, natural vegetation as control treatment and sorghum + cowpea in 4:2 and 4:3 row ratio (Patel and Rajagopal, 2002). Intercropping of sorghum with cowpea exhibit enhanced land equivalent ratio and competitive indices values conferred greater income, improved land use efficiency as well as increase the sustainability of crop productivity in 2:1 planting arrangement of sorghum and cowpea, respectively as compared to sole crop (Oseni, 2010).

Present study was planned to find out the effect of intercropping cowpea with newly introduced genotype of sorghum Chinese sweet sorghum grown in different seed ratios and row arrangements on forage yield and its quality parameters under agro-ecological conditions of Faisalabad.

MATERIALS AND METHODS

A field experiment was conducted in the Department of Agronomy, University of Agriculture, Faisalabad, Pakistan during the year 2013. The area is located at 73^{o}E, 31 N, and at an altitude of 184.4 m. Crop was sown on 20^{th} June 2013. For physio-chemical analysis of experimental soil, composite and representative soil samples to a depth of 0-20 cm were obtained with soil auger. Soil samples were analyzed for its various physio-chemical properties using standard procedures (Homer and Pratt, 1961). The soil was loamy having pH_s 7.7, EC_e 1.2 dS m^{-1}, organic matter 0.78%, total available nitrogen 0.048%, phosphorus 8.8 ppm and potassium 130 ppm. The experiment was laid out in RCBD with three replications. Net plot size was 2.7 x 8 m. It comprised following treatments,

T_1 = Chinese sweet sorghum sown alone in 30 cm apart rows.
T_2 = Cowpea sown alone in 30 cm apart rows.
T_3 = Blended seeds of Chinese sweet sorghum+cowpea sown by broadcast method,

T_4 = Blended seeds of Chinese sweet sorghum+cowpea sown in 30 cm apart rows.

T_5 = Sowing of Chinese sweet sorghum in 30 cm apart rows and intercropped with cowpea.

T_6 = Sowing of Chinese sweet sorghum in 30 cm apart rows and cowpea sown across the rows.

T_7 = Chinese sweet sorghum + cowpea planting in 2:1 row ratio.

T_8 = Chinese sweet sorghum + cowpea planting in 2:2 row ratio.

T_9 = Chinese sweet sorghum + cowpea mixed planting in 50:50 seed ratio in 30 cm apart rows.

T_{10} = Chinese sweet sorghum + cowpea mixed planting in 75:25 seed ratio in 30 cm apart rows.

The seed bed was prepared by cultivating the field for 3-4 times with tractor mounted cultivator, each followed by planking. Then the plots were laid out according to the layout plan. Bold and healthy seeds of both crops were selected for sowing. The seed rate of 75 and 30 kg ha^{-1} for sorghum and cowpea was used, respectively. Same seed rates were combined in case of sowing with blended seed. The seeds were sown in each plot 4-5 cm deep with single row hand drill (pora method). The recommended dose of fertilizer @ 87:57 kg ha^{-1} N and P_2O_5, was applied to sorghum and cowpea. Nitrogen and phosphorus were applied in the form of urea and DAP, respectively. Half of N and the entire quantity of P_2O_5 were applied at the time of sowing while remaining N dose was top dressed 20 days after sowing.

Three irrigations were applied overall during the growing season. All other agronomic practices except those under observation were kept normal and uniform for all treatments. To keep the crop free of weeds, one hand weeding was carried out. Crops were harvested at the completion of vegetative growth of sorghum and cowpea on 23rd August (64 days after sowing). Standard procedures were followed to evaluate growth and yield parameters. A chemical analysis of samples was carried out for quality evaluation following procedures of AOAC (1990). The data collected on all parameters were analyzed statistically using Fisher's analysis of variance technique and treatments means were compared at 5% probability level.

RESULTS AND DISCUSSION

Plant population

Different sowing techniques of intercropping showed a significant effect on plant population of sorghum and cowpea. Maximum plant population of sorghum (41.53 plants m^{-2}) was recorded in T_1 where it was sown alone in 30 cm apart rows while, minimum number of plants (18.20 m^{-2}) was recorded in T_9 (Chinese sweet sorghum+cowpea mixed planting in 50:50 seed ratio in 30 cm apart rows) (Table 1). The difference in plant population possibly may be due to half seed rate of recommended seed rate. These results are in accordance to Ibrahim *et al.,* (2006) who reported that maximum plant population of maize was achieved in case of pure crop than intercrop. Iqbal (2013) also found more plant population in sole cropping of pearl millet in 30 cm apart rows than intercropping with cowpea and guara. Similarly, in case of cowpea, maximum plant population (40.43 plants m^{-2}) was recorded from those plots where sorghum+cowpea planting was done in 2:2 row ratios (T_8), whereas minimum population (11.13 plants m^{-2}) was recorded in T_{10} (Chinese sweet sorghum+cowpea mixed planting in 75:25 seed ratio in 30 cm apart rows) (Table 2). This may be due to the use of less seed as compared to other treatments. These results are in line with those of Ayub and Shoaib (2009) who noted higher plant population in legume-cereal combinations than sole cropping.

Plant height

Significant differences in plant height of sorghum and cowpea were also observed due to effect of different sowing techniques of intercropping. Maximum plant height (201.13 cm) of sorghum was observed where Chinese sweet sorghum+cowpea was planted in 2:1 row ratio (T_7), against minimum plant height of sorghum (157.73 cm) in those plots where blended seeds of Chinese sweet sorghum+cowpea were sown by broadcast method (T_3) (Table 1). Similarly, maximum plant height (224.23 cm) of cowpea was also achieved in T_7 (sorghum+cowpea planted in 2:1 row ratio) against minimum plant height of cowpea in T_4

Table 1. Growth and yield response of sorghum sown alone and in association with cowpea with different planting techniques

Treatments	Plant population (m^{-2})	Plant height (cm)	No. of leaves/ plant	Green forage yield (t ha^{-1})	Dry matter yield (t ha^{-1})
T_1	41.53 a	184.93 ab	12.07 ab	40.20 a	5.53 a
T_2	-	-	-	-	-
T_3	27.42 c	157.73 c	10.27 c	18.21g	2.49 g
T_4	34.43 b	188.33 ab	11.33 bc	39.04 ab	5.34 ab
T_5	24.67 c	191.00 ab	12.07 ab	34.25 cd	4.66 cd
T_6	25.13 c	194.80 ab	11.53 bc	32.09 de	4.43 d
T_7	35.57 b	201.13 a	12.87 a	36.88 bc	5.05 bc
T_8	28.23 c	177.77 b	10.27 c	24.85 f	3.35 f
T_9	18.20 d	193.33 ab	11.93 ab	29.60 e	3.99 e
T_{10}	32.90 b	197.87 a	10.27 c	36.26 bc	4.85 cd
LSD ($P \leq 0.05$)	3.67	17.21	1.29	3.01	0.42

Means sharing the same letter for a single parameter do not differ significantly at $P \leq 0.05$.

Table 2. Growth and yield response of cowpea sown alone and in association with sorghum with different planting techniques.

Treatments	Plant population (m^{-2})	Plant height (cm)	No. of leaves/plant	Green forage yield (t ha^{-1})	Dry matter yield (t ha^{-1})
T_1	-	-	-	-	-
T_2	40.10 a	155.60 f	72.00 b	34.26 a	4.65 a
T_3	21.77 d	183.27 d	92.33 a	13.12 b	1.74 b
T_4	18.77 d	152.87 f	36.53 f	8.19 c	1.06 c
T_5	34.59 b	162.87 ef	46.73 e	7.94 c	1.07 c
T_6	30.33 c	178.13 de	32.87 g	8.66.c	1.16 c
T_7	36.77 b	224.23 a	52.07 d	7.33 c	0.99 c
T_8	40.43 a	201.20 bc	43.27 e	7.40 c	1.00 c
T_9	14.77 e	204.20 b	74.67 b	9.10 c	1.25 c
T_{10}	11.13 f	186.87 cd	66.20 c	3.24 d	0.44 d
LSD ($P \leq 0.05$)	3.16	16.58	3.55	3.24	0.43

Means sharing the same letter for a single parameter do not differ significantly at $P \leq 0.05$.

T_1:Chinese sweet sorghum sown alone in 30 cm apart rows, T_2:Cowpea sown alone in 30 cm apart rows, T_3:Blended seeds of Chinese sweet sorghum+cowpea sown by broadcast method, T_4:Blended seeds of Chinese sweet sorghum+cowpea sown in 30 cm apart rows, T_5:Sowing of Chinese sweet sorghum in 30 cm apart rows and intercropped with cowpea, T_6:Sowing of Chinese sweet sorghum in 30 cm apart rows and cowpea sown across the rows, T_7:Chinese sweet sorghum + cowpea planting in 2:1 row ratio, T_8:Chinese sweet sorghum + cowpea planting in 2:2 row ratio, T_9:Chinese sweet sorghum + cowpea mixed planting in 50:50 seed ratio in 30 cm apart rows, T_{10} : Chinese sweet sorghum + cowpea mixed planting in 75:25 seed ratio in 30 cm apart rows

(152.87cm) in (Table 2). Ayub *et al.* (2004) also observed significant effects of mixed cropping on plant height.

Number of leaves per plant

Different sowing techniques of intercropping had a significant effect on number of leaves per plant of sorghum and cowpea. Maximum number of leaves per plant of sorghum (12.87) was observed in T_7 (Chinese sweet sorghum+cowpea planting in 2:1 row ratio) (Table 1) while minimum number of leaves per plant (10.27) was observed in T_3, T_8 and T_{10} (Table 1). However, in case of cowpea maximum number of leaves per plant (92.33) was achieved in T_3 where blended seeds of Chinese sweet sorghum+cowpea were sown by broadcast method (Table 2). Minimum number of leaves (32.87) was recorded in T_6 where Chinese sweet sorghum was sown in 30 cm apart rows and cowpea sown across the rows (Table 2). These results are similar to those reported by Ayub *et al.* (2004) who found a significant effect on number of leaves per plant of both sole legume and legume + non-legume collectively.

Green forage yield

Intercropping of sorghum and cowpea under different sowing techniques had significant effect on green forage yield of sorghum. Maximum green forage yield of sorghum crop (40.20 t ha^{-1}) was obtained in T_1 where sole crop of sorghum was sown in 30 cm apart rows (Table 1), while minimum yield was recorded in T_3 (18.21 t ha^{-1}) where blended seeds of Chinese sweet sorghum+cowpea was sown by broadcast method. Yield reduction in broadcast plot may be due to uneven distribution of seed or due to the early germination of legume than sorghum which dominated later. Similarly, maximum green forage yield of cowpea (34.26 t ha^{-1}) was recorded in T_2 where Cowpea sown alone in 30 cm apart rows (Table 2). Minimum yield (3.24 t ha^{-1}) was recorded in T_{10} (Chinese sweet sorghum + cowpea mixed planting in 75:25 seed ratio in 30 cm apart rows) (Table 2). Reduction in yield in all intercropping techniques was due to shading effect of sorghum over cowpea or due to structure of crop. These results are supported by Kadam *et al.* (2005) who reported maximum sorghum yield within sole crop while compared to sorghum grown in association with soybean in different row ratios. Similarly, Jhansi (2004) also observed the highest green forage yield in monoculture of sorghum followed by sorghum intercropped with cowpea.

Dry matter yield

Highly significant effect of different sowing techniques of intercropping was observed on dry matter yield of sorghum and cowpea. Maximum dry matter yield of sorghum (5.53 t ha^{-1}) was recorded in T_1 (Chinese sweet sorghum sown alone in 30 cm apart rows) against minimum dry matter yield (2.49 t ha^{-1}) in T_3 where blended seeds of Chinese sweet sorghum+cowpea were sown by broadcast method (Table 1). Similarly, considerable increase in dry matter yield of sole sorghum and sorghum coupled with soybean was observed by Singh and Jadhav (2003). In case of cowpea maximum dry matter yield (4.65 t ha^{-1}) was obtained in T_2 where cowpea was sown alone in 30 cm apart rows, while minimum yield (0.44 t ha^{-1}) was recorded in T_{10} where Chinese sweet sorghum + cowpea mixed planting in 75:25 seed ratio in 30 cm apart rows was done (Table 2). Monoculture of cowpea gave maximum dry matter yield as compared to intercrop. The results indicate that plant growth and stress is reduced due to increase in planting densities, while growth of cowpea plant is negatively influenced by intercropping (Moriri *et al.,* 2010).

Total green forage yield

Significant effect of different sowing techniques on total green forage yield of both crops was observed. Maximum total green forage yield (47.23 t ha^{-1}) was obtained in T_4 (blended seeds of Chinese sweet sorghum+cowpea sown in 30 cm apart rows), while minimum green forage yield (32.25 t ha^{-1}) was recorded in T_8 (Chinese sweet sorghum+cowpea planted in 2:2 row ratio) (Table 3). Intercropping increased the green forage yield in mixed cropping. Iqbal *et al.* (2006) also reported that fresh forage yield was increased by intercropping. Moreover, Ram and Singh (2001) reported that sorghum intercropped with cowpea showed considerable higher forage yield.

Total dry matter yield

Different sowing techniques of intercropping had significant effect on total dry matter yield. Maximum total dry matter yield (6.40 t ha^{-1}) was obtained in T_4 (blended seeds of Chinese sweet sorghum+cowpea sown in 30 cm apart rows) (Table 3). Minimum dry matter production (4.24 t ha^{-1}) was attained in T_3 (blended seeds of Chinese sweet sorghum+cowpea sown by broadcast method). These results are in confirmity with those of Ibrahim *et al.* (2006) who reported that maize sown alone or in mixture with guara in different seed proportions showed a significant difference in dry matter. Ram and Singh (2003) also reported that forage yield of sorghum was significantly affected by intercropping. Ayub and Shoaib (2009) also reported similar results that intercropping had a significant effect over sole cropping. However, these results are in contradiction with Khot *et al.* (1992) who found more dry matter yield in sole cropping of maize than in mixtures. This contradiction may be due to differences in climatic conditions and soil fertility in addition to crop's traits/ genetics.

Table 3. Total green forage yield and quality attributes of sorghum sown alone and in association with different planting techniques.

Treatments	Fresh forage yield ($t\ ha^{-1}$)	Dry matter yield ($t\ ha^{-1}$)	Crude protein (%)	Crude fibre (%)	Ash (%)
T_1	40.20 bc	5.53 bc	9.49 g	25.92 f	9.11 g
T_2	34.26 d	4.65 d	22.12 c	16.87 g	16.22 f
T_3	31.33 d	4.24 d	18.37 f	42.14 f	25.56 c
T_4	47.23 a	6.40 a	27.08 a	44.69 c	26.45 b
T_5	42.20 bc	5.73 bc	21.87 c	45.94 b	28.003 a
T_6	40.75 bc	5.59 bc	24.60 b	57.65 a	25.99 bc
T_7	44.21 ab	6.04 ab	17.74 f	42.50 e	22.66 e
T_8	32.25 d	4.35 d	18.95 ef	44.57 cd	26.66 b
T_9	38.70 c	5.24 c	21.49 cd	45.18 c	23.99 d
T_{10}	39.51 c	5.29 c	20.27 de	43.91 d	26.44 b
LSD ($P \leq 0.05$)	4.30	0.57	1.48	0.68	0.77

Means sharing the same letter for a single parameter do not differ significantly at $P \leq 0.05$.

T_1:Chinese sweet sorghum sown alone in 30 cm apart rows, T_2:Cowpea sown alone in 30 cm apart rows, T_3:Blended seeds of Chinese sweet sorghum+cowpea sown by broadcast method, T_4:Blended seeds of Chinese sweet sorghum+cowpea sown in 30 cm apart rows, T_5:Sowing of Chinese sweet sorghum in 30 cm apart rows and intercropped with cowpea, T_6:Sowing of Chinese sweet sorghum in 30 cm apart rows and cowpea sown across the rows, T_7:Chinese sweet sorghum + cowpea planting in 2:1 row ratio, T_8:Chinese sweet sorghum + cowpea planting in 2:2 row ratio, T_9:Chinese sweet sorghum + cowpea mixed planting in 50:50 seed ratio in 30 cm apart rows, T_{10} : Chinese sweet sorghum + cowpea mixed planting in 75:25 seed ratio in 30 cm apart rows

Total crude protein contents

A significant effect of sowing techniques of intercropping was observed. Maximum crude protein contents (27.08 %) were recorded in T_4 (blended seeds of sorghum + cowsepea sown in 30 cm apart rows) (Table 3). Minimum crude protein contents (9.49%) were recorded in T_1 (Chinese sweet sorghum sown alone in 30 cm apart rows) (Table 3). Similar results have also been reported by Ngongoni *et al.,* (2007) who recommended that intercropping of cereals and legumes increased the forage quality particularly, the crude protein contents of the cereals on clay soils. Ram and Singh (2003) and Iqbal (2013) also reported a substantial increase in crude protein contents by growing cereal-legume mixtures.

Total crude fibre contents

Fibre contents usually increase with progress in growth of crop. Effect of different sowing techniques on fibre percentage of both crops was statistically significant. Maximum fibre contents (57.65%) were obtained from T_6 where Chinese sweet sorghum was sown in 30 cm apart rows and cowpea sown across the rows (Table 3). Similarly, minimum fibre contents (16.87%) were obtained in T_2 (cowpea sown alone in 30 cm apart rows). These results do not agree to those of Ayub *et al.* (2004) who reported higher crude fibre contents in sorghum sown alone than sorghum intercropped with cowpea. Low fibre percentage is present in legumes than cereal alone and legume-cereal mixtures (Ibrahim *et al.,* 2006).

Total ash contents

The highly significant effect of different intercropping techniques was observed on total ash percentage. Maximum ash (28.003%) was recorded in T_5 where sowing of Chinese sweet sorghum was done in 30 cm apart rows and intercropped with cowpea. Minimum ash contents (9.11%) were recorded in T_1 (Chinese sweet sorghum sown alone in 30 cm apart rows). Similar findings have been reported by Ayub *et al.* (2004) who found higher ash percentage in mixture of sorghum and ricebean. Similarly, Iqbal (2013) also found maximum ash percentage in mixture of pearl millet and cluster bean than sole cropping of millet.

CONCLUSION

The study concludes that blended seeds of Chinese sweet sorghum in association with cowpea in 30 cm apart rows improved the productivity of cereal fodders like sorghum instead of broadcast method under agro-ecological conditions of Faisalabad.

REFERENCES

Abbas, M. 2005. Studies on growth, yield and quality of sorghum fodder sown alone and with legumes in different geometrical patterns. M.Sc. (Hons.) Thesis, Deptt. Agron., Univ. Agri., Faisalabad.

Anon. 1996. Fodder production in Pakistan. Pakistan Agricultural Research Council, Islamabad and Food and Agricultural Organization, Islamabad. Pp. 9.

Ayub, M. and M. Shoaib. 2009. Studies on fodder yield and quality of sorghum grown alone and in mixture with guara under different planting techniques. Pak. J. Agri. Sci. 46: 25- 29.

Ayub, M., A. Tanveer, M.A. Nadeem and S. M. A.Shah. 2004. Studies on the fodder yield and quality of sorghum grown alone and in mixture with rice bean. Pak. J. Life Soc. Sci. 2: 46-48.

Balole, T. V., G. M. Legwaila. 2006. *Sorghum bicolor* (L.) Moench. Record from Protabase. Brink, M. and G. Belay, (eds). PROTA (Plant Resources of Tropical Africa / Ressources végétales de l'Afrique tropicale), Wageningen, Netherlands.

Banik, P., A. Midya, B.K. Sarkar and S.S. Ghose. 2006. Wheat and chickpea intercropping systems in an additive series experiment: advantages and weeds mothering. Eur. J. Agron., 24: 325–332.

Dahlberg, J. 2000. Classification and characterization of sorghum. p. 99-130. *In:* Smith, C.W. and R. A. Frederiksen (eds.). Sorghum Origin, History and Production. John Wiley Publishers, New York.

Dhima, K.V., A.S. Lithourgidis, I.B. Vasilakoglou and C.A. Dordas. 2007. Competition indices of common vetch and cereal intercrops in two seeding ratio. Field Crops Res. 100: 249–256.

GOP, 2013. Agricultural Statistics of Pakistan 2012-13. Ministry of Food, Agriculture and Livestock Division, Government of Pakistan. Islamabad, Pakistan. p.18-33.

Ibrahim, M., M. Rafiq, A. Sultan, M. Akram and M.A. Goheer. 2006. Green fodder yield and quality evaluation of maize and cowpea sown alone and in combination. J. Agric. Res. 44(1):15- 21.

Iqbal, A., M. Ayub, H. Zaman and R. Ahmad. 2006(a). Impact of nutrient management and legume association on agro-qualitative traits of maize forage. Pak. J. Bot., 38: 1079-1084.

Iqbal, M.N. 2013. Performance of pearl millet (*Pennisetum amaricanum* L.) fodder grown in association with clusterbean and cowpea. M.Sc. (Hons) Thesis, Dept. Agron., Univ. Agri., Faisalabad.

Javanmard, A., A.D.M. Nasab, A. Javanshir, M. Moghaddam and H. Janmohammadi. 2009. Forage yield and quality in intercropping of maize with different legumes as double-cropped. J. Food Agric. Environ., 7: 163-166.

Jhansi, A. 2004. Management of shootfly and stem borer incidence in fodder sorghum by intercropping with leguminous fodder crops. Ind. J. Pl. Prot. 32: 139-142.

Kadam, G. L., G. G. Shinde, M. A. Baig and S. S. More. 2005. Yield and monetary returns from sorghum + soybean intercropping system as affected by different row proportions. Karnataka J. Agric. Sci., 18: 801-802.

Khan, A.H., M.S.M. Chohan, S.K. Husnain, A. Majid, R.A. Kainth, Nitasha and K. Majid. 2013. Sorghum-2011: A new dual purpose *Sorghum bicolor* cultivar for agro-climatic conditions of Pakistan. J. Agric. Res. 51(1): 19-31.

Khot, R.B., J.S. Desale, A.A. Pisal and S.K. Patil.1992. Assessment of forage productive potential of maize (*Zea mays*) with forage legumes in various planting systems. Ind. J. Agron. 37: 343-345.

Lithourgidis, A.S., K.V. Dhima, I.B. Vasilakoglou, C.A. Dordas and M.D. Yiakoulaki. 2007. Sustainable production of barley and wheat by intercropping common vetch. Agron. Sustain. Dev. 27: 95–99.

Malede, B. 2013. Role of Seeding Rates and Cutting Stages on Yield and Quality of Forage Intercropping in the Case of North Gondar. Ethiopia, LAP, LAMBERT Academic Publishing, Germany, ISBN: 978-3-659-25690-5-1.

Moriri, S., L.G. Owoeye and I.K. Mariga. 2010. Influence of component crop densities and planting patterns on maize production in dry land maize/cowpea intercropping systems. African J. Agri. Res. 5: 1200-1207.

Muhammad, A.A. 2011. Performance of cowpea (*Vigna unguiculata* L. Walp) varieties under varying irrigation intervals and plant populations. Ph.D. Thesis, Department of Agronomy, Faculty of Agriculture, Ahmadu Bello University, Zaria Nigeria.

Ngongoni, N. T., M. Mwale, C.Mapiye, M. T. Moyo, H. Hamudikuwanda and M.Titterton. 2007. Evaluation of cereal-legume intercropped forages for small holder dairy production in Zimbabwe. Livestock Res. Rural Dev. 19: 145-148.

Oseni,T.O. 2010. Evaluation of sorghum-cowpea intercrop productivity in Savanna agro-ecology using competition indices. J. Agric. Sci. 2: 229-234.

Osman, K., E. M. Idris and A. K. Abdullah. 2006. Agronomic and economic evaluation of sesame and two cowpea varieties intercropped at different spatial arrangements. Sesame and Safflower Newsletter, 21:53-57.

Patel, J. R. and S. Rajagopal. 2002. Performance of sorghum and cowpea forage in intercropping. Forage Res. 28: 181-182.

Ram, S. N. and B. Singh. 2001. Effect of nitrogen and harvesting time on yield and quality of sorghum (*Sorghum bicolor*) intercropped with legumes. Ind. J. Agron. 46: 32-37.

Ram, S. N. and B. Singh. 2003. Growth, yield and quality of forage sorghum by intercropping, harvesting time and nitrogen fertilization under rainfed conditions. Ind. J. dryland Agri. Res. Dev. 18: 167-172.

Sani, B.M., N.M. Danmowa, Y.A. Sani and M.M. Jaliya. 2011. Growth, yield and water use efficiency of maize-sorghum intercrop at Samaru, Northern Guinea Savannah, Nigeria. Nigerian J. Basic and Applied Sci. 19: 253 - 259.

Sarwar,M., M.A. Khan and Z. Iqbal. 2002. Feed resources for livestock in Pakistan. Int. J. Agric. Biol. 4:186-192.

Singh, P. K. and A. S. Jadhav. 2003. Intercropping of sorghum with pigeonpea, groundnut and soybean under varying planting geometry. Ind. J. Dry land Agric. Res. Dev. 18: 126-129.

Tsubo, M., S. Walker, and H. O. Ogindo. 2005. A simulation model of cereal legume intercropping systems for semi-arid regions II. Model application. Field Crops Res. 93: 23–33.

Vasilakoglou, I., K. Dhima, A. Lithourgidis and I. Eleftherohorinos. 2008. Competitive ability of winter cereal-common vetch intercrops against sterile oat. Exp. Agric., 44: 50-52.

CONTRIBUTION OF AUTHORS

Asif Iqbal	**Planned the expeirment and helped in write-up**
Muhammad Umer Chattha	**Helped in write-up**
Muhammad Umair Hassan	**Helped in interpreting the data and write-up**
Imran Khan	**Provided technical assistance and helped in write-up**
Muhammad Bilal Chattha	**Helped in write-up**
Amina Iftikhar	**Conducted the research**
Mina Kharal	**Helped in data analysis**