Short communication

Fodder quality in fodder maize-legume intercropping systems

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Abstract

A field experiment was carried out during *kharif* 2011 to study the effect of different planting patterns in fodder maize-legumes intercropping systems on fodder quality as compared to sole cropping. Total dry matter production was higher in plots of maize in pairs plus cowpea followed by maize in pairs plus cluster beans. The treatment combination involving maize in pairs + cowpea produced the highest crude protein and chlorophyll contents (7.81% and 2.98 mg g^{-1}) and the lowest values (6.38% and 2.2 mg g^{-1}) were recorded in sole maize. Higher crude fibre content was observed in sole crop of fodder maize as compared to the different intercropping systems.

Keywords: Paired row planting, Cowpea, Cluster bean, Crude Protein, Crude Fibre

Quality forage production plays an important role in dairy industry. Cereal- based forage production has the potential to supply large amounts of energy-rich feed in animal diets. Unfortunately, they often contain less crude protein, and for desirable levels of milk or meat production the diets require some protein supplementation. Inclusion of legumes with cereals improves forage quality as legumes are rich in protein. The results of a field experiment to study the quality aspects of fodder maize intercropped with different legumes under different planting patterns are presented here.

The field experiment was carried out at the Agricultural College Farm, Baptla, Andhra Pradesh (15^0 54' N latitude, $80^0$25' E longitude, and 5.49 m above mean sea level) during *kharif* 2011. The soil of the experimental site was sandy clay loam with a pH of 7.6. The soil was medium in organic carbon (0.5%), low in available nitrogen (175 kg ha^{-1}), and high in available phosphorus (33.9 kg ha^{-1}) and potassium (532.5 kg ha^{-1}). A set of 10 treatment combinations involving maize and legumes, *viz.,* cowpea, clusterbean and pillipesara, were sown in different planting patterns in randomized block design with three replications. Fodder maize (African tall) and fodder legumes, *viz.,* cowpea (EC4216), pillipesara (local) and clusterbean (Bundel Guar 2) were sown during the first week of July. Fodder maize and fodder legume sole crops were sown at 45 cm x 10 cm spacing. In three treatments (T_5, T_6 and T_7), seeds of fodder maize and legumes were mixed and sown in lines spaced at 45 cm. In paired row planting, 30 cm between rows in a pair and 60 cm between two pairs were adopted and in between maize paired rows, two rows of legumes were included. Seed rates for maize, cowpea, pillipesara and clusterbean were 50, 30, 40 and 25 kg ha^{-1} respectively. A uniform dose of nitrogen, phosphorus and potassium were applied as per the recommendation i.e., 120 kg N, 50 kg P_2O_5 and 40 kg K_2O ha^{-1} through urea, single superphosphate (SSP) and muriate of potash (MOP) respectively to all the plots. The entire quantities of phosphorus and potassium were applied basally, whereas nitrogen was applied in two equal splits, one at the time of sowing and another at 30 days after sowing. Soil moisture was kept at an adequate level to prevent water stress during the crop period. Irrigation

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Table 1. Dry matter content (kg ha^{-1}) of fodder maize and legumes as influenced by different intercropping systems

Treatments	40 DAS			60 DAS		
	Maize	Intercrop	Total	Maize	Intercrop	Total
T_1 (maize))	4635	-	4635	7622	-	7622
T_2 (cowpea)	-	1621	1621	-	2701	2701
T_3 (pillipesara)	-	1144	1144	-	1907	1907
T_4 (cluster bean)	-	1585	1585	-	2557	2557
T_5 (M+cowpea)	4142	265	4408	6904	442	7346
T_6(M + pillipesara)	4280	43	4323	7133	72	7205
T_7(M+cluster bean)	4240	196	4436	7067	303	7370
T_8:maize in pairs + cowpea	4476	1019	5495	7506	1699	9205
T_9:maize in pairs + pillipesara	4502	91	4593	7504	151	7655
T_{10}:maize in pairs + cluster bean	4520	750	5270	7533	1161	8694
SEm+	259	44	236	414	79	382
CD (P=0.05)	NS	131	700	NS	237	1136

was given uniformly as and when needed. The crops were harvested 60 days after sowing. Quality parameters like crude protein, crude fibre, and total ash content were determined as per standard methods (Jackson, 1958; Mahadevan, 1965; Piper, 1966). The chlorophyll content in the fresh leaves was estimated colorimetrically by dimethyl sulphoxide (DSMO) method as described by Hiscox and Stan (1979).

Total dry matter yield and dry matter yield of intercrops were significantly affected by different intercropping treatments. However, the dry matter yield of maize was not affected (Table1). Higher dry matter accumulation was recorded in sole crops of legumes over their respective intercropped stands. Among the different sole fodder legumes, cowpea registered the highest dry matter accumulation (2701 kg ha^{-1}) while the lowest was in pillipesara. Cowpea is superior to other legumes because it can tolerate both drought and shade. Reductions of dry matter in legumes was observed when maize and legume seeds were mixed and sown in lines compared to row intercropping in between the fodder maize pairs. The reduction in legume dry matter can be attributed to increased population pressure and inter-specific competition. However, legume fodders intercropped within the pairs of maize performed better with lower reduction in dry matter indicating better utilization of environmental resources and the availability of ample space between paired rows. The highest total dry matter of 9205 kg ha^{-1} was recorded in the treatment, maize pairs + cowpea followed by 8694 kg ha^{-1} in maize pairs + cluster bean. The lowest total dry matter accumulation (7205 kg ha^{-1}) was recorded when maize and pillipesara seeds were mixed and sown in lines(T_6) and this was statistically comparable with total dry matter accumulation (7622 kg ha^{-1}) in maize sole cropping. As a whole, total dry matter production was higher in maize pairs + cowpea followed by maize in pairs + cluster bean. Intercropping offered more plants per unit area and efficient utilization of environmental and soil resources. Nutrient contribution of legume fodders may have also played a positive role.

Crude protein content of fodder maize, cowpea, pillipesara and clusterbean decreased with age upto 60 DAS (Table 2). At 40 DAS, crude protein content of maize alone was significantly influenced by various treatments. The highest crude protein content of maize (9.08%) was recorded in maize pairs + cowpea intercropping (T_8) and this treatment was statistically comparable to maize pairs + cluster bean intercropping (8.56%). Significantly lower crude protein content of fodder maize was recorded in sole maize (7.58%). Similar response to different treatments was also observed at 60 DAS, but the highest crude protein content of maize was 7.81 when cowpea was intercropped in between the pairs of maize. The lowest value of 6.27 per cent crude protein in fodder maize was recorded when maize and pillipesara seed were mixed and sown in lines (T_6), which was comparable with sole maize (T_1).Higher

Table 2. Crude protein and crude fibre content of fodder maize and legumes as influenced by different intercropping systems

Treatments	Crude protein (%)				Crude fibre (%)			
	40 DAS		60 DAS		40 DAS		60 DAS	
	Maize	Intercrop	Maize	Intercrop	Maize	Intercrop	Maize	Intercrop
T_1 (maize))	7.58	-	6.38	-	28.44	-	30.74	-
T_2 (cowpea)	-	17.38	-	16.79	-	21.60	-	23.72
T_3 (pillipesara)	-	16.52	-	16.13	-	19.30	-	21.42
T_4 (cluster bean)	-	17.19	-	16.63	-	22.00	-	24.12
T_5 (M+cowpea)	7.77	16.71	7.46	16.48	26.60	22.08	29.30	24.20
T_6(M+ pillipesara)	7.73	16.23	6.27	15.79	26.76	19.75	29.06	21.87
T_7(M+cluster bean)	7.77	16.88	6.58	15.85	26.59	22.21	29.22	24.33
T_8:maize in pairs + cowpea	9.08	17.31	7.81	16.71	25.94	21.76	28.25	23.88
T_9:maize in pairs + pillipesara	7.79	16.31	6.47	16.19	26.33	19.48	28.80	21.60
T_{10}:maize in pairs + cluster bean	8.56	16.85	7.44	16.50	26.43	22.05	28.26	24.17
SEm+	0.22	0.44	0.21	0.50	0.55	0.40	0.48	0.48
CD (P=0.05)	0.69	NS	0.67	NS	1.71	1.20	1.48	1.44

crude protein content in fodder maize pairs + cowpea might possibly be the result of fixation of higher amount of nitrogen and its release, either by direct excretion from legume root system with nodules or by decomposition of nodule and root debris. Ram (2008) reported that under wider row spacing, legume intercrops were able to grow better, fixing greater amount of atmospheric N, some part of which might become available to cereal crop.

The data in Table 2 indicates that there was a marked increase in crude fibre content (%) from 40 to 60 DAS. This increase in crude fibre content with increase in age could be ascribed to the accumulation of structural material such as hemicellulose, cellulose, lignin, silica etc (Hussain and Durrani, 2009). Crude fibre content of maize was significantly influenced by different crop combinations. The highest crude fibre content was observed in sole fodder maize (30.74 %). Low crude fibre values were recorded in fodder maize when it was intercropped with legumes *viz.,* cowpea, clusterbean and pillipesara at both sampling stages. Maize grown along with legumes might have availed better nitrogen nutrition making it more succulent. Ibrahim et al. (2012) observed negative correlation between nitrogen and crude fibre content.

Among the legumes, comparatively lower crude fibre content of 19.48 per cent and 21.6 percent was registered in pillipesara at 40 and 60 DAS respectively. Pillipesara developed profuse branching and more leaf matter among all the three intercrops and was highly succulent. This high succulence and greater leafiness of pillipesara could be the possible reason for low fibre content in pillipesara. Relatively higher crude fibre values of 22.21 per cent and 24.33 per cent were recorded in cluster bean at 40 and 60 DAS. The influence of different treatments on total ash content was non-significant (Table 3). Leaf chlorophyll content provides important information about photosynthetic activity of a plant. Chlorophyll content of fodder maize was significantly influenced by different treatments. The highest values for chlorophyll, *i.e*. chlorophyll 'a', chlorophyll 'b' and total chlorophyll (1.45 mg g^{-1} , 1.52 mg g^{-1} and 2.98 mg g^{-1} respectively) was in T_8 treatment (maize in pairs + cowpea intercropping). The lowest value for chlorophyll 'a' (1.05 mg g^{-1}), chlorophyll 'b' (1.16 mg g^{-1}) and total chlorophyll (2.21 mg g^{-1}) was observed in sole maize. Higher chlorophyll contents of fodder maize in T_8 and T_9 treatments might be due to higher nitrogen contribution by legume component to cereal through paired row intercropping. Saeid and Darbandi (2011) and Vanyine et al. (2012) reported positive relation between nitrogen and chlorophyll content in fodder maize.

The data on chlorophyll 'a' and 'b' contents in legumes

Table 3. Chlorophyll content and total ash content of fodder maize and legumes as influenced by different intercropping systems

Treatments	Chlorophyll content (mgg^{-1})						Total Ash content (%)	
	Chlorophyll a		Chlorophyll b		Total chlorophyll		Maize	Intercrop
	Maize	Intercrop	Maize	Intercrop	Maize	Intercrop		
T_1 (maize))	1.05	-	1.16	-	2.21	-	10.22	-
T_2 (cowpea)	-	1.62	-	1.68	-	3.30	-	15.88
T_3 (pillipesara)	-	1.52	-	1.58	-	3.09	-	15.96
T_4 (cluster bean)	-	1.57	-	1.60	-	3.17	-	15.66
T_5 (M+cowpea)	1.20	1.51	1.36	1.48	2.56	2.99	10.01	15.04
T_6(M+ pillipesara)	1.09	1.36	1.20	1.45	2.29	2.82	10.11	15.32
T_7(M+cluster bean)	1.12	1.46	1.30	1.48	2.42	2.94	10.15	15.01
T_8:maize in pairs + cowpea	1.45	1.65	1.52	1.54	2.98	3.20	10.55	15.81
T_9:maize in pairs + pillipesara	1.17	1.50	1.32	1.48	2.49	2.98	10.51	15.35
T_{10}:maize in pairs + cluster bean	1.39	1.62	1.42	1.52	2.80	3.14	10.40	15.42
SEm+	0.04	0.05	0.04	0.49	0.59	0.07	0.32	0.47
CD (P=0.05)	0.11	NS	0.14	NS	0.18	0.22	NS	NS

indicated that all the treatments were statistically on a par with each other. However total chlorophyll contents in various legumes were significantly influenced by the treatments tried. The highest total chlorophyll, 3.30 mg g^{-1}, was observed in T_2 treatment *i.e.* sole cowpea. The lowest total chlorophyll, 2.82 mg g^{-1}, was registered in T_6 treatment wherein pillipesara was mixed with fodder maize. Leguminous fodders in sole situation recorded higher total chlorophyll compared to intercropped situation. Under intercropped situation, maize fodder, by virtue of its faster and vigorous growth might have dominated and utilized the resources more efficiently and suppressed legume fodders.

The present investigation revealed that sowing fodder maize in paired rows with cowpea as intercrop was beneficial for higher dry matter production and fodder quality in terms of crude protein and crude fibre content.

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