RESEARCH ARTICLE

EFFECT OF FODDER BASED INTERCROPPING SYSTEMS ON YIELD AND QUALITY

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Abstract: A field experiment was conducted at the Instructional Farm of Agronomy, Maharana Pratap University of Agriculture and Technology, Udaipur to evaluate the performance of sole as well intercropping of cereals (sorghum, maize and pearl millet) and legumes (cowpea and cluster bean) system. The results shows that in sole cropping system sole sorghum recorded significantly higher green fodder yield of main crop than other sole and intercropping treatments in different row ratios. Among intercropping treatments, sorghum + cowpea in 2:1 ratio outperformed in green fodder yield of main crop but variations were at par with sorghum + cluster bean in 2:1 row ratio.

Keywords: Cropping system, Maize, Sorghum, Fodder

INTRODUCTION

In Indian agriculture, animal husbandry is closely linked with crop production programme as a complementary enterprise. On one hand, forage crops are of prime importance for economic feeding of the animals while on another hand, the livestock through supply of organic manures and draft power help in sustainable crop husbandry. India has a huge livestock population of 199.10 millions cattle and 105.30 millions buffalo which accounts for 16.24 and 56.90 per cent of world bovine population, respectively and stand first in the world in number of bovine population (Livestock Census 2007, GOI). The average milk yield of 300 kg per lactation is abysmally. Despite having the world's largest cattle population the milk productivity per animal in India comes to 987 kg year^{-1} whereas worldwide average productivity is 2200 kg per animal per year (Kumar *et al*., 2012). The projected shortage of dry and green fodder is 23.46 and 62.76 per cent of requirement of 589 and 1061 million tones, respectively (Hand Book of Agriculture, 2010). The available fodder can adequately meet the demand of only 47 per cent total cattle population which is a prime cause of poor cattle health and low milk productivity in the country. Sorghum (*Sorghum bicolor*), maize (*Zea mays*), pearlmillet (*Pennisetumglaucum*), cow pea (*Vignaunguiculata*) and cluster bean (*Cyamopsistetragonoloba*) are popular and traditional green fodder crops in India and Rajasthan as well due to their fast growth, palatable and nutritiousness and moreover due to their ability to grow under varying and diverse soil and agro climatic situations. The benefit of additional yield, better forage quality (more protein content) and soil fertility buildup via atmospheric nitrogen fixation that economizes the nitrogen use in botanically diverse cereal legume combinations/intercropping are well documented (Rao and Willey, 1980). Intercropping leads to utilization of land more effectively and provides stability in production (Tripathi, 1989) by virtue of spatial use of light and other growth resources on account of different canopy height and structures, rooting pattern and uptake of nutrients etc. Intercropping of fodder sorghum and maize with legumes like cowpea or cluster bean in different row proportions planting systems (1:1, 2:1, 3:1 and 2:2 etc.) is reported to produce more fodder in a short period without any mutual adverse effect on growth, and yield of component crops owing to complementary association that improves overall growth resource utilization besides helping in soil and water conservation as well as increasing soil fertility and benefit/ cost ratio (Sood and Sharma,1992).

MATERIAL AND METHOD

The experiment was conducted at the Instructional Farm of Agronomy, Rajasthan College of Agriculture, Udaipur situated at South-Eastern part of Rajasthan. The soil of the experimental field was clay loam in texture, slightly alkaline in reaction (pH 7.9), low in available nitrogen (260.00 kg ha^{-1}) and medium in available phosphorus (28.40 kg ha^{-1}). Total seventeen treatment combinations were viz., T_1 – Sorghum, T_2 – Maize, T_3 - Pearl millet, T_4 – Cowpea, T_5 - Cluster bean as a sole crop, T_6 - Sorghum + cowpea, T_7 - Sorghum + cluster bean, T_8- Maize + cowpea, T_9- Maize + cluster bean, T_{10} - Pearl millet + cowpea, T_{11} -Pearl millet + cluster bean intercropping in 1:1 ratio and T_7 - Sorghum + cowpea, T_8 - Sorghum + cluster bean, T_9- Maize + cowpea, T_{10}- Maize + cluster bean, T_{11} - Pearl millet + cowpea, T_{12} -Pearl millet + cluster bean

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intercropping in 2:1 ratio were used and evaluated under randomized block design with three replications.Full dose of phosphorus and half dose of nitrogen were applied at the time of sowing through urea and DAP as a basal application. The quantity ofnitrogen supplied through DAP was adjusted with urea. The remaining dose of nitrogen was top dressed in rows of sorghum, maize and pearl millet at 30 DAS. Whereas, cowpea and cluster bean were fertilized with full does of N at sowing. Yield components and yield were recorded at harvest and data were statistically analysed.

RESULT AND DISCUSSION

Data presented in Table 4.1 reveals that sole sorghum (T_1) recorded significantly higher green and dry fodder yield of main crop than other sole and intercropping treatments in different row ratios. Pure stands of different cereal fodder crops recorded significant variations in green as well as dry fodder yield that was in order of sole sorghum (T_1)> sole maize (T_2)> sole pearl millet (T_3). Results further reveal that pure stand of main crops recorded significantly higher green and dry fodder yield than the corresponding intercropping treatments while among intercropping treatments, green and dry fodder yield of main crop was significantly higher under in 2:1 row proportions than the corresponding treatments in 1:1 row ratio. Among intercropping treatments, sorghum + cowpea in 2:1 ratio (T_{12}) outperformed in green and dry fodder yield of main crop but variations were at par with sorghum + cluster bean in 2:1 row ratio (T_{13}).

An appraisal of data on green and dry fodder yield by different legumes in table 4.13 reveals that sole cowpea (T_4) outperformed sole cluster bean (T_5). Cowpea also outperformed the cluster bean in intercropping treatments. Data further revealed that different intercropping treatments recorded significantly higher green as well as dry fodder yield of legume intercrop under 1:1 row ratio than the corresponding treatments in 2:1 row proportion. Among intercropping treatments, significantly higher green and dry fodder yield of legume intercrop was recorded under sorghum + cowpea in 1:1 row (T_6).

A critical examination of data in table 4.1 reveals that among different pure and intercropping stands significantly higher green and dry fodder yield was recorded under sorghum + cowpea in 2:1 row proportion (T_{12}). Pure stand of main crops also recorded significant variations in green as well as dry fodder yield that was in order of sole sorghum (T_1)> sole maize (T_2)> sole pearl millet (T_3) while sole cowpea (T_4) outperformed sole cluster bean (T_5) in green and dry fodder yield. Results also clearly revealed that intercropping different cereal fodder crops with cowpea or cluster bean in 2:1 recorded significantly higher total green and dry fodder yield than the corresponding treatments in 1:1 row ratio. Results of present investigation revealing spatial intercropping advantage to both the components on net sown area basis are in close conformity with findings of Sharma *et al.* (2008),Surve and Arvadia (2012) and Pathak *et al.* (2013).

Table 1. Effect of intercropping cluster bean and cowpea with sorghum, maize and pearl millet in different row proportions on green and dry fodder yield (q ha^{-1}) at harvest

Treatment No.	Green fodder yield				Dry fodder yield		
	Treatment detail	Main crop	Inter crop	Total	Main crop	Inter crop	Total
T_1	Sole (S)	454.35	-	454.35	117.41	-	117.41
T_2	Sole (M)	388.65	-	388.65	100.56	-	100.56
T_3	Sole (PM)	332.06	-	332.06	86.34	-	86.34
T_4	Sole (CP)	-	148.69	148.69	-	43.80	43.80
T_5	Sole (CB)	-	139.44	139.44	-	41.01	41.01
T_6	1:1 (S+CP)	331.22	103.77	434.99	85.47	31.10	116.56
T_7	1:1 (S+CB)	329.88	98.60	428.47	84.99	28.94	113.93
T_8	1:1 (M+CP)	269.99	103.22	373.21	69.23	30.37	99.60
T_9	1:1 (M+CB)	269.71	96.24	365.94	68.84	28.28	97.12
T_{10}	1:1 (PM+CP)	216.44	102.24	318.68	56.15	29.51	85.67
T_{11}	1:1 (PM+CB)	215.02	93.25	308.26	55.71	27.49	83.20
T_{12}	2:1(S+CP)	402.19	70.90	473.09	105.90	21.15	127.04
T_{13}	2:1 (S+CB)	399.30	63.74	463.04	105.06	18.72	123.78
T_{14}	2:1 (M+CP)	335.39	70.02	405.41	88.55	20.63	109.18
T_{15}	2:1 (M+CB)	333.97	63.38	397.35	87.75	18.64	106.38
T_{16}	2:1 (PM+CP)	279.08	69.51	348.59	74.47	19.89	94.36
T_{17}	2:1 (PM+CB)	277.42	61.41	338.84	73.92	18.12	92.04
SEm±		2.10	0.66	1.96	1.38	0.59	1.25
CD at 5%		6.10	1.92	5.64	4.00	1.71	3.61

Note: S = sorghum, M= maize, PM= pearl millet, CP= cowpea and CB= cluster bean

Table 2. Effect of intercropping cluster bean and cowpea with sorghum, maize and pearl millet in different row proportions on crude protein, fiber, content (%)

Treatment No.	Crude protein			Crude fiber		TDN	
	Treatments	Main crop	Inter crop	Main crop	Inter crop	Main crop	Inter crop
T_1	Sole (S)	7.54	-	28.74	-	53.67	-
T_2	Sole (M)	7.63	-	34.80	-	66.98	-
T_3	Sole (PM)	7.45	-	32.65	-	61.00	-
T_4	Sole (CP)	-	13.82	-	26.33	-	55.41
T_5	Sole (CB)	-	13.81	-	27.24	-	54.77
T_6	1:1 (S+CP)	8.01	13.85	27.23	26.45	54.37	57.25
T_7	1:1 (S+CB)	7.99	13.82	27.50	27.35	54.27	56.60
T_8	1:1 (M+CP)	8.02	13.86	33.32	26.50	67.87	57.23
T_9	1:1 (M+CB)	8.01	13.84	33.36	27.38	67.85	56.60
T_{10}	1:1 (PM+CP)	7.83	13.84	31.21	26.37	61.71	57.12
T_{11}	1:1 (PM+CB)	7.78	13.84	31.26	27.39	61.69	56.50
T_{12}	2:1(S+CP)	7.89	13.84	27.32	26.36	54.35	56.22
T_{13}	2:1 (S+CB)	7.87	13.81	27.66	27.35	54.24	55.42
T_{14}	2:1 (M+CP)	7.91	13.84	33.55	26.40	67.57	56.24
T_{15}	2:1 (M+CB)	7.90	13.81	33.62	27.38	67.47	55.45
T_{16}	2:1 (PM+CP)	7.74	13.83	31.43	26.35	61.29	56.17
T_{17}	2:1 (PM+CB)	7.71	13.82	31.49	27.33	61.27	55.36
SEm±		0.03	0.06	0.24	0.18	0.11	0.16
CD at 5%		0.08	NS	0.69	0.53	0.33	0.49

A cursory look at data in Table 4.2 reveals that among different sole and intercropping treatments, maize + cowpea in 1:1 row ratio (T_8) recorded maximum crude protein, crude fiber and TDN content but variations were at par with sole stands of C_4 cereal crops (T_1, T_2, T_3), maize + cowpea or cluster bean in 1:1 row ratio (T_8, T_9) and sorghum + cluster bean in 1:1 ratio (T_7). Sole pearl millet (T_3) and different pearl millet based intercropping systems in 1:1 or 2:1 row ratio recorded lowest crude protein, crude fiber and TDN content than sorghum or pearl millet based legume intercropping in 1:1 or 2:1 row ratio. This reveals unsuitability of pearl millet in sub humid Rajasthan condition from nutritive value point of view than different sorghum or maize based sole and intercropping fodder systems. It is notable that intercropping legumes with sorghum, maize or pearl millet resulted in significantly higher crude protein content in main crop than their corresponding pure crop counterparts either in 1:1 or 2:1 row ratios. Significantly higher crude protein, crude fiber and TDN content of main crop was recorded under 1:1 ratio over corresponding 2:1 row ratios. Data further revealed that variations in crude protein content of legumes (cowpea or cluster bean) both under sole or intercropping stands were indifferent. These results on variations in crude fiber content and production among different pure and intercropping stands of cereal and fodder components are also supported byYilma (2002), Bishnoi (2002) and Chotiya (2005) also reported increased in crude protein, crude fiber, and total digestible nutrient.

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