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Productivity and economics of forage sorghum (*Sorghum bicolor*) in association with legumes under different harvesting times and nitrogen levels

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ABSTRACT

A field experiment was conducted during rainy (*kharif*) seasons of 1998 and 1999, to study the effect of intercrops havesting time and levels of nitrogen on productivity and economics of forage sorghum [*Sorghum bicolor* (L.) Moench] under rainfed conditions. Sorghum + cowpea [*Vigna unguiculata* (L.) Walp.] intercropping system recorded significantly higher green forage yield, dry-matter yield, sorghum green forage yield equivalent, net income and net return Re invested than sorghum alone and sorghum + clusterbean [*Cyamopsis tetragonoloba* (L.) Taubert] intercropping system during both the years. Harvesting done at 75 days after sowing being statistically at par with harvesting at 60 days registered significantly higher green forage yield of sorghum and sorghum + legumes as compared to harvesting at 45 days during both the years. Net income and net returns/Re invested obtained with the harvesting at 60 days was statistically higher than harvesting at 45 days and 75 days. Application of 80 kg N/ha significantly increased the forage yield, net income and net return/Re invested compared with the control and 40 kg N/ha during both the years.

Key words : Forage sorghum, Cowpea, Clusterbean, Intercropping, Harvesting time, Nitrogen, Productivity, Economics

Intercropping of legumes with cereals like sorghum economizes the use of nitrogen fertilizer and increases the production per unit area (Singh *et al.*, 1989). Nitrogen application and harvesting time are also important in forage sorghum intercropped with legumes for realizing higher forage yield and economics. The sufficient information is available on cereal–grain legume intercropping. However, information on cereal–forage legumes intercropping is still lacking. An investigation was therefore undertaken with a view to develop most productive and profitable forage

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production system which can be economically feasible to the farmers of eastern Uttar Pradesh.

MATERIALS AND METHODS

The field experiment was carried out during the rainy season of 1998 and 1999 at Agronomy Research Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad. The experiment was laid out in split-plot design, keeping the combinations of 3 intercrops, viz. sorghum alone, sorghum + cowpea and sorghum + clusterbean, and 3 harvesting times, viz. harvesting at 45, 60 and 75 days after sowing in main plots and 3 levels of nitrogen, viz. control, 40 and 80 kg/ha, in subplots and replicated 3 times. Sorghum variety hybrid 'SSG 5000' was sown in line 30 cm apart using a seed rate of 40 kg/ha. Sorghum was intercropped with 'Russian Giant' cowpea variety and 'Budel Guar 2' clusterbean in 1:1 sorghum: legumes alternate row 15 cm apart in additive series using the recommended seed rates. Cowpea was sown @ 30 kg seed/ha, while clusterbean @ 25 kg/ha. The uniform dose of 30 kg P_2O_5/ha and 30 kg K_2O/ha was applied to all the treatments at the time of last ploughing. The crop was maintained under rainfed environment.

The soil of the experimental field was

Table 1. Green forage and dry-matter yields of sorghum and sorghum green forage-yield equivalent as influenced by different treatments

Treatment	Green forage yield (q/ha)		Dry-matter yield (q/ha)		Sorghum green forage-yield equivalent (q/ha)	
	1998	1999	1998	1999	1998	1999
Intercrop						
Sorghum alone	359.14	382.52	87.87	96.11	359.14	382.52
Sorghum + cowpea	421.43	452.79	104.18	110.56	548.35	577.39
Sorghum + clusterbean	376.37	406.50	92.47	100.72	422.53	456.59
CD (P=0.05)	28.82	28.53	6.43	7.02	28.77	33.96
Harvesting time (DAS)						
45	234.00	267.58	49.90	59.40	290.00	318.44
60	448.87	475.80	108.01	116.21	501.38	534.71
75	474.06	498.44	126.61	131.78	534.95	563.19
CD (P=0.05)	28.82	28.53	6.43	7.02	28.77	33.96
Nitrogen (kg/ha)						
0	312.05	342.12	78.49	86.65	373.01	398.84
40	391.39	417.74	95.69	103.31	447.92	477.12
80	453.50	481.95	110.34	117.42	509.11	540.52
CD (P=005)	25.71	21.25	5.67	5.29	22.73	23.84

DAS, Days after sowing

silt loam and low in organic carbon and nitrogen and medium in phosphorus and rich in potassium. The values of pH and electrical conductivity of the experimental field were 8.5 and 0.35 dS/m during 1998 and 8.3 and 0.37 dS/m during 1999 respectively. The total rainfall of 836.40 mm and 1,083.70 mm was received during entire growth period of crop during 1998 and 1999 respectively.

RESULTS AND DISCUSSION

Intercropping of sorghum with cowpea recorded significantly higher green forage, dry-matter yields of sorghum and sorghum green forage-yield equivalent compared to sorghum alone and sorghum + clusterbean combinations. Intercropping of sorghum with clusterbean was also significantly superior in respect of sorghum green forage-yield equivalent than sorghum alone (Table 1). The higher green forage and dry-matter yields with the intercropping of sorghum with cowpea may be attributed to complementary effect of cowpea which supplemented nitrogen to sorghum and better utilization of environmental resources by sorghum + cowpea system. Sood and Sharma (1992), Mishra *et al.* (1997) and Barik *et al.* (1998) also reported similar results.

The maximum cost of cultivation was incurred in sorghum + clusterbean intercropping system due to more cost of seed of clusterbean. Intercopping of sorghum with cowpea gave significantly higher gross and net income as well as net returns/rupee invested compared to sorghum alone and intercropping of sorghum with clusterbean (Table 2). This was owing to higher green-forage yield obtained under sorghum + cowpea intercopping system and higher sale price of cowpea forage. These results are in close conformity with those of Mishra *et al.* (1997) and Raju *et al.* (1997).

Effect of harvesting times

Sorghum harvested 75 days after sowing yielded significantly higher green-forage and dry matter of sorghum than that harvested at 45 days, but being statistically at par for green forage yield and statistically higher for dry-matter yield with the harvesting done at 60 days during both the years (Table 1). This might be due to longer duration which increased the value of growth parameters due to more source available for the synthesis of metabolites. These results are in agreement with the findings of Noor Mohammad *et al.* (1998) and Ramamurthy and Vinod Shankar (1998). Harvesting at 75 days significantly increased the sorghum green forage-yield equivalent compared with harvesting at 60 days, which also showed significantly higher value than harvesting at 45 days (Table 1).

The harvesting of sorghum at 60 days was found more profitable and gave significantly higher gross income, net income and net returns/ rupee invested than harvesting at 45 days and 75 days (Table 2). This was owing higher green forage yield and sale price of sorghum and cowpea forage with the harvesting at 60 days. Gross income, net income and net returns/ rupee invested obtained with the harvesting at 75 days was also statistically higher than harvesting at 45 days during both the years.

Table 2. Economic of forage sorghum as influenced by intercrops, harvesting times and levels of nitrogen

Treatment	Cost of cultivation (Rs/ha)		Gross income (Rs/ha)		Net income (Rs/ha)		Net return/Re invested	
	1998	1999	1998	1999	1998	1999	1998	1999
Intercrop								
Sorghum alone	5,098	5,323	10,409	12,211	5,311	6,888	1.03	1.28
Sorghum + cowpea	5,792	6,049	15,988	185,52	10,196	12,502	1.75	2.06
Sorghum + clusterbean	5,877	6,208	12,277	146,34	6,400	8,426	1.07	1.34
CD (P=0.05)			1,518	1,799	856	1,072	0.13	0.15
Harvesting time (DAS)								
45	5,589	5,860	10,150	12,259	4,560	6,399	0.79	1.06
60	5,589	5,860	15,152	17,650	9,562	11,790	1.69	1.99
75	5,589	5,860	13,374	15,487	7,784	9,627	1.37	1.62
CD (P=0.05)			1,518	1,799	856	1,071	0.13	0.15
Nitrogen (kg/ha)								
0	5,182	5,418	10,809	12,749	5,627	7,331	1.07	1.34
40	5,589	5,860	13,023	15,296	7,434	9,436	1.32	1.60
80	5,996	6,301	14,843	17,352	8,846	11,050	1.46	1.74
CD (P=005)			1,380	1,644	636	812	0.10	0.12

DAS, Days after sowing

Effect of nitrogen

Nitrogen @ 80 kg/ha significantly increased green forage and dry matter yields of sorghum and sorghum green forage-yield equivalent compared with the control and 40 kg/ha. Nitrogen @ 40 kg/ha also proved significantly superior to the control treatment for green-forage yield, dry-matter yield and sorghum green forage-yield equivalent (Table 1). This is because of the fact the N is involved in increasing the protoplasmic constituents and accelerating the process of cell-division and elongation which in turn result in luxuriant vegetative growth for higher forage productivity. These findings confirm the results of Sood and Sharma (1992) and Barik *et al.* (1998).

The highest cost of cultivation was associated with the application of 80 kg N/ha. Application of N @ 80 kg/ha recorded significantly higher gross income, net income and net returns/Re invested compared with the control and 40 kg N/ha (Table 2). The increase in net income/Re invested with the application of 80 kg N/ha was owing to higher net income in proportionate to the cost of cultivation. Nitrogen @ 40 kg/ha also proved significantly superior to the control treatment for gross income, net income and net return/Re invested. Similar results were also reported by Patel *et al.* (1992)

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