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Response of sorghum (*Sorghum bicolor*) hybrids to nitrogen under zero tillage in rice-fallows of Coastal Andhra Pradesh

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Sorghum (*Sorghum bicolor* (L.) Moench) is a preferred crop in semi-arid regions with high temperature and water stress because of its drought adaptation capability (Paterson *et al*. 2009). In India it is grown in both rainy (June-October) and post-rainy (November-February) seasons. In spite of its multiple uses as food, feed, fodder and bio-fuel, the area under grain sorghum in India has declined from 18.61 million ha in 1969–70 to 7.06 million ha in 2010–11 (ASG 2012).With the increase in human and animal population and a fragile balance between food supplies and demand for it, production of sorghum must be increased to meet the current and future food and fodder needs. With the threat of climate change looming large on the crop productivity, sorghum will play an important role in food, feed and fodder security in dryland economy.

In rice-fallows of coastal Andhra Pradesh, sorghum is gaining popularity among the farmers and the area under sorghum has increased from 2000 ha in 2005–06 to >21000 ha during 2011–12. Usually farmers plant pulses (greengram and blackgram) in rice-fallows in the Krishna-Godavari zone of Andhra Pradesh as *utera* cropping (broadcasting of seeds in standing crop of rice). However, in the recent times, the area under pulses has declined due to late planting of rice and severe attack of viral diseases and parasitic weed *Cuscuta* (Mishra *et al.* 2009). Farmers of the region are now growing sorghum (in less irrigated areas) in rice-fallows as an alternate crop to pulses. However, they are using the fertilizers, especially nitrogen and pesticides indiscriminately but harvesting very high grain yield (on an average 6.0-6.5 tonnes/ha). Mishra *et al*. (2011) reported as high as 8.44 tonnes/ha grain yield of sorghum in rice-fallows. Nitrogen fertility is becoming an increasingly important in gauging the economic and environmental viability of agroecosystems and exploiting genotypic differences in N demand and efficiency have been proposed as possible alternatives for reducing the cost and reliance upon fertilizer N (Gardner *et al*. 1994). Many promising sorghum hybrids have been evolved for traditional sorghum growing areas, making it essential to investigate the differential response of promising hybrids to nitrogen in non-traditional areas like rice-fallows. The present investigation was therefore undertaken to find out the relative response of sorghum hybrids to nitrogen in rice-fallows of coastal Andhra Pradesh.

A field experiment was conducted during *rabi* 2009–10 at farmer's field in Kondura village, Tenali (16°18' N, 80°29' E, 31.5 m above mean sea-level), in Guntur district of Coastal Andhra Pradesh. The soil was clay loam (Vertisol), medium in organic carbon (0.55%), available nitrogen (301 kg/ha), phosphorus (38.8 kg/ha) and high in available potassium (378 kg/ha) content with pH 7.6 and EC 0.28. Treatments consisting of 5 nitrogen levels (25, 75, 125, 175 and 225 kg/ha) and 7 sorghum hybrids [Mahalaxmi 296 (Devgen Seeds Pvt Ltd), NSH 27 (Nuziveedu Seed Pvt Ltd), SBSH 151 (Safal Seeds Pvt Ltd), Kaveri 6363 (Kaveri Seed Co. Ltd), CSH 23, CSH 16 and CSH 15R (Directorate of Sorghum Research)] were replicated thrice in factorial randomized block design. After harvest of *kharif* transplanted rice, the sorghum cultivars were sown on 16 December 2009 under zero tillage to utilize the residual soil moisture. The sowing was done manually in rows (45 cm × 15 cm) at 4-6 cm depth by making a hole with wooden stick and putting 2-3 seeds in each hole. For effective weed control, tank mixed application of atrazine + paraquat (1.0 + 0.50 kg/ha) was done one day after sowing. No fertilizer was applied at sowing. However, at 30 days after sowing (at first irrigation), 50% of N (as per treatment), 80 kg P_2O_5/ha and 60 kg/ha K_2O/ha were side dressed to individual plants. Remaining 50% of N was side dressed at 60 DAS (at 2[nd] irrigation). Furodon 3G at 12 kg/ha was applied in leaf whorl of individual plant at 40 days

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Table 1 Effect of nitrogen levels and genotypes on growth, yield attributes and yields of sorghum cultivars in rice-fallows

Treatment	Plant height at harvest (cm)	Leaf area index	Panicles/ m^2	Panicle length (cm)	Grains/ panicle	Grain weight/ panicle (g)	100-grain weight (g)	Grain yield (tonnes/ha)
Nitrogen levels (kg/ha)								
25	159	2.19	13.1	26.24	1 401	38.39	2.63	4.81
75	170	2.29	13.3	26.33	1 851	48.10	2.69	5.96
125	177	2.91	12.9	28.19	2 225	58.81	2.74	7.38
175	187	3.26	12.4	29.10	2 391	65.81	2.78	7.82
225	188	3.94	13.2	29.05	2 249	66.35	2.96	8.04
LSD (P=0.05)	12	0.36	1.7	0.85	93	2.79	0.09	0.89
Genotypes								
Mahalaxmi 296	139	2.58	12.6	31.73	2 229	59.26	2.66	7.09
NSH 27	160	3.01	12.7	29.73	2 267	59.71	2.63	7.23
SBSH 151	171	2.48	11.6	29.00	2 307	64.93	2.85	7.27
Kaveri 6363	168	2.31	12.7	25.27	2 370	63.82	2.69	7.24
CSH 23	149	2.16	13.2	28.00	1 571	44.99	2.86	5.88
CSH 16	180	2.89	13.3	29.80	2 107	57.05	2.70	7.24
CSH 15R	266	4.99	14.7	20.93	1 317	38.69	2.94	5.67
LSD (P=0.05)	10	0.41	1.1	1.01	100	2.48	0.05	0.57

after sowing. Crop was harvested manually at 115 days after sowing. Nutrient content in sorghum grain was analysed after the crop harvest as per the standard procedures. Protein content in grain was calculated by multiplying N content to 6.25. The economic indicators were calculated based on the existing price of the inputs and outputs. The returns were calculated by using minimum support price of sorghum (₹ 9.80/kg) for 2011–12.

Application of 225 kg N/ha resulted in maximum plant height (188 cm) but the response was significant up to 125 kg N/ha (Table 1). However, the successive increase in N levels from 75 kg N/ha significantly increased the leaf area index (LAI) and maximum LAI (3.94) was recorded at 225 kg N/ha. Significant increase in yield attributes, viz. panicle length (29.10 cm), grains/panicle (2 391) and grain weight/ panicle (65.81 g) was recorded at 175 kg N/ha but the increase in 100-grain weight was significantly higher at 225 kg N/ha (2.96 g) as compared to 175 kg N/ha (2.78 g). Application of 225 kg N/ha produced the highest grain yield of sorghum (8.04 tonnes/ha) which was 2.8, 8.9, 36.3 and 67.2% higher than that of 175, 125, 75 and 25 kg/ha, respectively. Grain yield obtained with 225 kg N/ha (8.04 tonnes/ha) was on a par with that of 175 kg/ha (7.82 tonnes/ ha) and 125 kg N/ha (7.38 tonnes/ha) but significantly superior to 75 kg N/ha (5.96 tonnes/ha). The net returns (₹ 54 782/ha) and benefit: cost ratio (3.13) were the highest with 225 kg N/ ha. The nutrients (NPK) content in sorghum grain increased with increasing levels of nitrogen but the effect was more pronounced on N content (Table 2). The concentration of nutrients in plant is an indication of their relative supply to the crop from the growing medium, resulting in to increased concentration with increasing levels of nitrogen (Majumdar *et al*. 2005). Nitrogen fertilization substantially increased the nutrient uptake by the sorghum grain. Application of 225 kg N/ha showed the highest nutrient uptake in sorghum grain (129, 40, 28.8 kg NPK/ha) due to increase in both nutrient content and respective grain yield. Maximum protein content in sorghum grain (9.86%) was recorded with 225 kg N/ha which was on a par with 175 kg N/ha (9.81%) but significantly superior to 125 kg/ha (9.69%).

Among sorghum hybrids, CSH 15R produced significantly the tallest plants (266 cm) and Mahalaxmi 296, the shortest (139 cm). CSH 15R also produced the maximum LAI (4.99) due to more number of leaves/plant (Table 1). The lowest LAI (2.16) was recorded with CSH 23. Longer panicles (31.73 cm) were produced by Mahalaxmi 296 followed by CSH 16 (29.80 cm) and NSH 27 (29.73 cm). Though the number of grains/panicle were significantly higher in Kaveri 6363 (2370) and SBSH 151 (2307) as compared to CSH 16 (2107), CSH 23 (1571) and CSH 15R (1317), the 100-seed weight was significantly higher in CSH 15R (2.94 g) as compared to Kaveri 6363 (2.69 g) and SBSH 151 (2.85 g). Grain yield of different sorghum hybrids varied significantly in their response to applied nitrogen (Fig 1). Hybrids CSH 23 and CSH 15R were less responsive to higher doses of nitrogen as compared to other hybrids. Among hybrids, SBSH 151, CSH 16, Kaveri 6363, NSH 27 and Mahalaxmi 296 being on a par with each other produced significantly higher grain yields (7.09–7.27 tonnes/ha) as compared to CSH 23 (5.88 tonnes/ha) and CSH 15R (5.67 tonnes/ha). Nutrient content in grain varied significantly with hybrids. The maximum N content was observed in CSH

Table 2 Effect of nitrogen levels and genotypes on nutrient content and uptake in sorghum grains

Treatment	Nutrient content (%) in grain			Nutrient uptake (kg/ha) by grain			Protein content (%)	Net returns (₹/ha)	B:C ratio
	N	P	K	N	P	K			
Nitrogen levels (kg/ha)									
25	1.49	0.46	0.33	72.6	22.1	16.0	9.31	24 625	2.05
75	1.54	0.48	0.34	96.1	29.9	21.1	9.61	35 589	2.48
125	1.55	0.49	0.34	112.3	35.5	24.6	9.69	49 254	3.00
175	1.57	0.49	0.34	120.2	37.6	26.1	9.81	53 060	3.11
225	1.58	0.49	0.35	129.4	40.0	28.8	9.86	54 782	3.13
LSD (P=0.05)	0.03	0.01	0.01	5.3	3.4	2.3	0.26	2 127	0.15
Genotypes									
Mahalaxmi 296	1.57	0.50	0.33	111.4	35.5	23.4	9.81	46 305	2.87
NSH 27	1.50	0.49	0.35	108.2	35.4	25.3	9.36	47 745	2.93
SBSH 151	1.55	0.46	0.34	113.2	33.4	24.4	9.69	48 165	2.94
Kaveri 6363	1.51	0.48	0.33	109.6	34.8	23.9	9.44	47 825	2.93
CSH 23	1.42	0.48	0.32	83.4	28.2	18.8	8.88	34 245	2.38
CSH 16	1.60	0.49	0.40	116.1	35.5	29.0	10.00	47 825	2.93
CSH 15R	1.61	0.49	0.33	91.3	27.8	18.7	10.06	32 125	2.30
LSD (P=0.05)	0.03	0.01	0.02	6.4	3.7	2.5	0.32	3 526	0.20

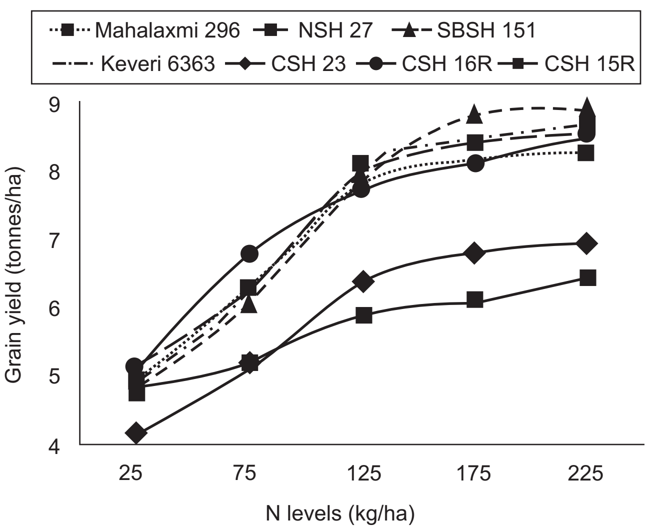

Fig 1 Response of sorghum hybrids to nitrogen in rice-fallows

15R (1.61%) and the maximum K content (0.40%) in CSH 16 (Table 2). Maximum NPK uptake was recorded by CSH 16 and minimum by CSH 23. Higher protein content in sorghum grains (10.0–10.06%) was recorded by CSH 15R and CSH 16 due to higher nitrogen concentration (1.6-1.61%). Sorghum hybrid SBSH 151 produced maximum net returns (₹ 48 165/ha) and B: C ratio (2.94) closely followed by CSH 16 and NSH 27. Hybrids CSH 15R and CSH 23 were less economical due to their lower grain yields.

SUMMARY

Seven sorghum hybrids (Mahalaxmi 296, NSH 27, SBSH 151, Kaveri 6363, CSH 23, CSH 16 and CSH 15R were evaluated for their relative response to 5 levels of nitrogen (25, 75, 125, 175 and 225 kg/ha) in rice-fallows under zero tillage during *rabi* 2009–10 at farmer's field in Guntur district of coastal Andhra Pradesh. Significantly highest grain yield (8.04 tonnes/ha), nutrient uptake and benefits were recorded with 225 kg N/ha. Among different hybrids, SBSH 151, CSH 16, Kaveri 6363, NSH 27 and Mahalaxmi 296 being on a par with each other produced significantly higher grain yields (7.09-7.27 tonnes/ha). The lowest grain yield (5.67 tonnes/ha) was recorded with CSH 15R followed by CSH 23 (5.88 tonnes/ha). Higher protein content in sorghum grains (10.0-10.06%) was recorded by CSH 15R and CSH 16 due to higher nitrogen concentration (1.6-1.61%).

REFERENCES

Gardner J C, Maranville J W and Paparozzi E T. 1994. Nitrogen-use efficiency among diverse sorghum cultivars. *Crop Science* **34**: 728–33.

A S G 2012. *Agricultural Statistics at a Glance*. Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India.

Majumdar B, Venkatesh M S, Kumar Kailash and Patiram 2005. Nitrogen requirement for lowland rice in valley lands of Meghalaya. *Indian Journal of Agricultural Sciences* **75**(8): 504–6.

Mishra J S, Rayudu B S, Chapke R R and Seetharama N. 2011. Evaluation of sorghum (*Sorghum bicolor*) cultivars in rice (*Oryza sativa*) fallows under zero tillage. *Indian Journal of Agricultural Sciences* **81**(3): 277–9.

Mishra J S, Subbarayudu B, Chapke, R R and Seetharama N. 2009. Sorghum-a potential high yielder in rice-fallows of Andhra Pradesh. *ICAR News* **15**(4): 8.

Paterson A H, Bowers J E and Bruggmann R. 2009. The *Sorghum bicolor* genome and the diversification of grasses. *Nature* **457**: 551–6.