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Optimization of Nitrogen Fertilizer Rate for High Cane and Sugar Yield of Sweet Sorghum in Sandy Loam Soils

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ABSTRACT

The field experiment was conducted for two years to find out the optimum dose of nitrogen for high cane and sugar yield in sweet sorghum in sandy loam soils during *kharif*, 2009 & 2010. The results revealed that all the parameters *viz.,* cane yield, juice yield, sugar yield and total sugar index were significantly influenced by the application of graded doses of nitrogen. Data on plant stand and brix % at harvest showed non significant influence due to application of levels of nitrogen. Both cane yield and sugar yield increased with increasing levels of nitrogen application up to 120 kg ha^{-1} which was found to be on par with application of 80 kg N ha^{-1}. It can be concluded from the study that the application of nitrogen @ 80 kg ha^{-1} is economical and optimum for high cane and sugar yield of sweet sorghum in sandy loam soils.

Key words : Juice quality parameters, Nitrogen levels, Sweet sorghum,Yield

Sweet sorghum (*Sorghum bicolor L. Monech*) is an important crop for food, fodder, syrup, forage, silage and jaggery or sugar production. Sweet sorghum is similar to grain sorghum, having fast growth, high biomass production and wider adaptability and is known to have great potential in ethanol production (Reddy *et al.*, 2005). It has high yield potential as a supplementary source to sugarcane industry and jaggery preparation or ethanol production along with grain and fodder. It requires less labor, water, fertilizers and duration than sugarcane. To make sweet sorghum a sustainable and profitable crop, there is a need to standardize agronomic practices, apart from breeding for high yielding cultivars, which can contribute to increased yields resulting in higher returns to farmers. Application of fertilizers has a direct impact on crop productivity. Nitrogen is one of the major nutrients that support crop growth and is the most responsive nutrient required by sorghum in both irrigated and rain fed environments (Singh *et al.*, 1972). In view of this the present study was carried out to standardize the optimum nitrogen dose for realizing high cane and sugar yield in sweet sorghum.

MATERIALS AND METHODS:

The present field study was conducted during *kharif*, 2009 and 2010 at Agricultural Research Station, Perumallapalle, Andhra Pradesh. The soil of the experimental field was sandy loam in texture, neutral in reaction, non saline, low in organic carbon, low in available nitrogen, low in available phosphorus and high in available potassium. The experiment was laid out in simple Randomized Block Design with seven treatments replicated thrice. The seven treatments comprises graded levels of nitrogen Viz., T1: No nitrogen; T2: 20 kg N ha^{-1}; T3: 40 kg N ha^{-1}; T4: 60 kg N ha^{-1}; T5: 80 kg N ha^{-1}; T6: 100 kg N ha^{-1} and T7: 120 kg N ha^{-1}. Nitrogen was applied in the form of urea in two equal splits, one at the time of sowing and other at 35 days after sowing the crop. Uniform dose of phosphorus and potassium were applied @ 40 kg ha^{-1} in the form of single super phosphate and muriate of potash, respectively to all the treatments at the time of sowing. The cultivar, SSV 84 was used as test variety. Each treatment consisted of 10 rows, each of 6 m length. A spacing of 60 cm between rows and 15 cm between plants in a row was maintained.

Data were recorded for agronomic parameters viz., plant stand at harvest, plant height at harvest, fresh biomass, stalk yield and grain yield. Data on juice quality parameters viz., juice yield, juice extraction %, brix %, sugar yield and total sugar index were also recorded at harvest by following standard procedures (Spencer and Meade, 1963). Data was analyzed statistically (Panse and Sukhatme, 1978) and the results on different parameters were presented here.

Table 1. Effect of nitrogen on yield and yield attributes of sweet sorghum.

Nitrogen (kg ha^{-1})	Plant stand at harvest '000 ha^{-1}	Plant height (cm)	Stalk diameter (cm)	Fresh biomass (t ha^{-1})	Stalk yield (t ha^{-1})	Grain yield (q ha^{-1})
0	91.12	231.5	1.2	25.51	19.84	15.13
20	91.23	240.8	1.5	26.95	21.00	17.86
40	91.86	262.5	1.9	29.99	24.52	20.55
60	92.10	280.7	2.4	31.16	26.62	22.46
80	92.05	299.5	2.9	36.97	31.43	26.90
100	92.28	305.8	2.9	37.45	32.22	27.83
120	92.17	309.5	3.0	37.90	32.89	27.95
CV%	10.18	7.2	9.2	11.36	17.40	14.64
SEd	0.98	3.6	0.1	2.27	1.39	1.27
LSD (0.05)	NS	9.2	0.2	4.96	3.85	3.89

RESULTS AND DISCUSSION

The results pertaining to growth parameters yield and juice quality parameters of sweet sorghum as affected by application of different levels of nitrogen were presented and discussed here.

Growth parameters:

The data recorded on plant stand at harvest was found non significant due to application of different levels of nitrogen where as plant height and cane diameter at harvest were positively and significantly influenced by the application of nitrogen. Plant height increased with increased levels of nitrogen and significantly higher plant height (309.5 cm) was recorded at 120 kg N ha^{-1} but it was found on par with application of 80 kg N ha^{-1}. Similar trend was observed with cane diameter at harvest (Table 1). Similar results were earlier reported by Kanne *et al.,* (2008) in sweet sorghum clay soils of Vidarbha region, Akola.

Yield parameters:

Fresh biomass increased positively with increased levels of nitrogen up to 120 kg N ha^{-1} (Table 2). Significantly highest fresh biomass (37.97 t ha^{-1}) was recorded at application of 120 kg N ha^{-1} which was on par with application of 80 kg N/ha (36.90 t ha^{-1}). Higher dose of nitrogen increased the availability of and nutrient uptake by the plants. Ultimately there was a good growth by the plant which resulted in higher biomass. The results are in comparison with those reported in sweet sorghum by Kanne *et al,* (2008).

Gradual increase in stalk yield was recorded with graded dose of nitrogen and significantly highest stalk yield (32.81 t ha^{-1}) was recorded with application of 120 kg N ha^{-1} but was at par with 80 kg N ha^{-1} (31.43 t ha^{-1}). The extent of increase with application of 80 kg N ha^{-1} over control about 11.59 tonnes (Table 1). Similar results were reported by Sinare *et al,* (2006) in sweet sorghum with the split application of nitrogen and Almodares *et al.,* (2009). The profound influence of increased nitrogen on crop growth seems to be due to maintaining congenial nutritional environment of plant system on account of their greater availability from the soil media. The extensive root system helps in exploiting the maximum nutrients and water from the soil (Tandon, 1987).

Application of 120 kg N ha^{-1} produced significantly highest grain yield of 27.95 q ha^{-1} as compared to other levels of nitrogen but was found on par with application of nitrogen at 80 and 100 kg ha^{-1}. Application of 80 kg N ha^{-1} gave increase in grain yield by 43% over control (Fig 1). The results are in conformity with the findings of Sareen and Sharma (2010) in sweet sorghum. The higher grain yields under the influence of 80 kg N ha^{-1} could be ascribed to its positive influence on both vegetative and reproductive growth of the crop which led to increase in yield attributes, grain yield there by higher biomass production. The results of the study corroborate findings of Singh and Sumaria (2002) in sweet sorghum crop.

Fig 1. Effect of levels of nitrogen on stalk yield, grain yield and sugar yield of sweet sorghum in *kharif* season

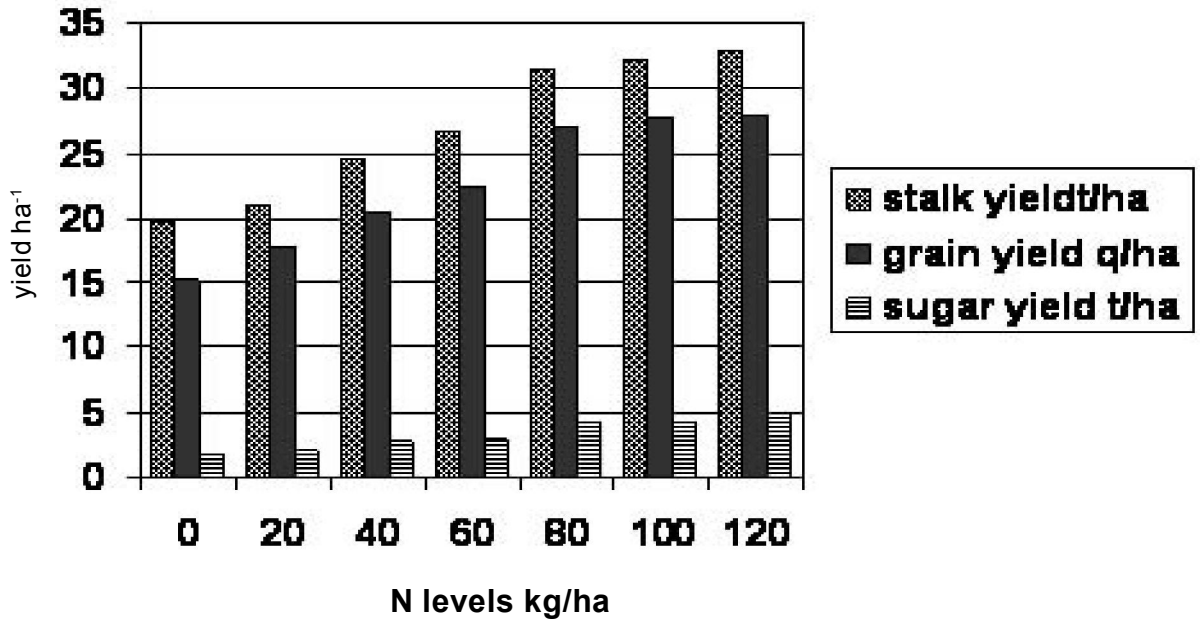

Fig 2. Positive linear relation between nitrogen levels, green stalk yield and juice yield

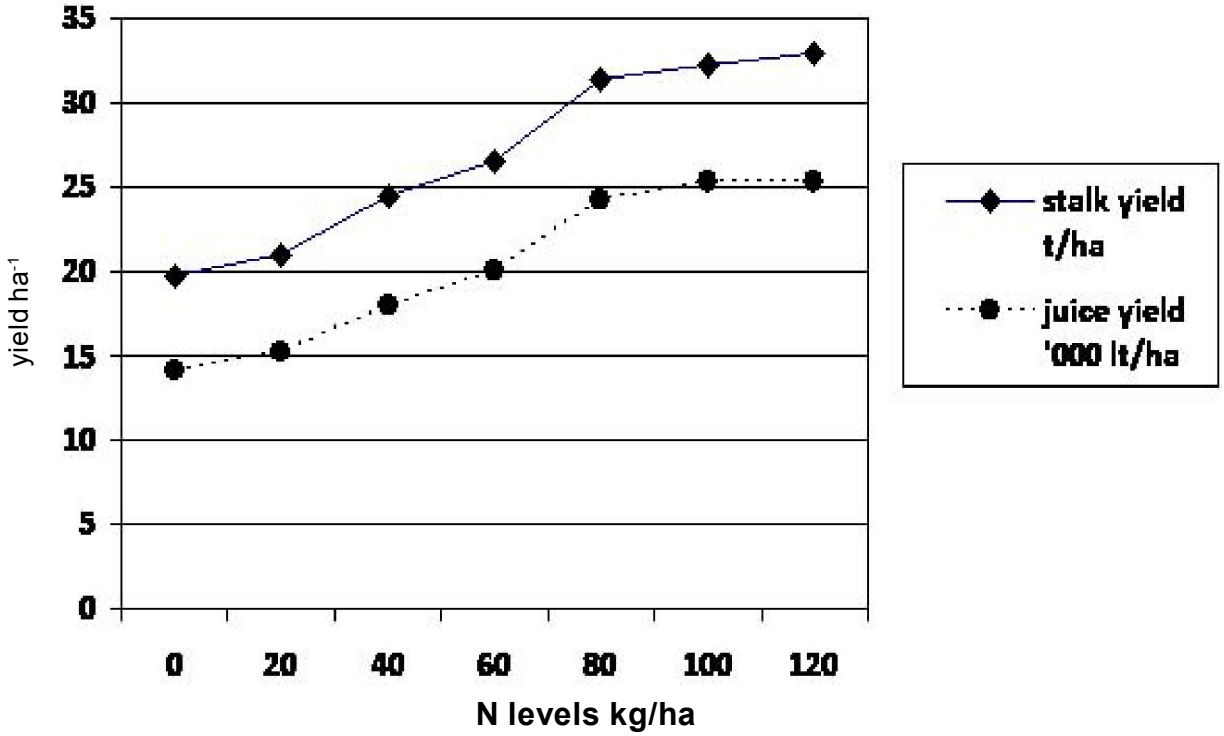

Table 2. Effect of nitrogen on juice quality parameters of sweet sorghum.

Nitrogen (kg ha^{-1})	Juice yield '000 lt ha^{-1}	Juice Extraction%	Sugar yield t ha^{-1}	Total Sugar Index (q ha^{-1})	Brix %
0	14.09	30.66	1.82	23.67	16.8
20	15.22	32.73	2.14	23.13	15.2
40	17.96	33.72	2.91	27.65	15.4
60	20.08	35.03	2.95	33.73	16.8
80	25.77	38.17	3.33	39.88	16.5
100	25.25	39.75	4.18	40.15	15.9
120	25.33	41.11	4.95	40.78	16.1
CV%	12.70	12.41	13.24	4.73	10.1
SEd	1.58	1.22	0.15	1.22	0.6
LSD (0.05)	3.26	2.98	0.48	2.72	NS

Juice yield and quality parameters:

Nitrogen levels effects were also significant for the traits juice yield, juice extraction %, sugar yield and total sugar index denoting that the sweet sorghum responded significantly to different nitrogen levels for these traits (Table 2). Significantly highest juice yield was recorded with application of 80 kg N ha^{-1} since sweet sorghum juice is extracted from the stem, the highest green stalk yield the highest would be the juice yield (Fig 2). Any input or the management technology that helps the cultivar attain its potential green stalk yield can help increase the juice yield in sweet sorghum (Kumar *et al.*, 2008). The nitrogen levels had lesser influence on brix %. The response was not significant for brix % due to application of different levels of nitrogen. There is no particular trend was observed with brix % reading with increased levels of nitrogen application. The results are in conformity with results of Sanjana Reddy *et al.,* (2008) in sweet sorghum.

The highest sugar yield was recorded with 120 kg N ha^{-1} which was on par with 80 and 100 kg N ha^{-1}. The highest sugar yield might be due to the high cane yield recorded with the same treatment. Similar trend was observed with total sugar index by Sanjana Reddy *et al.,* (2008) indicating that the 80 kg N ha^{-1} is sufficient to obtain maximum sugar yield at maturity.

Based on the results of two seasons, it can be concluded that for higher cane yield and maximum sugar yield in sweet sorghum application of 80 kg N ha^{-1} is optimum and found economical in sandy loam soils for *kharif* season.

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