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Sowing Dates and Nitrogen Levels on Yield and Juice Quality of Sweet Sorghum

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Abstract: An field experiment was conducted during *kharif*, 2005 at Tamil Nadu Agricultural University Farm, Coimbatore, India to study the effect of different sowing dates (June 8th, June 23rd, July 8th and July 23rd) and nitrogen (N) levels (90 kg N ha^{-1},120 kg N ha^{-1}, 150 Kg N ha^{-1} and control) on yield (grain and millable cane) and juice quality (extractable juice percentage, brix, sucrose percentage and purity percentage). June 8th sowing recorded higher grain (2483 kg ha^{-1}) and millable cane yield (37.17 t ha^{-1}) due to favourable environment prevailed during growing season. Maximum grain yield, millable cane yiled and Juice yield were recorded with the application of 150 kg N ha^{-1}.

Key words: Sweet Sorghum, Millable cane, yield, Juice quality

INTRODUCTION

In the ever growing scenario of food and energy crisis, there is a need to develop a multi-purpose sorghum crop. Sweet sorghum is an efficient crop in terms of photosynthates and directly produces fermentable sugar as well as grain. Sweet sorghum is being cultivated for ethanol production[5]. It also produces higher biomass and grain yield. The Juice of fresh green millable cane is used for syrup and alcohol production. Sweet sorghum is similar to grain sorghum with a sugar-rich stalk, almost like sugarcane.The ethanol production process is more eco-friendly than that of sugarcane and its molasses. The ethanol production from sweet sorghum (5,600 litres ha^{-1} year^{-1} from 140 t ha^{-1} per two crop annum^{-1} @ 40 L t^{-1}) is comparatively well with the production from sugarcane (6,500 litres ha^{-1} from 85-90 t ha^{-1} per crop @ 75 L t^{-1}). The juice content of cane varies with the weather prevailing during growing season. The yield and quality of sweet sorghum varies with different sowing dates like May[3,4]. So sowing time is one of the crucial factors to increase the yield. The grain yield of sweet sorghum found to increase with nitrogen (N) application from 80 kg ha^{-1}[2] to 150 kg ha^{-1}[10]. The highest millable cane yield was recorded with various N levels of 90 kg N ha^{-1}[11], 100 kg N ha^{-1}[1] and 120 kg N ha^{-1}[9]. Hence, the present experiment was conducted to identify optimum time of sowing and N level for achieving higher yield and juice quality.

MATERIALS AND METHODS

An field experiment was conducted during *kharif*, 2005 at Tamil Nadu Agricultural University Farm, Coimbatore, India in sandy clay loam soil. The experimental field was low in available N (KMnO4-N: 187.6 kg ha^{-1}), medium in available phosphorus (Olsen-P: 14.0 kg ha^{-1}) and high in available potassium (NH4OAc-K: 420.1 kg ha^{-1}). The experiment was laid out in split plot design with three replication. Different dates of sowing were assigned to the main plots and N levels to the sub plots. In *kharif* sorghum, the sowing window adopted by the farmers of Coimbatore district is from starting of the 2nd week of June to end of July. Hence, first date of sowing was fixed as 8th June and after that in 15 days interval subsequent sowings were taken up. Similarly, 90 kg N ha^{-1} is the normal recommended dose of N for sweet sorghum and treatment N levels fixed as 90, 120 and 150 kg N ha^{-1} with N control. The treatment details were given in Table 1. One ½ of the N, full dose of phosphorus (40 kg ha^{-1}) in the form of single super phosphate and full dose of potassium (40 kg ha^{-1}) as muriate of potash were applied as basal. The remaining ½ of the N was applied in two equal splits at 20th and 45th days after sowing. Gap filling was done on 7th day after sowing and thinning was done on 15th day after sowing so as to maintain one healthy seedling hill^{-1}.

The crop was harvested at physiological maturity stage. The leaves, side branch if any and ear heads

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Table 1: Experiment Details

Treatment	Notation	Treatment details
Times of sowing: Main plot treatments		
T_1	D_1	June 8th, 2005
T_2	D_2	June 23rd, 2005
T_3	D_3	July 08th, 2005
T_4	D_4	July 23rd, 2005
Nitrogen levels: Subplot treatments		
T_5	N_1	90 kg N ha^{-1}
T_6	N_2	120 kg N ha^{-1}
T_7	N_3	150 kg N ha^{-1}
T_8	N_4	control

Table 2: Effect of times of sowing and nitrogen levels on the grain yield (kg ha^{-1}) of sweet sorghum

Treatments	N1	N2	N3	N4	Mean
D1	2590	2675	2680	1987	2483
D2	2145	2260	2350	1115	1968
D3	1803	2080	2110	1505	1875
D4	1145	1237	1550	750	1171
Mean	1921	2063	2173	1339	
		SEd	CD (P=0.05)		
	D	46.3	113.4		
	N	65.0	134.2		
	D x N	121.8	258.1		
	N x D	130.1	268.4		

Table 3: Effect of times of sowing and nitrogen levels on millable cane yield (t ha^{-1}), extractable juice (%) and juice yield ('000 lit ha^{-1}) of sweet sorghum

Treatments	Millable cane yield (t ha^{-1})	Extractable percentage of juice	Juice yield ('000 lit ha^{-1})
D_1	37.17	41.2	15.37
D_2	34.73	40.2	14.03
D_3	33.80	34.6	11.68
D_4	25.76	30.4	8.33
SEd	0.505	0.40	0.255
CD (P=0.05)	1.235	0.99	0.624
N_1	33.02	38.2	12.62
N_2	33.90	38.6	13.07
N_3	34.19	38.6	13.21
N_4	30.12	30.9	9.37
SEd	0.484	0.17	0.083
CD (P=0.05)	0.997	0.35	0.172

were removed from the stalks and the stripped stalk yield was recorded from the net plot area. Immediately after harvest, canes from each net plot were cleaned and crushed using three-roller squeezer to extract juice. The percentage of extractable juice was calculated from the juice volume of the sample and weight of the millable portion (cane yield) of the sample by using the following formula[8]. The juice yield was estimated by using the following formula and expressed in L ha

$$\text{Juice yield} = \frac{\text{Extractable percentage of juice} \times \text{Cane yield (kg ha}^{-1}\text{)}}{100}$$

Table 4: Effect of times of sowing and nitrogen levels on juice quality characters of sweet sorghum

Treatments	Brix	Sucrose (%)	Purity (%)
D_1	16.61	13.27	79.82
D_2	16.10	12.29	76.22
D_3	15.23	11.41	74.81
D_4	14.86	10.22	68.76
SEd	0.747	0.469	3.214
CD (P=0.05)	1.644	1.149	NS
N_1	16.00	11.96	74.52
N_2	16.48	12.36	74.84
N_3	16.89	12.95	76.54
N_4	13.42	9.91	73.71
SEd	0.760	0.544	3.138
CD (P=0.05)	1.672	1.088	NS

Standard brix hydrometer was used to determine the brix values of extracted juice. The sucrose per cent of juice was obtained from the pol reading and uncorrected brix values by referring to Schimit's table[7]. The purity percentage was calculated by using the following formula

$$\text{Juice purity (\%)} = \frac{\text{Sucrose}}{\text{Brix}} x100$$

The observations collected from the field experiment and the data on the results of analysis of soil and plant samples were subjected to statistical analysis as per the procedure of Gomez and Gomez[6].

RESULTS AND DISCUSSION

Effect of Dates of Sowing: Among the different dates of sowing, June 8th sowing registered significantly higher grain yield and millable cane yield over other dates of sowing. July 23rd sowing recorded the lowest grain as well as millable cane yield. Grain yield and cane yield were higher in June 8th sowing by 32 and 7 per cent respectively over June 23rd sowing, 32 and 9 per cent respectively over July 8th sowing and 12 and 38 per cent respectively over July 23rd sowing.

Increase in yield under June 8th sowing might be due to the favourable environment prevailed during the crop growing season. Though the rainfall quantum received under this treatment was low, the experimental field was maintained without any soil moisture stress. Other sowing dates especially July 8th and July 23rd sowings had excess rainfall in different stages of crop growth which has resulted in more of pest and disease problem and hence, the photosynthates from the source could not be effectively transferred from the source to the sink thereby reduction in yield.

The highest juice yield was also obtained under June 8th sowing. The juice yield was higher by 86 per cent under June 8th sowing over the lowest juice yield recorded under July 23rd sowing.

The extractable percentage of juice, brix and sucrose percentage (Table 3) were higher at June 8th sowing as a result of higher millable cane yield and juice yield. Delaying the sowing dates resulted in reduced extractable percentages of juice. Juice purity percentage significantly altered neither by different dates of sowing nor by different levels of treatment tried.

Effect of Nitrogen levels: The grain yield increased with increased levels of N. The highest grain yield was obtained with 150 kg N ha^{-1} (2173 kg ha^{-1}) which was comparable with 120 kg N ha^{-1} (2063 kg ha^{-1}). The increase in grain yield was 62, 54 and 43 per cent higher under 150 kg N ha^{-1}, 120 kg N ha^{-1} and 90 kg N ha^{-1} respectively over control. The increased grain yield at high N levels might be due to the boost up of yield attributing characters and nutrient uptake under these treatments. Higher N application of 150 kg N ha^{-1} recorded higher millable cane yield of sweet sorghum compared to lower doses of N application as well as complete control.

Nitrogen levels had not influenced the purity percentage. Among the various nitrogen levels studied, N_3 (150 kg N ha^{-1}) registered higher brix and sucrose value and it was at par with N_2 (120 kg N ha^{-1}) and N_1 (90 kg N ha^{-1}) levels of nitrogen.

The juice yield got increased with increasing nitrogen levels. The highest juice yield of 13.21 l ha^{-1} was recorded with the application of 150 kg N ha^{-1} and it was at par with 120 kg N ha^{-1}. This could be attributed to increased production of millable cane yield with increased doses of nitrogen application. As a result of higher millable cane yield and juice yield, 150 kg N ha^{-1} treatment had recorded higher extractable juice percentage since it is a derived parameter of millable cane yield and juice yield.

Conclusions: Under June 8th sowing, though total amount of rainfall received was lesser (161.2 mm), it was distributed evenly through out the crop growing period. In June 23rd, July 8th and July 23rd sown crops excess rainfall received during the flowering and harvesting stage affected the yield and juice yield of the sweet sorghum crop. The highest grain yield, millable cane yield and juice quality characters were registered when the crop was sown on June 8th and applied with 150 kg N ha^{-1}.

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