

Performance of Sweet Sorghum Crop at Various Level of Fertilizer in the Gangetic Plains of West Bengal

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Abstract – Sustainable bio energy crop system requires high yield but and efficient use of inputs. Sweet sorghum (*Sorghum bicolor* L. Moench) has great potential as a bioethanol crop. To make an indifferent profit from cultivation of sweet sorghum in gangetic plains of West Bengal, several agronomic practices would be developed in general and nutrient management. This study is to observe the response of different N:P:K doses on sweet sorghum crop in this agro climatic region. The experiment was conducted at Block Seed Farm, Panskura, East Midnapur, West Bengal in the year 2016-17. Randomized block design (RBD) was used for the experiment. The total number of treatment combinations was 18 (N3×P2×K3) replicated thrice and total number of plots become 54. Data was collected on every 30 days interval starting from 40 Days after Sowing to 130 DAS. The maximum plant height of 191.18 cm was observed in N3P2K3 treatment at 130 DAS. The maximum Green Biomass of 24.81 t/ha was observed with N3P2K3 treatment at 100 DAS. The maximum sugar concentration of 9.77% was observed with N3P2K3 treatment at 100 DAS and highest sugar yield of 1789.17 kg/ha was observed with N3P2K3 at 100 DAS. Harvesting at 130 to 140 days after sowing might be suitable for sweet sorghum for this agro climatic zone of West Bengal with N3P2K3.

Keywords – Bio-Ethanol, Nitrogen, Stalk, Sugar, Sweet Sorghum.

I. INTRODUCTION

Sweet Sorghum production ranks fifth in the worldwide as a grain crop among cereals after wheat, rice, maize and barley. Sweet Sorghum (*Sorghum bicolor* L.) is generally grows on arid and semi arid areas of the world and is moderate saline (Almodares et al., 2007; Gates, 2009). It is a crop which is capable to produce even under water deficit conditions. It makes an important grain crop that may be used as a source of food, fiber, fuel, feed, and chemical/biofuels in the global agromarket. Sorghum is a leading tropical crop having larger genomes and more genes like sugarcane which is most promising crop of world's most efficient biomass-production and the leading biofuel source in the world (Paterson et al., 2009). Due to its high tolerance to various stresses, it is extensively grown as a major source of fodder challenging over maize (Reddy et al., 2004). Different growth stages of sorghum produce varying levels of sugar in stem quantitatively and qualitatively, maximum sugar content are accumulated at matured stage (Parvatikar and Manjunath, 1991). Although at the time of flowering stage in sweet sorghum, it is showed that sucrose content increased while invert sugar decreased. But Total sugar increases mainly in

the growth stages in sweet sorghum and reach to its highest following stem maturity (Parvatikar and Manjunath, 1991). so there is relationship between sugar content and stages of growth (Vietor et al., 1990). Zanini (1990) in sweet sorghum reported that at the plant maturity invert sugar decreased. Sweet sorghum (*Sorghum bicolor* (L.) Moench) is considered a promising bioethanol crop that could ease this conflict, as it produces a sugar-rich cane for ethanol production without hindering the production of grain used for food. Cultivation of sweet sorghum as a raw material for ethanol production have been practised (Dalianis, 1997) and breeding programs have been developed in many countries (e.g. India, Australia). Ture et al. (1997) reported that the bioenergy production from sweet sorghum can achieve a 90% reduction of CO₂ emissions. Although sweet sorghum produces well under low input cultivation conditions, yields are generally higher under conditions of balanced fertilization and adequate irrigation. It is also a crop with good nitrogen (N) use efficiency (Gardner et al., 1994) but inappropriate N fertilization limits yields. Depending on soil fertility, sorghum producers often apply 45 to 224 kg N ha⁻¹ (Zhao et al., 2005). However, high N fertilization should be avoided since excessive N may reduce crop ethanol yield (Wiedenfeld, 1984) as well as considerably increase production costs and reduce energy efficiency, due to the fact that N fertilization accounts for up to 50% of the total energy input in arable crops (Kuesters and Lammell, 1999). Nevertheless, the appropriate timing of N application is reported to have a higher effect on plant growth rate (Tsialtas and Maslaris, 2005) and yield (Almodares and Darany, 2006) than the total amount of N applied. In this particular study we have studied the issue of plant adaptability in general and efficiency of nutrient response in particular. To make an appreciable profit from cultivating sweet sorghum in gangetic plains of West Bengal, different agronomic practices would be developed in general and nutrient management in particular need to be standardized.

II. MATERIAL AND METHODS

The research experiment was conducted in 2016-2017 at Block Seed Farm, Panskura, East Midnapur and Soil texture of Panskura is mainly alluvial and organic carbon content is mainly Medium to High type and phosphate content is mainly Low to Medium & potash content mainly low and pH range between 6.0 to 7.0.

The experiment was arranged as a randomized block design (3×2×3) where total treatment combinations are eighteen (18) with three (3) replications and each plot measuring (4m×3m). To study the effect of fertilizer in sorghum growth, three levels of Nitrogen {0 (N1), 50 (N2) and 100 (N3) Kg/ha} were applied as urea (46% N). Two levels of Phosphorous {0 (P1), 60 (P2) Kg/ha} were applied as single super phosphate (16% P) and three levels of potassium {0 (K1), 60 (K2), 80 (K3) Kg/ha} were applied as Muriate of potash (60% K). All fertilizers were applied as basal dose except nitrogen. Half of the nitrogen was applied as basal and another half as top dressing at 30 days after Sowing. All the data was statistically analyzed using Analysis of Variance technique as described by Gomez and Gomez (1984).

Row to Row 45 cm and Plant to Plant 15 cm spacing were maintained. Plot Size 12 Sq. m (4m×3m), Plant Population 96 /Plot (12×8). Sweet sorghum varieties were namely Madhura was supplied from Dry land cereals Research Programme, ICRISAT (International Crops Research Institute for the Semi-Arid Tropics, Patancheru, Andhra Pradesh). Data was collected every 30 days interval starting from 40 DAS (Days After Sowing) up to 130 DAS so, the research experiment started from 14/06/2015 to 22/10/2015. Randomly ten selected plants were collected from each treatment for plant heights, green bio mass, sugar concentration, sugar yield from four different harvests. Plant height/stalk length (cm): Height of the primary shoot was measured from the ground level to the base of the youngest fully opened leaf until ear head emergence, after which plant height was measured from the base of the plant to the tip of the ear head and expressed in centimeters. Green Bio-mass: Total weight of ten randomly selected plants in each treatment and expressed as the average bio-mass yield (t/ha). Sugar concentration (%) Brix is the percentage of solids in the sample. Juice brix values were recorded by using hand refractometer (0-300) and correction was made with room temperature and corrected values were expressed in percentage. Sugar Yield (Kg/ha): Sugar yield: Calculated sugar yield per hectare was worked out using the formula and expressed in terms of ton per hectare (Reddi 2006).

Calculated sugar yield (t/ha) = $\{S - 0.4(B - S)\} \times F \times Y / 100$
 B and S = Brix & pol per cent, respectively of the juice sample extracted. F = Value of the factor depending on the fibre percentage of the sample. Y = weight of the stripped stalk (t/ha).

III. RESULT AND DISCUSSION

Effect on Plant Height (cm):

In case of Interaction effects between nitrogen, potassium and phosphorous N3P2K3 (100:60:80) gave highest length (186.88 cm) at 130 DAS similar results was found Roy et al (2016) have recommended that 100:60:80 kg ha⁻¹ of NPK recorded highest plant height (191.18 cm). Interaction effects of nitrogen, potassium, phosphorous were

significantly different at 40 DAS, 70 DAS and 100 DAS, among the interaction data at 40 DAS of plant height N3P2K3 (100:60:80) gave highest length (70.92 cm) and Similar result found at 70 DAS where N3P2K3 (100:60:80) give highest length (150.58 cm) and Similar result found at 100 DAS where N4P2K4 (100:60:80) give highest length (182.25 cm)

Effect on green biomass (ton/ha):

The results showed that the effect of green biomass on Interaction effects of nitrogen, potassium, phosphorous were significantly (Table-2) different at 40 DAS, 70 DAS and 130 DAS, among the interaction data at 40 DAS of plant green biomass N3P2K3 (100:60:80) gave highest yield (13.80 t/ha) and Similar result found at 70 DAS where N3P2K3 (100:60:80) give highest yield (18.4 t/ha) and Similar result found at 130 DAS where N3P2K3 (100:60:80) give highest yield (23.89 t/ha) where the highest green biomass (t/ha) yield found of 100 DAS (24.81 t/ha) at N3P2K3 (100:60:80) treatment combination. which is similarly observed by Roy et al (2016) have recommended that 100:60:80 kg ha⁻¹ of NPK recorded highest green biomass (25.26 t/ha).

Effect on Sugar Percentage (%):

The results showed that the effect of sugar percentage (%) on Interaction effect of nitrogen, potassium, phosphorous were significantly (Table-3) different at 40 DAS, 70 DAS and 130 DAS, among the interaction data at 40 DAS of plant sugar percentage N3P2K3 (100:60:80) gave highest percentage (5.68 %) and Similar result found at 70 DAS where N3P2K3 (100:60:80) give highest sugar percentage (7.84 %) and Similar result found at 130 DAS where N3P2K3 (100:60:80) give highest sugar percentage (9.69 %) where the highest sugar percentage (%) found of 100 DAS (9.77 %) at N3P2K3 (100:60:80) treatment combination. which is similarly observed by Roy et al (2016) have recommended that 100:60:80 kg ha⁻¹ of NPK recorded highest sugar parentage (10.25 t/ha).

Effect on Sugar Yield (kg/ha):

The results showed that the effect of sugar yield (kg/ha) on Interaction effect of nitrogen, potassium, phosphorous were significantly (Table-4) different at 40 DAS, 70 DAS and 130 DAS, among the interaction data at 40 DAS of plant sugar yield N3P2K3 (100:60:80) gave highest yield (585.17 kg/ha) and Similar result found at 70 DAS where N3P2K3 (100:60:80) give highest sugar yield (1081.79 kg/ha) and Similar result found at 130 DAS where N3P2K3 (100:60:80) give highest sugar yield (1707.49 kg/ha) where the highest sugar yield (kg/ha) found of 100 DAS (1789.17 kg/ha) at N3P2K3 (100:60:80) treatment combination. which is similarly observed by Roy et al (2016) have recommended that 100:60:80 kg ha⁻¹ of NPK recorded highest sugar yield (1816.50 kg/ha).



Table 1: Plant Height (cm) At Various Growth Stages of Sweet Sorghum by Different Fertilizer Doses

TREATMENT	PLANT HIGHT			
	40 DAS	70 DAS	100 DAS	130DAS
NITROGEN				
N1	46.69	126.39	151.35	156.28
N2	58.46	139.88	171.70	176.79
N3	66.84	148.55	181.38	186.37
SE	0.43	0.42	0.31	0.30
LSD	0.87	0.86	0.63	0.61
POTASSIUM				
K1	54.00	135.65	165.58	170.57
K2	57.51	138.26	168.28	173.26
K3	60.49	140.90	170.57	175.61
SE	0.43	0.42	0.31	0.30
LSD	0.87	0.86	0.63	0.61
PHOSPHORUS				
P1	54.48	136.17	166.10	171.07
P2	60.18	140.37	170.18	175.22
SE	0.35	0.35	0.25	0.24
LSD	0.71	0.70	0.52	0.50
INTERACTION				
N1P1K1	37.10	118.02	143.56	147.51
N1P1K2	40.74	118.62	145.43	149.76
N1P1K3	42.81	121.97	148.90	153.25
N2P1K1	48.99	131.00	162.16	166.82
N2P1K2	52.54	134.30	166.79	171.19
N2P1K3	54.50	136.07	168.51	172.94
N3P1K1	58.32	139.48	173.50	177.90
N3P1K2	59.67	143.53	175.28	179.68
N3P1K3	64.15	143.83	177.50	181.90
N1P2K1	42.93	121.56	146.41	150.94
N1P2K2	46.58	124.20	150.23	154.64
N1P2K3	48.96	128.16	151.35	155.75
N2P2K1	55.49	135.83	168.03	172.43
N2P2K2	57.68	137.24	170.12	174.45
N2P2K3	60.58	139.02	172.40	177.10
N3P2K1	60.14	142.21	177.61	182.01
N3P2K2	66.86	145.85	179.65	184.03
N3P2K3	70.92	150.58	182.55	186.88

SE	1.05	1.04	0.76	0.73
LSD	2.13	2.11	1.55	1.49

Table 2: Green Biomass (t/ha) At Various Growth Stages Of Sweet Sorghum By Different Fertilizer Doses

TREATMENT	PLANT GREEN BIOMASS			
	40 DAS	70 DAS	100 DAS	130DAS
NITROGEN				
N1	13.40	18.26	24.32	23.49
N2	13.69	18.54	24.76	23.87
N3	14.08	18.90	25.10	24.26
SE	0.008	0.008	0.009	0.007
LSD	0.016	0.016	0.018	0.015
POTASSIUM				
K1	13.60	18.48	24.63	23.77
K2	13.74	18.57	24.74	23.88
K3	13.84	18.65	24.81	23.97
SE	0.008	0.008	0.009	0.007
LSD	0.016	0.016	0.018	0.015
PHOSPHORUS				
P1	13.65	18.46	24.64	23.82
P2	13.80	18.67	24.81	23.93
SE	0.007	0.007	0.007	0.006
LSD	0.013	0.013	0.015	0.012
INTERACTION				
N1P1K1	12.67	17.42	23.72	22.78
N1P1K2	12.83	17.47	23.78	22.90
N1P1K3	12.89	17.54	23.86	22.96
N2P1K1	12.98	17.64	24.10	23.19
N2P1K2	13.05	17.73	24.23	23.27
N2P1K3	13.13	17.79	24.30	23.38
N3P1K1	13.30	17.94	24.45	23.55
N3P1K2	13.38	18.05	24.59	23.69
N3P1K3	13.52	18.13	24.65	23.78
N1P2K1	12.74	17.49	23.85	22.95
N1P2K2	12.92	17.6	23.96	23.00
N1P2K3	12.96	17.75	24.04	23.10
N2P2K1	13.07	17.85	24.27	23.32
N2P2K2	13.18	17.93	24.44	23.39
N2P2K3	13.30	18.01	24.51	23.44
N3P2K1	13.41	18.25	24.67	23.61
N3P2K2	13.68	18.35	24.73	23.81
N3P2K3	13.80	18.4	24.81	23.89



SE	0.020	0.020	0.022	0.018
LSD	0.040	0.040	0.044	0.036

Table 3: Sugar percentage (%) At Various Growth Stages Of Sweet Sorghum By Different Fertilizer Doses

TREATMENT	SUGAR PERCENTAGE			
	40 DAS	70 DAS	100 DAS	130DAS
NITROGEN				
N1	3.53	6.64	8.60	8.32
N2	5.02	7.62	9.24	9.00
N3	5.81	8.05	10.05	9.76
SE	0.0081	0.0087	0.0070	0.0088
LSD	0.0164	0.0177	0.0143	0.0179
POTASSIUM				
K1	4.65	7.33	9.18	8.90
K2	4.81	7.46	9.31	9.02
K3	4.90	7.53	9.40	9.17
SE	0.0081	0.0087	0.0070	0.0088
LSD	0.0164	0.0177	0.0143	0.0179
PHOSPHORUS				
P1	4.59	7.26	9.23	8.87
P2	4.98	7.61	9.36	9.18
SE	0.0066	0.0071	0.0057	0.0072
LSD	0.0134	0.0144	0.0117	0.0146
INTERACTION				
N1P1K1	2.87	5.91	7.94	7.69
N1P1K2	2.91	6.07	8.05	7.81
N1P1K3	2.93	6.15	8.15	7.91
N2P1K1	4.44	6.84	8.63	8.34
N2P1K2	4.6	7.01	8.75	8.49
N2P1K3	4.72	7.05	8.82	8.61
N3P1K1	5.14	7.29	9.39	8.92
N3P1K2	5.44	7.45	9.46	9.01
N3P1K3	5.57	7.56	9.57	9.31
N1P2K1	3.44	6.31	8.15	7.89
N1P2K2	3.57	6.33	8.2	7.99
N1P2K3	3.63	6.36	8.25	8.13
N2P2K1	4.72	7.26	8.55	8.52
N2P2K2	4.85	7.38	8.84	8.7
N2P2K3	5.01	7.48	8.96	8.83
N3P2K1	5.5	7.66	9.56	9.53
N3P2K2	5.68	7.78	9.67	9.59
N3P2K3	5.73	7.84	9.77	9.69

SE	0.0198	0.0213	0.0172	0.0216
LSD	0.0402	0.0433	0.0350	0.0438

Table 4: Sugar Yield (kg/ha) At Various Growth Stages of Sweet Sorghum by Different Fertilizer Doses

TREATMENT	SUGAR YIELD			
	40 DAS	70 DAS	100 DAS	130DAS
NITROGEN				
N1	331.77	850.55	1468.14	1371.61
N2	482.68	991.45	1604.72	1507.53
N3	574.45	1067.13	1770.20	1661.97
SE	0.57	0.88	0.92	1.09
LSD	1.17	1.78	1.86	2.21
POTASSIUM				
K1	445.56	951.07	1588.30	1485.93
K2	465.69	972.33	1616.75	1512.42
K3	477.66	985.73	1638.01	1542.76
SE	0.57	0.88	0.92	1.09
LSD	1.17	1.78	1.86	2.21
PHOSPHORUS				
P1	441.57	941.72	1597.07	1484.21
P2	484.36	997.71	1631.64	1543.19
SE	0.47	0.72	0.75	0.89
LSD	0.95	1.45	1.52	1.80
INTERACTION				
N1P1K1	271.49	778.62	1401.03	1301.44
N1P1K2	279.51	801.83	1422.34	1327.27
N1P1K3	282.6	815.55	1444.55	1347.97
N2P1K1	427.65	908.77	1541.39	1432.61
N2P1K2	445.7	935.63	1570.48	1462.23
N2P1K3	459.55	944.14	1588.33	1489.6
N3P1K1	506.86	982.21	1697.94	1552.64
N3P1K2	539.01	1010.12	1718.54	1578.02
N3P1K3	557.5	1028.22	1743.03	1634.04
N1P2K1	326.59	833.4	1444.14	1343.15
N1P2K2	343.85	841.03	1459.94	1362.97
N1P2K3	350.4	852.64	1472.84	1392.1
N2P2K1	458.19	973.86	1538.38	1470.38
N2P2K2	474.29	994.25	1599.58	1505
N2P2K3	494.53	1011.85	1626.2	1530.63
N3P2K1	546.38	1049.34	1742.92	1660.61
N3P2K2	575.56	1070.89	1765.64	1684.26
N3P2K3	585.17	1081.76	1789.17	1707.49

SE	1.41	2.15	2.24	2.66
LSD	2.86	4.36	4.56	5.40

IV. CONCLUSION

Result for this field study conclude that the interactive dose of N:P:K....100:60:80 is more effective for the vegetative growth of Sweet Sorghum for the cultivars of the particular location. As lower gangetic plains is prominent for alluvial soil nature, it affects the plant biomass production of Sweet Sorghum which can also need to be standardized much more.. Thus This data helped to observe the cultivars how the recommended dose and soil nature effects upon the growth parameters as well as bioethanol production of Sweet Sorghum.

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