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GROWTH AND YIELD BEHAVIOR OF *RABI* SEASON SWEET SORGHUM [*SORGHUM BICOLOR* (L.) MOENCH] AS INFLUENCED BY DIFFERENT SOWING DATES AND PLANTING GEOMETRY

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ABSTRACT

An experiment was conducted with four sowing dates (S_1: 2nd week of October, S_2: 4th week of October, S_3: 2nd week of November and S_4: 4th week of November) and three levels of planting geometry (P_1: 45 x 20 cm, P_2: 60 x 15 cm and P_3: 30 x 30 cm) to study the response of sweet sorghum [*Sorghum bicolor* (L.) Moench]. First date of sowing (S_1 : 2nd week of October) recorded significantly highest plant height (243.75 cm), leaf area index (2.60), 1000 grain weight (23.05 g) stalk yield (28.07 t ha^{-1}), grain yield (12.98 q ha^{-1}) and juice yield (6399.40 l ha^{-1}) over remaining sowing dates. Among the different planting geometry treatment P_3 (30 x 30 cm) recorded maximum values for growth and yield parameters with 26.64 q ha^{-1} stalk yield and 12.14 q ha^{-1} grain yield but did not differ significantly with other planting geometries.Hence, sowing of winter season sweet sorghum during 2nd week of October with 30 x 30 cm geometry is recommended.

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INTRODUCTION

Sweet sorghum [*Sorghum bicolor* (L.)Moench] is a member of the Poaceae family, which includes all the important cereal crops cultivated in the world and is an annual warm-season grass that utilizes the C_4 carbon fixation pathway and native to northern Africa. Sweet sorghum is being developed for the simultaneous production of grain and sweet stalk with sweet juicy stems, used for forage and silage or to produce syrup. It has been investigated as a potential source of fermentable sugars for fuel ethanol production. Sweet sorghum bagasse has higher biological value and can be used as animal feed or to co-generate heat and power (Seetharama *et al*., 2002). It has better digestibility than fodder sorghum (Morris and Mc Cormic, 1994). The fodder of sweet sorghum is rich source of nutrients (Singh, 2009). Stalk juice of sweet sorghum contains relatively higher amount of reducing sugars than sugarcane juice impeding crystallization of sugar, therefore, sweet sorghum is considered as a multipurpose industrial crop.Future demand for sugarcane production may exert pressure due to its lengthier growing season and higher fertilizer requirements. So sugarcane may be replaced by other supplementary sources like sweet sorghum. In order to meet the food, fodder and fuel requirement of growing population of human and livestock, the greatest challenge is to establish a balance between environment and available resources. It has wider adaptability, drought resistance and tolerance to water logging and relatively low water and fertilizer requirements.

Sowing of the crop at right time ensures better plant growth and also inhibits weed growth. There are evidences that optimum time of sowing is one of the several cultural manipulations and play vital role in boosting up the yield, particularly in Indian sub continent where the optimum time of sowing varies to great extent due to varying agro-climatic conditions. The yield and quality of sweet sorghum has been reported to vary with different sowing dates (Hipp *et al*., 1969 and Broadhead, 1972).The optimum planting geometry provides better conditions for plant growth which results in timely commencement of reproductive phase and formation of sink. The optimum planting geometry per unit area of land is contributory factor, which determines the yield of sweet sorghum. Efficient interception of radiant energy and incident to crop surface requires uniformly distributed and adequate leaf area to give maximum ground cover.

The information available on sowing dates and planting geometry especially in sweet sorghum is very scare in India. Hence present investigation was planned to find out the suitable sowing time and planting geometry to augment the production of this highly important crop.

MATERIALS AND METHODS

The present study was conducted on the college farm, Navsari Agriculture University, Navsari during *rabi* season of 2012-13. The soil of experiment plot was clayey in texture, low in nitrogen (173 kg ha^{-1}), medium in available phosphorus (31.00 kg ha^{-1}), fairly rich in available potassium (348 kg ha^{-1}) and slightly alkaline in reaction with a pH of 7.70 and normal electrical conductivity (0.36 dS m^{-1}). The experiment

was conducted in split plot design with total 12 treatment combination consisting of 4different dates of sowing viz.,S_1 : 2nd week of October, S_2 : 4th week of October, S_3 : 2nd week of November, S_4 : 4th week of November and 3 levels of planting geometry viz., P_1 : 45 x 20 cm, P_2 : 60 x 15 cm, P_3 : 30 x 30 cm.The crop was uniformly fertilized with a recommended dose of fertilizer @ 80:40:00 kg N:P:K ha^{-1}. Plot wise seeds were sown manually as per treatment at a depth of 5-7 cm in the furrow in which fertilizers were band placed previously followed by seed covering with fine soil. Five plants were selected at random from each net plot and tagged for recording periodical observations for other growth and yield attributing parameters. Leaf area meter (Model L1-COR 3100) was used for recording the area of leaves at each stage and recorded accordingly. Leaf area index was determined using the formula (LAI = Leaf area/Ground area) prescribed by Watson (1947). Two kilogram millable stalk was taken from each net plot and juice was extracted with the help of power drawn sugarcane crusher (Kolhu). Juice weight was recorded with the help of a balance and finally juice yield ha^{-1} was worked out and expressed as litres ha^{-1}. The statistical analysis of data recorded for different characters during the course of investigation was carried out in the department of Agricultural Statistics, N.M. College of Agriculture, Navsari Agricultural University, Navsari through the procedure appropriate to the design of the experiment as described by Panse and Sukhatme (1967). The significance of difference was tested by "F'' test.

RESULTS AND DISCUSSION

Effect of sowing dates

The different dates of sowing had a remarkable influence on different growth parameters (Table 1) as well as yield attributes and yield parameters (Table 2). Treatment S_1 (sowing on 2nd week of October) recorded significantly higher plant height (243.75 cm), number of internodes $plant^{-1}$ (12.32), stem girth (2.30 cm), Leaf area index (2.60), dry matter accumulation $plant^{-1}$ (105.25 g), number of functional leaves $plant^{-1}$ (8.05),stalk yield (28.07 t ha^{-1}), grain yield (12.98 q ha^{-1}), dry fodder yield (97.45 q ha^{-1}) and juice yield (6399.40 l ha^{-1}). However, treatment S_1 (sowing on 2nd week of October) did

Table 1: Effect of different sowing dates and planting geometry on growth of sweet sorghum

Treatments	Plant height (cm) at harvest	Number of internodes $plant^{-1}$ at harvest	Stem girth (cm) at harvest	Leaf area index at harvest	Dry matter accumulation (g $plant^{-1}$) at harvest	Number of functional leaves $plant^{-1}$ at harvest
A. Sowing dates (S)						
S_1	243.75	12.32	2.30	2.60	105.25	8.05
S_2	238.39	11.98	1.98	2.50	103.29	7.84
S_3	223.52	10.73	1.81	2.44	97.80	7.21
S_4	210.45	9.96	1.72	2.38	95.60	6.90
S. Em. ±	4.07	0.32	0.07	0.05	1.78	0.21
C. D. at 5%	12.22	0.95	0.21	NS	5.33	0.62
B. Planting geometry (P)						
P_1	228.85	11.31	1.97	2.48	100.86	7.42
P_2	225.76	10.81	1.89	2.46	98.58	7.23
P_3	232.47	11.61	2.00	2.50	102.02	7.86
S. Em. ±	3.53	0.28	0.06	0.05	1.54	0.18
C. D. at 5%	NS	NS	NS	NS	NS	NS
C. Interaction (S x P)						
C. D. at 5%	NS	NS	NS	NS	NS	NS

S_1 : 2nd week of October, S_2 : 4th week of October, S_3 : 2nd week of November, S_4 : 4th week of November, P_1 : 45 x 20 cm, P_2 : 60 x 15 cm, P_3 : 30 x 30 cm

Table 2: Effect of different sowing dates and planting geometry on yield of sweet sorghum.

Treatments	1000 grain weight (g)	Stalk yield(t ha^{-1})	Grain yield(q ha^{-1})	Dry fodder yield(q ha^{-1})	Juice yield (L ha^{-1})
A. Sowing dates (S)					
S_1	23.05	28.07	12.98	97.45	6399.40
S_2	22.66	27.08	12.37	96.30	6131.10
S_3	21.77	25.14	11.16	92.40	5689.10
S_4	21.13	23.68	10.59	90.01	5343.50
S. Em. ±	0.76	0.49	0.25	1.49	111.42
C. D. at 5%	NS	1.46	0.75	4.46	334.05
B. Planting geometry (P)					
P_1	22.10	26.09	11.83	94.01	5902.78
P_2	21.92	25.26	11.35	93.88	5710.22
P_3	22.44	26.64	12.14	94.23	6059.31
S. Em. ±	0.66	0.42	0.22	1.29	96.50
C. D. at 5%	NS	NS	NS	NS	NS
C. Interaction (S x P)					
C. D. at 5%	NS	NS	NS	NS	NS

S_1 : 2nd week of October, S_2 : 4th week of October, S_3 : 2nd week of November, S_4 : 4th week of November, P_1 : 45 x 20 cm, P_2 : 60 x 15 cm, P_3 : 30 x 30 cm

not differ significantly with treatment S_2 (sowing on 4th week of October) with respect to plant height, number of internodes plant^{-1}, dry matter accumulation plant^{-1}, number of functional leaves plant^{-1}, stalk yield, grain yield, dry fodder yield and juice yield. Maximum weight of 1000 grains (23.05 g) was recorded with treatment S_1 over the remaining dates of sowing but did not differ significantly with other treatment. The magnitude of increase in seed yield kg ha^{-1} under S_1 was 22.56, 16.31 and 4.93%, respectively over S_4, S_3 and S_2. This is probably due to early sown crop may enjoy favorable climatic conditions in term of temperature and other climatic parameter during various crop growth stages, which reflected into better growth. This is also attributed to early germination and initial vigorous growth of plant in early sowing compared to late sowing. Better growth of plant in terms of plant height, number of leaves, number of internodes, internode length, stem girth and dry matter accumulation reflected into better development of yield parameters under early sown crop. These results collaborate with the findings of Biradar and Gollagi (2006); Reddi (2006); Reddy *et al*. (2007); Reddi *et al*. (2013) and Dinda *et al*. (2015).

Effect of planting geometry

Different planting geometries did not shown significant influence on growth parameters (Table 1) as well as yield parameters (Table 2). Sweet sorghum crop sown with a spacing of 30 x 30 cm (P_3) recorded highest plant height (232.47cm), number of internodes plant^{-1} (11.61), stem girth (8.05cm), Leaf area index (2.50), dry matter accumulation plant^{-1} (102.02 g), number of functional leaves plant^{-1} (7.86), 1000 grains weight (22.44 g), stalk yield (22.64 t ha^{-1}), grain yield (12.14 q ha^{-1}), dry fodder yield (94.23 q ha^{-1}) and juice yield (6069.31 l ha^{-1}) over P_1 (45 x 20 cm) and P_2 (60 x 15 cm). However, treatment P_3 found to be non significant with respect to all growth as well as yield parameters with treatments P_2 and P_1. Under present investigation the minor influence of plant geometry observed on performance of sweet sorghum crop. It could be due to almost an equal ground area available for each plant which directly dictated the availability of various growth inputs to individual plants in the community and also the extent of least competition between and within the rows for various growth inputs (sunlight, water and nutrients). Though, sufficient vegetative growth and adequate supply of moisture and nutrients under all the planting geometry offered the negligible differences in growth as well as yield parameters. Similar findings were also reported by Kaushik and Shaktawat (2004); Guler *et al*. (2008); Mahmood *et al*. (2012); Snider *et al*. (2012); Sawagaonkar *et al*. (2013) and Singh *et al*. (2015).

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