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Effect of spacing and nitrogen levels on growth and yield of rabi fodder sorghum (*Sorghum bicolor* L. Moench)

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Abstract
A field experiment was carried out during rabi season of 2017-18 at the Instructional Farm, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh. The experiment was laid out in a Split Plot Design with four replication. The results revealed that sowing of the fodder sorghum crop at 40 cm wider row spacing recorded significantly higher values of almost all the growth characters viz., Plant height, number of leaves plant-1, number of internodes plant-1, stem thickness and dry matter accumulation while, plant population at initial and final, green fodder yield and dry fodder yield of fodder sorghum were significantly higher under closer row spacing of 20 cm. The parameters such as length of internodes, leaf: stem ratio, days to 50% flowering, remained unaffected due to different spacings. The growth characters, yield attributes, quality parameters, green and dry fodder yields were found significantly higher when crop was fertilized with 120 kg N ha-1 followed by 100 kg N ha-1, except plant population at initial and final; which was not significantly affected by the different nitrogen levels. Available nitrogen in soil after harvest of crop was significantly higher under wider row spacing of 40 cm. Higher gross and net realization of 40,556 and 21,785 ha-1, respectively with B: C ratio of 2.16 was obtained when fodder sorghum crop sown at 20 cm row spacing. Maximum gross (41,544 ha-1) and net realization (22,912 ha-1) along with higher B: C ratio of 2.23 were observed under nitrogen level 120 kg N ha-1 followed by nitrogen level 100 kg N ha-1.

Keywords: Fodder sorghum, rabi, spacing, nitrogen levels

Introduction
Sorghum is one of the gifted grass genera of the tropics. It provides food, feed, stover and fuel to millions of poor farm families and their livestock in the arid and semi-arid tropical region of the world. India is a notable for its huge livestock population and its economic integration with farm production, particularly under the less mechanized dry land agriculture. Sorghum is very important crop to resource poor farmers for nutritional and livelihood security. India supports 512.1 million of livestock, which includes 37.3 per cent cattle, 21.2 per cent buffalo, 12.7 per cent sheep, 26.4 per cent goat and 2.0 per cent pig (Census, 2012). Deficiencies in feed and fodder have been identified as one of the major components in achieving the desired level of livestock production. The shortage in dry fodder is 21.8 per cent compared with requirement of 560 million tons for the current livestock populations (Rana *et al*., 2013) [14]. Gujarat state has total animal population of 23.78 million heads and their total dry fodder requirement is 15.36 million tones and green fodder requirement is 37.88 million tones whereas, only 15.09 million tones of dry and 26.08 million tones of green fodder is made available in normal year (Shah *et al*., 2011) [16].

Materials and Methods
The experiment was conducted in rabi season of the year 2017-18 at Instructional Farm, College of Agriculture, Junagadh Agricultural University, Junagadh. The soil of experimental field was medium black in texture, medium in available nitrogen, phosphorus and potassium. Twelve treatment combinations consisted of three spacing viz., S1:20 cm, S2:30 cm, S3:40 cm and four levels of nitrogen viz., N1:00 kg N ha-1, N2:80 kg N ha-1, N3:100 kg N ha-1 and N4: 120 kg N ha-1 were tested under split plot design with four replications. Furrows at 20 cm, 30 cm and 40 cm distance were opened by bullock drawn cultivar in the whole experimental field. Before sowing the seed, nitrogen was applied through urea. Half of the nitrogen applied at the time of sowing and the rest at 30 - 35 days after sowing as top dressing as per

treatments, when there was adequate moisture in the soil. A uniform dose of phosphorus at 40 kg P2O5 ha-1 was applied as basal through diammonium phosphate (DAP). Herbicide Pendimethalin 30 EC @ 0.9 kg ha-1 was applied as pre-emergence with irrigation water. Two manual weeding was done in between the rows at 20 and 35 days after sowing of crop. The first common irrigation was applied immediately after sowing. Second common irrigation was given 7DAS for proper germination and establishment of the seedlings.

Results and Discussion

Effect of spacing

The initial and final plant population was recorded under the effect of spacing had their significant influence on plant population. Plant population per unit area was higher (487088 ha-1) in closer row spacing (20 cm) over wider row spacing (40 cm). Plant height at 40, 60DAS and at harvest recorded significantly higher 82.5, 138.2 and 173.5 cm, respectively when crop was sown at wider row spacing of 40 cm as compared to closer row spacing of 20 cm. The wider row spacing of 40 cm recorded higher plant height might be due to efficient utilization of growth resources like sunlight, moisture and nutrients. These results are conforms the findings Afzal *et al*. (2013) [2], Taleshi *et al*. (2013) [18] and Chavan *et al*. (2017) [6]. Fodder sorghum sown at 40 cm spacing produced significantly more number of leaves plant-1 6.7, 8.9 and 11.5, respectively at 40, 60DAS and at harvest over closer spacing of 20 cm (Table-1). These might be due to lesser inter row competition for light and have adequate space to extend its leaf and intercept more light with less competition. The results obtained in present study are in close agreement with those reported by Afzal *et al*. (2013) [2] and Akhtar *et al*. (2013) [3]. Sowing of fodder sorghum at wider row spacing of 40 cm recorded significantly higher number of internodes plant-1 (10.6) than closer row spacing of 20 and 30 cm (Table-1). Wider row spacing provided more space around each plant resulting in more metabolic activities through better utilization of light, space, water and nutrients which might be turned in better vegetative growth in terms of number of internodes plant-1. The results corroborates with the findings of Chavan *et al*. (2017) [6]. The wider row spacing (40 cm) had maximum stem thickness (1.47 cm) which closely followed by 30 cm row spacing and the lowest stem thickness (1.33 cm) was found under 20 cm row spacing. These results are in conformity with those reported by Afzal *et al*. (2013) [2] and Zand and Shakiba (2013) [19].

Dry matter accumulation at 40, 60DAS and at harvest significantly increase when fodder sorghum sown at wider row spacing 40 cm (24.8, 47.5 and 71.8 g plant-1) at par with each other except at 40DAS and recorded significantly higher dry matter accumulation plant-1 than closer row spacing of 20 cm (Table-1). Dense population under closer plant geometry reduced dry matter production might be due to less availability of space for each plant which increased competition among the plants for resources. The results corroborates with the findings of Kaushik and Shaktawat (2005) [9] and Afzal *et al*. (2013) [2]. Fodder sorghum sown at closer row spacing of 20 cm produced significantly higher green and dry fodder yields of 20278 and 9438 kg ha-1, respectively than crop sown at 40 cm row spacing and it was at par with row spacing of 30 cm (Table-2). Higher green and dry fodder yields with closer row spacing of 20 cm might be due to closer spacing accommodate more number of plants per unit area and might contributes cumulative towards more green and dry fodder yields than wider spaced plant. The findings are in close conformity with the results reported by Bahrani and Chandankar *et al*. (2005) [5], Manjunatha *et al*. (2013) [10], Prajapati *et al*. (2017) [13] and Sanmugapriya and Kalpana (2017) [15]. The growth attributes such as length of internodes, leaf: stem ratio and days to 50% flowering were not affected significantly.

The economic evaluation of different treatments revealed that the gross and net realization with B: C ratio differed appreciably (Table-2). The maximum gross and net realization of ₹ 40,556 ha-1, ₹ 21,785 ha-1 with B: C ratio of 2.16, respectively, were obtained under narrow spacing S1 (20 cm) followed by S2 (30 cm) with giving gross and net realization of ₹ 37,590 ha-1, ₹ 20,096 ha-1 with B: C ratio of 2.15, accordingly (Table-2).

Effect of nitrogen levels

The results show that the application of 120 kg N ha-1 was found significantly superior to 80 kg and 100 kg N ha-1 as it enhanced the almost all the growth parameters, yield attributes and quality parameters. Among the growth parameters studied, plant height, number of leaves plant-1 and dry matter accumulation at 40, 60DAS and at harvest (26.6, 56.5 and 84.4 g plant-1), Number of internodes plant-1 (10.2), stem thickness (1.44 cm) and length of internodes plant-1 (28.0 cm) increased with increase in nitrogen levels from 0 to 120 kg N ha-1. Application of 120 kg N kg ha-1 to fodder sorghum produced significantly higher green and dry fodder yields of 20772 and 9573 kg ha-1, respectively and which was found at par with 100 kg N ha-1 in case of green fodder yield (Table-2). The increase in growth parameters like plant height, number of leaves, dry matter accumulation, number of internodes, thickness and length of internodes with increase in nitrogen levels could be attributed to favourable effect of nitrogen in increasing cell wall material resulted in increased size of cell. It contributes to cell division and cell elongation. Also meristematic tissue has very active protein metabolism and photosynthetic transport to sites of growth which are used predominantly in synthesis of nucleic acid and protein. These results are in accordance with the findings of Patidar and Mali (2004) [12], Chotiya and Singh (2005) [8], Singh and Sumeriya (2010) [17], Mishra *et al*. (2013) [11], Adam and Taleim (2018) [1] and Chaudhary *et al*. (2018) [7].

Data further showed that fodder sorghum fertilized with 120 kg N ha-1 (N4) recorded maximum gross and net return of ₹ 41,544 ha-1, ₹ 22,912 ha-1, respectively (Table-2). This might be attributed to sufficient availability and more uptake of nitrogen by crop ultimately resulted in better vegetative growth such as plant height, number of leaves, number of internodes, green and dry fodder yields at harvest which leads to higher gross return, net return and B: C ratio.

Table 1: Effect of spacing and nitrogen levels on growth and yield attributes of fodder sorghum

Treatments	Plant population	Plant height (cm)	No. of leaves plant-1	No. of internodes plant-1	Length of internode (cm)	Stem thickness (cm)	Dry matter accumulation (g plant-1)
Spacing (cm)							
S1-20	481288	151.8	10.2	8.5	24.2	1.33	64.7
S1-30	320858	162.2	10.8	9.5	25.4	1.42	69.5
S1-40	246506	173.5	11.5	10.6	26.9	1.47	71.8
SEm.±	9411	3.53	0.24	0.20	0.61	0.02	1.57
C.D. at%	32568	12.21	0.84	0.71	NS	0.05	5.43
Nitrogen levels (kg N ha-1)							
N1-00	344716	143.0	9.3	8.6	22.2	1.36	53.7
N2-80	343165	153.5	10.4	9.3	24.4	1.41	64.1
N3-100	351942	174.0	11.6	10.0	27.4	1.43	72.4
N4-120	358379	179.6	11.9	10.2	28.0	1.44	84.4
SEm.±	5683	3.39	0.20	0.13	0.54	0.02	1.30
C.D. at%	NS	9.84	0.58	0.37	1.56	0.05	3.77

Table 2: Effect of spacing and nitrogen levels on yield and economics of fodder sorghum

Treatments	Green fodder yield (kg ha-1)	Dry fodder yield kg ha-1)	Gross return (₹ha-1)	Net return (₹ha-1)	B: C ratio
Spacing (cm)					
S1-20	20278	9438	40556	21785	2.16
S1-30	18795	8458	37590	20096	2.15
S1-40	17313	7791	34626	17770	2.05
SEm.±	576	279			
C.D. at%	1994	967			
Nitrogen levels (kg N ha-1)					
N1-00	16715	7558	33430	18490	2.23
N2-80	17814	8094	35628	17590	1.98
N3-100	19881	9024	39762	21427	2.17
N4-120	20772	9573	41544	22912	2.23
SEm.±	509	272			
C.D. at%	1478	789			

Conclusion

Based on the results from one year experimentation, it seems quite logical to conclude that under medium black soil of South Saurashtra Agro- climatic zone for getting higher green fodder yield and net realization, rabi fodder sorghum (GFS-5) should be sown at 20 cm and fertilized with 120 kg N ha-1 along with other recommended package of practices.

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