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Comprehensive efforts for juice quality improvement of sugarcane through planting material, spacing and nitrogen management

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Abstract
A Field experiment were conducted at Navsari Agricultural University, Navsari during 2016-17 and 2017-18 to study the effect of planting material, spacing and nitrogen management on sugarcane seed crop production under south Gujarat condition. Total sixteen treatments comprised of four planting material; tissue culture, nursery seedling, one budded sprouted and two budded setts and two plant spacing of 120 cm x 45 cm and 120 cm x 60 cm with two nitrogen levels; 250 kg N/ha and 300 kg N/ha. One the basis of pooled analysis of experiment showed that significantly maximum sugarcane yield (99.47 t/ha) was obtained with two budded setts planting material due to maximum yield attributing characters, similarly, juice quality (brix, purity, reducing sugar, non-reducing sugar and commercial cane sugar) as well as content and uptake as compare to other planting material. The plant spacing of 120 cm x 60 cm was recorded significantly higher cane yield (75.98 t/ha) with yield attributing characters. Similarly, quality of juice. The application of 300 kg N/ha were recorded significantly higher in all the yield attributing characters as well as juice quality and sugarcane yield (75.03 t/ha) which is higher to 250 kg N/ha.

Keywords: Economic, juice quality, nitrogen, planting material, tissue culture, spacing

Introduction
Sugarcane is an important commercial cash and industrial crop in India. Sugarcane plants raised through seeds (fuzz) are highly heterozygous and used only for breeding purpose. As a result, for commercial propagation, it is propagated vegetatively through stem cuttings. However, the conventional propagation method where stem cuttings with two to three buds used as planting material has various limitations. The multiplication rate of sugarcane planting material is very slow (1:5-1:7). Moreover, the yield of the existing few commercial cane varieties is declining sharply and some productive varieties were obsolete due to lack of alternative technologies for disease cleansing and rejuvenation of old sugarcane varieties. Tissue culture, nursery seedling and one budded spouted plant is a tool for obtaining rapid rejuvenation and mass multiplication of disease free, true to type and uniform planting materials of sugarcane. Moreover, planting material with agronomical management practices like spacing and nitrogen nutrient also very important. Solar energy, nutrient uptake and all soil resource utilization depends on plant population per unit area. Less competition between plant to plant gave higher yield. Nitrogen nutrient is very important among all essential nutrient. Nitrogen fertilization enhances and increases the growth of sugarcane and enables the plants to take up other nutrients. Increasing the level of nitrogen splits applications of the seed cane plants correspondingly increases sett yield and quality (Herbert, 1956). Moreover, the yield advantage and profitability of using this technology need to be clearly known. Therefore, the objective of this study was to evaluate the seed quality improvement of sugarcane through a planting material, spacing and nitrogen management

Materials and Methods
A field experiment was conducted during *kharif* season of 2016-17 and 2017-18 at Agronomy Instructional farm, N. M. College of Agriculture, Navsari agricultural University, Navsari, to study the "Effect of planting material, spacing and nitrogen management on sugarcane seed crop under south Gujarat condition". Geographically, the Navsari is situated at 200 57' North Latitude and 720 54' East longitude with an elevation of 18 meter above the mean sea level

and situated in the south Gujarat agro-climate region. The climate of the region is warm humid with heavy monsoon. The soil of the experimental field was clayey in texture, low in organic carbon (0.36% and 0.41 %) and showed medium rating for available nitrogen (276 kg/ha and 294 kg/ha) and phosphorus (37 kg/ha and 34 kg/ha) and high rating for available potassium (365 kg/ha and 355 kg/ha). The soil was found slightly alkaline (pH 7.6 and 7.2) with normal electrical conductivity (0.58 dS/m and 0.40 dS/m). Total sixteen treatment was test out *viz*., (P_1) planting material; (P_2) tissue culture seedling, (P_3) nursery seedling, (P_4) one budded sprouts and two budded setts and spacing; (S_1) 120 cm x 45 cm and (S_2) 120 cm x 60 cm with two nitrogen treatment of 250 kg N/ha (N_1) (four split, 15%, 30%, 20% and 35% at basal, 45, 90 and 180 DAP) and 300 kg N/ha (N_1) (Six equally split of 50 kg N/ha at basal, 45, 90, 135, 180 and 270 DAP) were evaluated in spilt plot design with three replications. Urea used as source of nitrogen and recommended dose of phosphorus @125 kg P_2O_5/ha and potassium @125 kg K_2O/ha was appended through single supper phosphate and murite of potash applied at the time of sowing. Organic manures were thoroughly incorporated in soil in furrow as per treatment and fertilizers were applied according to the treatments manually before sowing the setts. All other cultural practices were performed uniformly for all the treatments. All the data pertaining to yield were recorded from the net plot. Gap filling were carried out after 45 days after planting to maintain optimum plant population in the experimental plots for knowing the treatment effect. Weeding and plant protection measures were undertaken as per the need and the required plant population was maintained. The collected data for various parameters were statistically analysed using Fishers' analysis of variance (ANOVA) technique and the treatments were compared at 5% level of significance (Steel and Torrie, 1997).

Yield

Effect of planting material

Data showed on Table 1 revealed that significant effect on cane yield. Two budded setts (P_4) recorded significantly maximum cane yield (99.47 t/ha) as compare to other planting materials and followed by tissue culture seedling (81.39 t/ha) (P_1) and nursery seedling (63.16 t/ha) (P_2) while significantly lower cane yield (50.54 t/ha) was recorded with single budded sprouts (P_3) in sugarcane seed crop. The difference in individual cane weight can be attributed to the variations in can yield. The higher cane length, cane girth and single cane weight under two budded setts planting material may be due to better growth of plant, higher leaf area and moisture in cane and nutrient uptake pattern resulted more cane yield in two budded setts. Tissue culture (P_1) have higher millable canes per clump but its fail to give higher yield due to light weight of single cane and less cane girth. Patel and Patel (2014) [9] reported same resulted.

Effect of spacing

Plant spacing of 120 cm x 60 cm (S_2) were recorded significantly maximum higher cane yield (75.98 t/ha) while significantly lower cane yield (71.30 t/ha) was recorded with 120 cm x 45 cm (S_1) at harvest of sugarcane seed crop. Plant height in sugarcane is a combination of better crop growing conditions and varietal characteristics. It contributes considerably to increase crop biomass. Cheema *et al*. (2002) [2] and Rasker and Bhoi (2003) [10] also recorded significantly higher cane yield with a 90 cm intra-row spacing compared with 60 cm intra row spacing. This attributed to better growth of plant in term of plant height and number of tillers. This was might be due to less number of plant in wider spacing is uniform in solar radiation, nutrient distribution and water requirement.

Effect of nitrogen management

Nitrogen management with 300 kg N/ha (N_2) (Six splits) was recorded significantly maximum cane yield (75.03 t/ha) and followed by 250 kg N/ha (72.25 t/ha) (N_1) (Four splits) in sugarcane seed crop. This variety of sugarcane CoN 07072 (GNS 8) was indeterminate type, so sugarcane gave response of applied nitrogen up to the harvest, that why last two split of nitrogen resulted more cane yield. Cane yield which is function of yield contributing characters and improvement of cane yield was associated with yield components. Favourable effect of nitrogen on cane has also been reported by Kumar *et al.* (2012) [7] and Lamba *et al*. (2016) [8].

Juice quality

Effect of planting material

The data on presented on Table 1 indicated that, planting material significantly affected quality of sugarcane juice at harvest. The better juice quality obtained under two budded setts planting material (P_4) respect to brix (%), non-reducing sugar (%), reducing sugar(%), total sugar (%), purity (%), CCS (%), CCS (t/ha), fiber (%) and juice extraction (%) due to overall good plant growth enabling plant growth enabling plant to accumulate more photosythates for synthesis of sucrose. Tissue culture plant material (P_1) was at par with two budded setts (P_4) in brix (%), non-reducing (%), purity (%) and CCS (t/ha). Nursery seedling (P_2) was at par with two budded setts (P_4) in reducing sugar. Commercial cane sugar yield increase may be due to cane yield and some extent to improved juice quality. Same results findings by Geetha and Padmanabhan (2002) [4] and Devi *et al*. (2011) [3].

Effect of spacing

The sugarcane quality in term of brix and purity content in juice were not influenced significantly by different plant spacing, but non- reducing sugar (%), reducing sugar (%), total sugar (%), commercial cane sugar (% and t/ha), fiber (%) and juice extraction (%) was significantly higher noticed with the cane spaced at 60 cm (S_2) as compare to 45 cm (S_1) plant spacing. Brix (%) and purity (%) was non-significant might be due to genetic characteristics of these varieties for these characters while non-reducing sugar (%), reducing sugar (%), total sugar (%), commercial cane sugar (% and t/ha), fiber (%) and juice extraction (%) was higher because wider spacing (S_2) produce more sink due to efficient use of resources, less competition between plants, good growth of plant therefore 60 cm plant spacing (S_2) gave significantly better juice quality. Thompson and Du Toit (1965) recorded 16.2 per cent sucrose at 90 cm spacing as against 15.6 per cent at 45 cm spacing. Gupta and Lal (1975) found more sucrose per cent at 112.5 cm spacing than 75 cm spacing. Those results supported by Singh *et al.* (2012) [11] and Chakrawal and Kumar (2014) [1].

Effect of nitrogen

Significantly higher brix (%), non-reducing sugar (%), reducing sugar (%), total sugar (%), purity (%), commercial cane sugar percentage (%), fiber (%) and juice extraction (%)

was realized with the cane at nitrogen level of 300 kg nitrogen per hectare (N_2), which was significantly superior. Significantly lesser value of brix was associated with the cane that received 250 kg nitrogen per hectare (N_2). Non-reducing (%), reducing sugar (%) and total sugar content (%) in the cane juice, setts with more moisture was highest with the higher dose of nutrient level might be due to extended level of nutrient availability. Commercial cane sugar yield (t/ha) was non-significant due to cane yield. All over juice quality was higher under the 300 kg nitrogen at six equal splits per hectare (N_2) as compare to 250 kg nitrogen at four splits (N_1) due to continuously availability of nitrogen up to maturity stage, more conversation of sugar resulted higher juice quality. Similarly, in respect of quality parameters of sugarcane were observed by Singh *et al.* (2002), Saini *et al.* (2005) and Kumar *et al.* (2012) [7].

Nitrogen content and uptake

Effect of plant material

Significantly higher nitrogen content (%) and uptake (t/ha) in cane and leaf and total uptake found in two budded setts planting material (P_4). Two budded setts planting material (P_4) have well in growth and development resulted more dry matter accumulation. The removal of nutrient is a function of its content multiplied by the dry matter yield, thus higher uptake can be credited largely to enhanced yield due to two budded setts (P_4). Nutrient absorption and growth are generally correlated so, more growth is resulted due to more uptake of nutrient from soil.

Effect of spacing

The seed cane harvested at plant distance of 60 cm (S_2) showed significantly higher nitrogen content (%) in cane while leaf and total content was non-significant. The numerically higher content of nitrogen in leaf and total content sugarcane noticed under 60 cm plant spacing (S_2) of sugarcane. This was mainly because at wider plant spacing (S_2) the N content in both cane and leaf was higher than closely spaced planting (S_1). Availability of more space per plant might have led to greater N concentration in cane and leaf. Total uptake of nitrogen were appreciably more in the treatment 120 cm x 60 cm (S_2). This might be due to comparatively higher respective sugarcane component production under this treatment. Higher growth and yield attributes characters in wider spaced planted sugarcane (S_2) have positively more demand for nutrient and due to less number of clump per unit area sufficient nutrient may available per clump resulted in more content (%) and uptake (kg/ha) of nutrient in wider planted sugarcane (S_2).

Effect on nitrogen

The cane that received 300 kg nitrogen per hectare (P_4) resulted in significantly higher content (%) and uptake (kg/ha) in cane and leaf and total uptake. This might also be attributed to better availability of nitrogen in the soil due to application of nitrogen with six splits (N_2) during sugarcane growing period. Highest nitrogen content (%) and uptake (kg/ha) in the plant might be due to application of higher dose of nutrients which favours higher uptake. Significant improvement in uptake of nitrogen might be attributed to their concentration in cane and leaf and associated with higher cane (Table 2).

Table 1: Effect of planting material, spacing and nitrogen management on juice quality of sugarcane crop (Pooled).

Treatments	Brix (%)	Non-reducing sugar (%)	Reducing sugar (%)	Total sugar (%)	Purity (%)	Commercial cane sugar		Fiber (%)
						(%)	(t/ha)	
Main Plot (Planting material x Spacing)								
P_1: Tissue culture	20.71	17.88	2.65	20.38	86.22	12.21	9.94	12.84
P_2: Nursery seedlings	20.06	17.17	2.98	19.99	85.77	11.74	7.41	13.57
P_3: One budded sprouts	19.94	17.09	2.91	19.86	85.68	11.70	5.91	13.70
P_4: Two budded setts	20.93	18.09	3.02	20.95	86.48	12.38	12.31	14.20
S.E.m. ±	0.13	0.12	0.01	0.14	0.09	0.08	0.17	0.04
C.D. (P=0.05%)	0.38	0.35	0.04	0.40	0.25	0.24	0.48	0.12
Spacing (S)								
S_1: 120 cm x 45 cm	20.27	17.41	2.86	20.12	85.96	11.92	8.50	13.46
S_2: 120 cm x 60 cm	20.55	17.71	2.92	20.47	86.12	12.10	9.19	13.69
S.E.m. ±	0.08	0.08	0.01	0.10	0.06	0.06	0.12	0.03
C.D. (P=0.05%)	0.25	0.25	0.03	0.29	NS	0.17	0.34	0.09
CV %	3.09	3.35	2.40	3.36	0.50	3.37	9.17	1.50
Interaction	-	-	-	-	-	-	-	-
Sub plot (Nitrogen)								
N_1: 250 kg N/ha	20.28	17.41	2.86	20.11	85.91	11.93	8.62	13.53
N_2: 300 kg N/ha	20.55	17.71	2.92	20.48	86.16	12.12	9.09	13.61
S.E.m. ±	0.06	0.07	0.01	0.08	0.06	0.05	0.09	0.01
C.D. (P=0.05%)	0.19	0.20	0.03	0.24	0.16	0.14	0.29	0.05
CV %	2.27	2.78	2.22	2.82	0.46	2.73	7.20	0.99
Interaction	-	-	-	-	-	-	-	-

Table 2: Effect of planting material, spacing and nitrogen management on yield, nitrogen content and uptake of sugarcane crop (Pooled).

Treatments	Cane yield (t/ha)	N content in cane (%)	N content in leaf (%)	N uptake in cane (kg/ha)	N uptake in leaf (kg/ha)	Total N uptake (kg/ha)
Main Plot (Planting material x Spacing)						
P_1: Tissue culture	81.39	0.223	0.618	53.50	21.27	74.77
P_2: Nursery seedlings	63.16	0.219	0.630	43.83	23.67	67.50
P_3: One budded sprouts	50.54	0.216	0.604	35.14	23.82	58.95
P_4: Two budded setts	99.47	0.242	0.653	70.44	35.54	105.98
S.E.m. ±	1.23	0.002	0.007	0.76	0.82	1.10
C.D. (P=0.05%)	3.57	0.006	0.021	2.20	2.39	3.18
Spacing (S)						
S_1: 120 cm x 45 cm	71.30	0.220	0.621	48.14	24.52	74.66
S_2: 120 cm x 60 cm	75.98	0.231	0.631	53.31	25.63	78.94
S.E.m. ±	0.87	0.001	0.005	0.54	0.58	0.78
C.D. (P=0.05%)	2.52	0.004	NS	1.56	NS	2.25
CV %	8.20	4.47	10.75	7.35	11.80	7.96
Interaction	-	-	-	-	-	-
Sub plot (Nitrogen)						
N_1: 250 kg N/ha	72.25	0.222	0.616	49.00	24.76	73.77
N_2: 300 kg N/ha	75.03	0.229	0.635	52.45	27.39	79.84
S.E.m. ±	0.61	0.001	0.003	0.46	0.62	0.76
C.D. (P=0.05%)	1.74	0.004	0.010	1.32	1.80	2.18
CV %	5.69	4.02	8.00	6.30	8.56	6.23
Interaction	-	-	-	-	-	-

Conclusion

Results obtained from the investigation, it can be conclude that higher cane yield as well as good quality sugarcane juice and sugar recovery was obtained with two budded setts planting material with plant spacing of 120 cm x 60 cm and apply 300 kg N/ha to sugarcane crop under south Gujarat condition.

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