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SUGARCANE YIELD AND NUTRIENT UPTAKE UNDER PLANT GEOMETRY AND VARIETY IN RELATION TO MECHANIZATION

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ABSTRACT

A field experiment was conducted for 2 years (2010-11 and 2011-12) at Main Sugarcane Research Station, Navsari Agricultural University, Navsari, Gujarat to find out the plant geometry and variety of sugarcane (*Saccharum officinarum*) feasible under mechanization. The results indicated that plant geometry 120 cm normal row spacing found significantly superior in increasing number of internodes (23.00), cane length (251.28 cm), number of millable canes (114745 ha^{-1}), cane (127 tha^{-1}) and CCS (17 tha^{-1}) yield as compared to 90 cm, 150 cm and 30:150 cm row spacing. The increase in cane yield was 8.06 %, 7.60 % and 7.95 % over 90 cm, 150 cm and 30: 150 cm row spacing respectively. Moreover, it showed significantly higher N (195.56 $kgha^{-1}$), P_2O_5 (113.33 $kgha^{-1}$) and K_2O uptake (300.08 $kgha^{-1}$). Various varieties had significant impact on yield parametres and nutrient uptake. Variety CoN 05071 increased number of internode (23.00), cane girth (2.53 cm), cane length (252.69 cm), cane (132 tha^{-1}) and CCS (18 tha^{-1}) yield significantly as compared to variety CoN 08072, Co 86032 and Co 99004. Wide row spacing with erect variety is found suitable for mechanized operation. Thus, higher production of sugarcane can be achieved by planting setts at 120 cm normal row spacing with variety CoN 05071 while mechanization is feasible under plant geometry 120 cm normal row or 30:150 cm twin rowwith variety CoN 08072.

INTRODUCTION

Sugarcane is the second most important industrial crop of India with highestproduction of sugar after Brazil. The area occupying in the country is 5.04 million ha with the production and productivity of 361.04 million tonnes and 71.6 t ha^{-1}, respectively (Anon., 2013a). Sugarcane is emerging as a multiproduct crop used as a basic raw material for the production of sugar, ethanol, electricity, paper and boards besides a host of ancillary products viz., molasses, spirit, bagasse, compost etc. In recent times, tremendous increase in various industries resulted in scarcity of labours making all the operation difficult to carry out at proper time. Moreover, labours are not preferring to work in agriculture because of attractive wages and other benefits offered by industrialist. Hence, farmers are in search of that option which is less human labour oriented. In this context, mechanized farming is need of hour. Mechanized operation mainly introduced to reduce the human efforts and improve the working efficiency. For operating big machine, wide row spacing upto 120-180 cm require. This wide row will facilitate the use of power tillers, other machinery and harvester for operations like weeding, earthing up and harvesting and to reduce cost of production in contrast to conventional method of planting. This technology is spreading fast in tropical states and found to produce higher cane yield, facilitate mechanization of field operation and reduce production costs (Sundara, 2003). Wider row spacing of 120-150 cm may advisable for long duration high tillering varietiesunder high soil fertile conditions and is recommended to adopt mechanization for better workability of harvester.It helps to provide abundant sunlight for increasing cane yield, provides proper space for intercropping and interculturing operations and also proper adoption of mechanization thereby increasing the per unit profitability (Panghal, 2010 and Chaudhari *et al.,* 2010).To facilitate mechanized operation, sugarcane varieties with suitable characteristics are needed. The varieties which are erect, uniform in height, limited/non flowering, resistant to lodging and having shorter stalk with high tillering are more preferable for mechanized operation. Moreover, the varieties having high or low tiller dynamics shows variable response to change in planting density/row spacing. Early and short duration varieties perform well under closer spacing while late varieties require wider spacing (Gopalasundaram, 2009). In view of the above, the present study was undertaken to assess the performance of variety and their requirement for spacing that may suitable for mechanized operation.

MATERIALS AND METHODS

A field experiment was conducted for two years (2010-2011 and 2011-2012) at Main Sugarcane Research Station, Navsari Agricultural University, Navsari, Gujarat. The experimental soil was clayey in texture with slightly alkaline in reaction (pH 7.86), EC (0.2 dsm^{-1}), medium in available nitrogen (293.2 $kgha^{-1}$), medium in available phosphorus (29.43 $kgha^{-1}$) and fairly reach in available potassium (322.00 $kgha^{-1}$). Treatment consisted of four plant geometries (90 cm normal row spacing (P_1), 120 cm normal row spacing (P_2), 150 cm normal row spacing (P_3) and 30:150 cm twin row planting (P_4)) and four varieties (CoN 05071 (V_1), CoN 08072 (V_2), Co 86032 (V_3) and Co 99004 (V_4)). There were 16 treatment combination

replicated four times in split plot design. The crop was uniformly fertilized with recommended dose of 250 kg N, 125 kg P_2O_5 and 125 kg K_2Oha^{-1}. Urea, single super phosphate and muriate of potash were taken as sources of nitrogen, phosphorus and potassium, respectively. 100 % recommended dose of P_2O_5 (125 kg ha^{-1}) and K_2O (125 kg ha^{-1}) applied at the time of planting while nitrogen 100 % (250 kgha^{-1}) applied in four splits among which 15 % of recommended dose of N (37.5 kgha^{-1}) was applied at the time of planting and remaining 85 % of N was applied in three splits *i.* e. 30 %, 20 % and 35 % at 1.5 month, 3 and 5 month after planting respectively. Using same seed rate in all the plant geometries two budded healthycane setts @ 50,000 having viable buds were planted after sett treatment in different experimental plots. The planting was done at in the first and second fortnight of December during 2010-2011 and 2011-12 respectively and both year crops were harvested in first and second week of January during 2010-2011 and 2011-12 respectively. The irrigation and other packages of practices were adopted as per recommendations during the crop growth period in both the years.

Observation on different parametres was recorded at their respective growth stages following standard procedures. Five canes were randomly selected from each plot for estimation of yield attributes. The concentration of N, P_2O_5 and K_2O in plant was analysed using standard procedure given by Jackson (1967). The uptake of nutrients was calculated by multiplying the dry matter yield with the respective percentage of compositions of different nutrients. To know the feasibility of mechanization, certain observation inclusive of visual eye and database were taken into consideration. Convenience, comfort and shoot and root injury were observed and noted for different treatments while data on plant population and cane yield, weed count and dry weight of weeds were used to evaluate the mechanized operation.

RESULTS AND DISCUSSION

Yield and yield attributes

Among different sugarcane yield attributes viz., cane length, number of millable canes, number of internodes per cane, cane and commercial cane sugar (CCS) (Table 1) exhibited significant differences among the various plant geometries. Higher cane length (251.28 cm), number of millable canes (114745ha^{-1}) was recorded with the plant geometry P_2 (120 cm normal row spacing). Cane length increased may be due to better development of growth parametres. This was in accordance with the findings of Ghaffar *et al.* (2012) and Anon. (2013b) while number of millable canes could be attributed to higher number of tillers, more efficient utilization of moisture, nutrients and solar energy with less inter and intra plant competition. These results confirm the findings of Chattha *et al.* (2007) and Zafar *et al.* (2010)

Significantly higher cane (126.80 tha^{-1}) and CCS (16.92 tha^{-1}) were found with plant geometry P_2 (120 cm normal row spacing). The marked increase in yield appears due to better light interception, greater availability of moisture, more aeration to individual setts and increased plant population; better tillering and tiller retention which resulted in taller stalks and increased cane weight at harvest to the rest of plant geometries. Favourable effect of wider row planting on cane and sugar yield in sugarcane has also been reported by Anon.(2013b). Cane girth, number of internodes per cane and single cane weight were not reach the level of significance due to various plant geometries. This might be due to varietal characters of specific variety which may not alter generally under favourable conditions. These findings are in agreement with those reported by Karamathullah *et al.* (1992).

Nutrient uptake

Various plant geometries significantly increased N, P_2O_5 and K_2O uptake (Table 2). The higher N, P_2O_5 and K_2Ouptake of 195.56, 113.33 and 300.08 kgha^{-1} were recorded at 120 cm normal row spacing (P_2) respectively. This might be due to comparatively higher respective sugarcane component production under this plant geometry. Almost similar findings were reported by Patel (2003).

The differences for N, P_2O_5 and K_2O uptake in sugarcane due to various varieties were found to be significant (Table 2). Among the various varieties the highest N (203.71 kg ha^{-1}), P_2O_5 (111.47 kgha^{-1}) and K_2O (297.62 kgha^{-1}) uptake was due to variety CoN 05071 which was significantly higher than other varieties (CoN 08072, Co 86032 and Co 99004). This

Table 1: Yield and yield parameters of sugarcane at harvest as influenced by plant geometry and variety

Treatment	Number of internode/millable canes	Cane girth (cm)	Cane length (cm)	Number of millable canes (ha^{-1})	Single cane weight (kg)	Cane yield (t ha^{-1})	CCS yield (t ha^{-1})
Plant geometry							
P_1	22.00	2.49	233.44	107391	1.18	117.34	15.70
P_2	23.00	2.50	251.28	114745	1.18	126.80	16.92
P_3	22.00	2.47	241.87	106667	1.15	117.84	15.78
P_4	22.00	2.46	246.28	104940	1.19	117.46	15.77
S. Em.±	0.29	0.017	3.07	1427.02	0.013	2.14	0.27
C.D. at 5%	0.84	NS	9.02	4197.66	NS	6.36	0.80
Variety							
V_1	23.00	2.53	252.69	111265	1.27	132.40	18.25
V_2	21.00	2.42	230.19	114122	1.11	117.86	14.84
V_3	21.00	2.48	239.75	117351	1.15	115.26	15.68
V_4	23.00	2.48	250.25	91004	1.16	113.91	15.41
S. Em.±	0.33	0.015	3.67	2027.61	0.018	2.05	0.30
C.D. at 5%	0.93	0.044	10.36	5720.62	0.051	5.78	0.85

Table 2: Nutrient uptake by plant at harvest as influenced by plant geometry and variety

Treatment	N uptake(kg ha^{-1})	P_2O_5 uptake(kg ha^{-1})	K_2O uptake (kg ha^{-1})
Plant geometry			
P_1	179.01	97.01	257.27
P_2	195.56	113.33	300.08
P_3	177.56	88.32	238.73
P_4	181.94	96.86	254.31
S. Em.±	4.05	1.92	5.44
C.D. at 5%	11.92	5.65	16.00
Variety			
V_1	203.71	111.47	297.62
V_2	172.48	96.07	245.76
V_3	170.86	95.00	245.11
V_4	186.92	92.98	261.89
S. Em.±	2.93	1.93	5.25
C.D. at 5%	8.28	5.46	14.82

might be due to higher yield and nutrients content observed with this variety. These results confirm the findings of Narayanmurthi *et al.* (1997).

Feasibility of mechanization

Wide row spacing at 120 cm and 30:150 cm (twin row planting) found suitable for cultural operations viz., weeding and earthing up. This method of planting is easy for the human labour to move inside field for operations like trashing, propping, plant protection, guiding irrigation water. It may be due to wide row facilitate the use of power tillers and other small machineries and provide more space for germinating shoot, facilitate tillering and better tiller survival. It also permit the use of mechanical planter and harvester which reduces the planting and harvesting costs, trash burning and stubble shaving as machine harvested plot cut down canes near to the ground level which boost up profit margin to the cane growers upto certain level and reduce labour cost. These results are in accordance with Murali and Balakrishnan (2012) and Rajula Shanthy and Muthusamy (2012).

Erect varieties with high tillering are suitable and feasible under wide row planting for carrying out mechanized operations. Among four varieties, CoN 05071performed well in terms of cane yield, amenable for wide row spacing and CoN 08072 with advantageous characters like better tillering and erectness which facilitate easy mechanized operations.

Wide row spacing (120 cm and 30:150 cm twin row) coupled with erect variety CoN 05071 and CoN 08072 reduce cost of cultivation, increase cane yield and suitable for adoption of mechanization thereby increase the per unit profitability. Almost similar findings were reported by Richard *et al.* (1991) and Hemaprabha (2011).

From the results of the 2 year experimentation on sugarcane and discussion it may be concluded that higher production of sugarcane crop can be achieved by planting of sugarcane setts at 120 cm normal row spacing with variety CoN 05071while mechanized operation found suitable and feasible under 120 cm normal row or 30:150 twin row spacing with variety CoN 08072 under South Gujarat condition.

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