Sugarcane (*Saccharum officinarum* L) yield and quality in relation to planting methods, spacing and intercropping

VISHAKHA D CHAUDHARI[1], HM VIRDIA[2] and NARESH CHAUDHARI[2]

[1]Department of Agronomy, BA College of Agriculture
Anand Agricultural University, Anand 388001 Gujarat, India
[2]Main Sugarcane Research Station
Navsari Agricultural University, Navsari 386450 Gujarat, India
Email for correspondence: vishakha@aau.in

 Received: 04.06.2021/Accepted: 09.07.2021

ABSTRACT

The study was carried out in south Gujarat at the Navsari Agricultural University, Navsari, Gujarat during 2015-16 and 2016-17. Different planting methods with plant spacing and intercropping system were evaluated on sugarcane crop. Different planting methods including seedlings raised in nursery tray and sprouted one-budded eye with two different plant spacings of 90 x 30 cm and 120 x 30 cm along with four intercrops namely onion, cabbage, greengram and control (sole cane) were tested. The results indicated that significantly higher cane yield (112.98 tonnes/ha) was recorded under the treatment having seedlings raised in nursery tray due to higher number of internodes (22.76), cane girth (10.46 cm) and number of millable canes (1,05,809/ha). The wider row spacing of 120 cm recorded significantly higher cane yield (112.27 tonnes/ha) and yield attributes. Significantly higher cane yield (112.75 tonnes/ha) was observed with sole crop of sugarcane; higher brix (20.43%), pol per cent cane (14.18%) and commercial cane sugar yield (14.44 tonnes/ha) with seedlings raised in nursery tray; higher commercial cane sugar yield (14.21 tonnes/ha) under spacing 120 x 30 cm and higher pol per cent juice (18.38%), pol per cent cane (14.22%) and commercial cane sugar (12.84%) were recorded with sugarcane + greengram which was at par with treatments sugarcane + onion and sugarcane + cabbage. Significantly higher commercial cane sugar yield (14.33 tonnes/ha) was recorded with treatment sugarcane + onion and it was at par with sugarcane + greengram (13.91 tonnes/ha) and control (13.48 tonnes/ha).

Keywords: Sugarcane; planting methods; wider spacing; intercropping; yield; quality

INTRODUCTION

Sugarcane (*Saccharum* spp) is most important perennial commercial crop of the country. It is a long duration crop and requires large quantity of planting material and nutrients throughout its life cycle for proper growth and development. In India, for conventional system of sugarcane cultivation, about 6-8 tonnes seed cane/ha is used as planting material which comprises about 32,000-50,000 stalk pieces having 3/2 buds. This large mass of planting material poses a great problem in transport, handling and storage of seed cane and undergoes rapid deterioration thus reducing the viability of buds and subsequently their sprouting. One alternative to reduce the mass and improve the quality of seed cane would be to plant excised axillary buds of cane stalk, popularly known as bud chips. These single bud chips are raised in nursery and settlings transplanted in the field. The bud chip technology holds great promise in rapid multiplication of new cane varieties.

Sugarcane has dense canopy cover throughout the life period. This causes problems in aeration of the crop yield and it results in reduced crop yield. The plant population per unit area and distance between cane rows play important role in influencing the yield. Wider row spaced planting technology of sugarcane is spreading fast mainly in tropical states (Sundara 2003). Basically the concept of wider row spaced planting was developed to make easy mechanical harvesting of the crop. The larger interspaces between the wider spaced sugarcane rows can be utilized by the intercrops

for better exploitation of the natural resources like soil moisture, light, nutrients and carbon dioxide. The slow establishment of sugarcane during the initial period and adoption of comparatively wider row spacing offer vast scope for intercropping. Temporal differences can be best exploited by using varieties or species of intercrops that are early maturing and harvested before they compete with sugarcane (Verma and Yadav 1986). With the introduction of high tillering and high yielding varieties of sugarcane, it is possible to maintain the cane population and final cane yield even at relatively wider row spacing. Increasing the row spacing of sugarcane from the present recommended spacing of 90 to 120 cm would greatly facilitate not only easy management of intercropping without any competition effects but also provide enough scope for intercrops to get higher productivity (Shahi 2002). The present study was conducted to find out the effect of different planting methods, spacing and intercropping system on yield and quality of sugarcane.

MATERIAL and METHODS

The field study was carried out consecutively for two years 2015-16 and 2016-17 at the college farm, Navsari Agricultural University, Navsari, Gujarat. The climatic condition of this region is warm humid with heavy monsoon. The soil of experimental field was clayey in texture, medium in available nitrogen (266 and 284 kg/ha) and phosphorus (27.2 and 30.5 kg/ha) and fairly rich in available potash (354.3 and 365.8 kg/ha) during the years of 2015-16 and 2016-17. The site was slightly alkaline in reaction (pH 7.8 and 8.0) with normal electrical conductivity (0.35 and 0.40). The experiments were conducted with total sixteen treatment combinations of factor M x S (main plot) and I (sub-plot) viz two planting methods (M), seedlings raised in nursery tray, sprouted one-budded eye. two plant spacings (S), 90 x 30 cm and 120 x 30 cm and four intercropping practices (I), onion, cabbage, greengram and control (sole cane) and were evaluated in split plot design with three replications. Organic manures were applied thoroughly in soil in each furrow as per treatment and fertilizers were applied manually according to the treatments before sowing the seedlings. All cultural practices were performed uniformly for all the treatments. The observations on different yield attributes viz number of internodes, cane girth, number of millable canes, cane yield (tonnes/ha) and sugarcane equivalent yield (tonnes/ha) and quality parameters viz Brix (%), pol per cent juice, per cent purity coefficient, pol per cent cane, CCS (%), commercial cane sugar yield (tonnes/ha) and fiber (%) cane were recorded as per the standard procedures and formulae.

RESULTS and DISCUSSION

Yield parameters

Effect of planting methods: Yield attributes presented in Table 1 show that number of internodes per cane (22.76), girth of cane (10.46 cm), number of millable canes (1,05,809/ha), cane yield (112.98 tonnes/ha) and sugarcane equivalent yield (151.77 tonnes/ha) were found significantly higher under seedlings raised in nursery tray planting method as compared to sprouted one-budded eye planting method. The maximum cane girth and number of internodes per cane were obtained under seedlings raised in nursery tray planting method because of good growth of plant, maximum leaf area, higher nutrient availability etc during the crop growth period. The maximum vegetative growth of plant recorded in terms of plant height, number of tillers and dry matter accumulation converted it in millable cane and than cane yield. Similar findings were reported by Sopan (2002) and Saini et al (2012).

Effect of spacing: Significantly higher number of internodes (22.53) was observed under treatment S_1 (90 x 30 cm). It might be due to the reason that maximum plant height was recorded in plot where plants grown in narrow spacing produced more number of internodes per cane as compared to wider spacing. Similar results were reported by Chaudhari and Virdia (2019). However significantly higher cane girth (10.41 cm), number of millable canes (1,05,728/ha) and cane yield (112.27 tonnes/ha) were recorded under treatment S_2 (120 x 30 cm) as compared to treatment S_1 (90 x 30 cm). This could be due to less number of plants per unit area that lead to more tillers and proper utilization of moisture, nutrients, space and solar energy with less competition among plants. It resulted into better growth and higher values of most of the yield attributes and yield under wider row spacing than narrow spacing of plants. Similar results were reported by Patel et al (2014).

Effect of intercropping: Sugarcane intercropping with onion recorded significantly higher number of internodes per cane (22.65) and cane girth (10.55 cm) followed by control (sole cane) and greengram

Table 1. Effect of planting methods, spacing and intercropping on yield attributes and yield of sugarcane (pooled data)

Treatment	Number of internodes	Cane girth (cm)	Number of millable canes (tonnes/ha)	Cane yield (tonnes/ha)	Sugarcane equivalent yield (tonnes/ha)
Main plot (Planting method x Spacing)					
M_1: Seedlings raised in nursery tray	22.76	10.46	1,05,809	112.98	151.77
M_2: Sprouted one-budded eye	21.05	9.86	1,00,569	105.43	143.72
SEm±	0.28	0.10	973	1.08	1.21
$CD_{0.05}$	0.87	0.29	2,974	3.29	3.68
Spacing (S)					
S_1: 90 x 30 cm	22.53	9.91	1,00,651	106.15	144.09
S_2: 120 x 30 cm	21.27	10.41	1,05,728	112.27	151.39
SEm±	0.28	0.09	974	1.04	1.16
$CD_{0.05}$	0.87	0.29	2,976	3.17	3.56
CV (%)	9.36	6.69	6.80	6.85	5.68
Sub-plot (Intercrops)					
I_1: Onion	22.65	10.55	1,04,437	111.75	186.31
I_2: Cabbage	20.37	9.65	98,221	104.34	165.47
I_3: Greengram	22.16	10.20	1,03,396	107.99	126.43
I_4: Control	22.43	10.25	1,06,703	112.75	112.75
SEm±	0.40	0.12	1,370	1.38	1.59
$CD_{0.05}$	1.14	0.35	3,893	3.92	4.52
CV (%)	9.24	6.15	6.70	6.36	5.38

intercropping. It may be due to the reason that as compared to other crops, onion exerted least detrimental effect on the emergence of tillers, millable canes and yield of sugarcane (Hossain 1984). However higher number of millable canes (1,06,703 tonnes/ha) and cane yield (112.75 tonnes/ha) were observed under control (sole crop) which was comparable with intercropping of onion and greengram. This could be due to non-existence of intercrop to compete for the growth resources like light, water, nutrient and space. Yield reduction of sugarcane was minimum with intercropping of onion and greengram as it would have adjusted itself with partial shade in the intercropping system. Kumar et al (2011) made similar observations. Significantly higher sugarcane equivalent yield (186.31 tonnes/ha) was noticed under sugarcane + onion intercropping system and the lowest (112.75) was obtained with sole sugarcane treatment. Higher sugarcane equivalent yield under sugarcane + onion intercropping system could be due to the additional yield advantage of intercropping without adverse effect on sugarcane and good market price of intercrop.

Quality parameters

Effect of planting methods: Quality parameters were not influenced by the different planting methods during both the years of study except Brix (20.43%) and pol per cent cane (14.18%). The commercial cane sugar yield (14.44 tonne/ha) was found significantly higher under the treatment M_1 (seedlings raised in nursery tray) could be mainly due to overall better plant growth which encouraged plants to accumulate more photosynthates for synthesis of juice sucrose. Commercial cane sugar yield which is a function of cane yield and CCS (%) was significantly increased in treatment with seedlings raised in nursery tray as compared to sprouted one-budded eye treatment. Such increase in commercial cane sugar yield may be attributed primarily to increased cane yield and to some extent to improved juice quality. Similar results were also reported by Devi et al (2011).

Effect of spacing: All the quality parameters were not influenced by different plant spacings except commercial cane sugar yield. Significantly higher commercial cane sugar yield (14.21 tonnes/ha) was obtained with the wider row spacing of 120 x 30 cm as compared to narrow spacing of 90 x 30 cm. Although spacing did not affect the quality parameters significantly yet there was better juice quality which may be explained on the basis that wider plant spacing produced more sink because of efficient use of all resources, minimum competition between plants and

Table 2. Effect of planting methods, spacing and intercropping on various quality parameters of sugarcane (pooled data)

Treatments	Brix (%)	Pol per cent juice	Per cent purity coefficient	Pol per cent cane	Commercial cane sugar (%)	Commercial cane sugar yield (tonnes/ha)	Fiber (%)
Main Plot (Planting method x Spacing)							
M_1: Seedlings raised in nursery tray	20.43	18.32	90.02	14.18	12.76	14.44	13.14
M_2: Sprouted one-budded eye	19.75	17.74	89.55	13.76	12.36	13.01	13.03
SEm±	0.19	0.20	0.66	0.14	0.18	0.23	0.12
$CD_{0.05}$	0.58	NS	NS	0.41	NS	0.70	NS
Spacing (S)							
S_1: 90 x 30 cm	19.89	17.89	89.54	13.86	12.47	13.24	13.05
S_2: 120 x 30 cm	20.30	18.18	90.02	14.08	12.65	14.21	13.12
SEm±	0.19	0.20	0.66	0.14	0.18	0.23	0.12
$CD_{0.05}$	NS	NS	NS	NS	NS	0.70	NS
CV (%)	6.84	7.89	5.22	6.99	10.53	11.98	6.71
Sub-plot (Intercrops)							
I_1: Onion	20.31	18.26	89.94	14.14	12.82	14.33	13.13
I_2: Cabbage	20.16	18.15	89.70	14.06	12.64	13.18	13.09
I_3: Greengram	20.37	18.38	90.68	14.22	12.84	13.91	13.15
I_4: Control	19.55	17.34	88.81	13.46	11.95	13.48	12.97
SEm±	0.20	0.20	0.89	0.15	0.20	0.27	0.13
$CD_{0.05}$	NS	0.55	NS	0.44	0.57	0.77	NS
CV (%)	4.78	5.37	4.97	5.58	8.06	9.95	4.99

better plant growth. Sugarcane planted at 120 cm spacing gave significantly higher juice quality. Gupta and Lal (1975) recorded more sucrose at 112.5 cm spacing as compared to 75 cm spacing. Singh et al (2012) also reported the same results.

Effect of intercropping: There was no significant effect of intercrops on cane quality parameters viz Brix (%), per cent purity co-efficient and fiber percentage. Significantly higher pol juice percentage (18.38), pol per cent cane (14.22) and commercial cane sugar (12.84%) were recorded with sugarcane + greengram and it was at par with treatment sugarcane + onion and sugarcane + cabbage. Significantly higher commercial cane sugar yield (14.33 tonnes/ha) was recorded under treatment sugarcane + onion and it was at par with sugarcane + greengram and control (sole cane).

CONCLUSION

In the present study higher sugarcane equivalent yield as well as good quality sugarcane juice were obtained with seedlings raised in nursery tray with intercropping of onion and wider row spacing of 120 x 30 cm which may be recommended for south Gujarat conditions.

REFERENCES

Chaudhari NN and Virdia HM 2019. Assessing feasibility of growing sugarcane seed crop by different planting material, plant spacing and nitrogen management for higher seed cane yield. Green Farming **10(3):** 323-327.

Devi TC, Bharathalakshmi M, Gouri V, Kumari M, Naidu NV and Rao KP 2011. Studies on the effect of sett size, seed rate and sett treatments on yield and quality of sugarcane. Indian Journal of Sugarcane Technology **26(2):** 4-6.

Gupta DN and Lal U 1975. Sugarcane yield and quality: effect of seed rate cum row distance cum nitrogen level. Cooperative Sugar **4(9):** 483-484.

Hossain A 1984. Intercropping with reference to sugarcane cultivation in Bangladesh. MSc (TAD) Thesis, University of Reading, England.

Kumar S, Singh SS and Singh A 2011. Production potential of winter vegetables as intercrops in autumn planted sugarcane under valley condition of Uttarakhand. Progressive Horticilture **43(1):** 153-154.

Patel DD, Raj VC, Tandel B, Patel B, Patil P, Patel AM and Patel DU 2014. Sugarcane yield and nutrient uptake

under plant geometry and variety in relation to mechanization. Bioscan **9(4):** 1445-1448.

Saini SP, Sidhu AP and Singh P 2012. Crop yield, efficiency and economics of autumn and spring sown single bud sugarcane intercropped with pulse crops. Indian Journal of Sugarcane Technology **3(2):** 60-65.

Shahi HN 2002. Sugarcane crushing prices cause concern. The Hindu Survey of Indian Agriculture, Jan 2002, pp 119-124.

Singh GD, Saini SK, Bhatnagar A and Singh G 2012. Effect of planting methods and irrigation scheduling on growth, yield and quality of spring planting sugarcane (*Saccharum officinarum* L). Annals of Agricultural Research, New Series **33(1-2):** 21-24.

Sopan RB 2002. Response of sugarcane CO-86032 to planting materials, intra-row spacings and fertilizers levels under drip irrigation. PhD Thesis, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India.

Sundara B 2003. Response of new sugarcane varieties to wide row spacing. Proceedings of the 65th Annual Convention of the Sugar Technologists' Association of India, Bhubneshwar, Orissa, India, 22-24 Aug 2003.

Verma RS and Yadav RL 1986. Growth and yield of sugarcane and potato in companion cropping system. Journal of Agricultural Science **107(1):** 125-231.