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Kuldeep Singh

Department of Agronomy, CCS
Haryana Agricultural
University, Hisar, Haryana,
India

Ran Singh Rinwa

Department of Agronomy, CCS
Haryana Agricultural
University, Hisar, Haryana,
India

Parveen Kumar

Department of Agronomy, CCS
Haryana Agricultural
University, Hisar, Haryana,
India

Correspondence**Kuldeep Singh**

Department of Agronomy, CCS
Haryana Agricultural
University, Hisar, Haryana,
India

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Yield and economics of spring planted sugarcane (*Saccharum officinarum*) under different planting method and nitrogen level

Kuldeep Singh, Ran Singh Rinwa and Parveen Kumar

Abstract

A field experiment was conducted at Regional Research Station, Karnal, CCS Haryana Agricultural University during spring 2017 to study on effect of planting methods and nitrogen levels on cane yield and economics of sugarcane. The experiment was conducted in split plot design with three replications. The treatments comprises of four methods of planting *viz.* conventional planting at 75 cm (M₁), Half ridge open furrow irrigation planting at 75 cm (M₂), Wide bed and furrow paired row planting (M₃) and Wider planting (M₄) at 120 cm and six different nitrogen levels *viz.* control (N₁), 75 (N₂), 100 (N₃), 125 (N₄), 150 (N₅), 175 kg N ha⁻¹ (N₆). The results of finding reveals that planting the sugarcane with wide bed and furrow paired row planting significantly increased number of millable cane, cane length, single cane weight, cane yield over conventional planting. Significantly highest cane yield (93.6 t/ha) was recorded in wide bed and furrow paired row planting followed by wider planting (86.7 t/ha) and half ridge open furrow irrigation planting (86.1 t/ha) over conventional methods (76.0 t/ha) with higher increment of 23.2% in M₃, 14.1% in M₄ and 13.3% in M₂ than M₁ method, respectively was obtained. Moreover, the crop fertilized with 175 kg N ha⁻¹ recorded significantly higher number of millable cane as compared to lower dose of nitrogen 0, 75, 100, 125 kg N ha⁻¹ but did not differ significantly with 150 kg N ha⁻¹. The net return in wide bed and furrow paired row planting, wider planting, half ridge open furrow irrigation planting and conventional planting was Rs. 184039, Rs.164056, Rs.159692 ha⁻¹ and Rs.128035 ha⁻¹, respectively. Simultaneously, B:C was higher in wide bed and furrow paired row planting (2.53), wider planting (2.40) and half ridge open furrow irrigation planting (2.33) than in conventional planting (2.07).

Keywords: sugarcane, planting methods, yield attributes, nitrogen, yield, BC ratio

Introduction

Sugarcane being C₄ plant is the most efficient converter of solar energy into sugar. During the peak growth period it has the potentiality to produce around half a tone of dry matter per hectare per day (Yadav, 1991) [16]. It is major commercial crop that sustains sugar industry - second largest next to the cotton and textile industry. India is the second largest producer of sugarcane in the world after Brazil with an area of 4.5 and 8.6 mha and productivity of 67.8 and 79.5 t ha⁻¹, respectively, Anonymous (2015) [1]. Haryana covers an area of 0.94 m ha with a production of 7.0 mt and average productivity of 73.9 t ha⁻¹ (Directorate of Economics & Statistic, Ministry of Agriculture, 2016-17). Generally, in north India sugarcane is planted with conventional method at 60-75cm. Although this method is less time consuming but fast depletion of soil and setts moisture results in lower germination (30 - 35%), resulting in lesser plant population and lower cane yield (Singh *et al.*, 2009) [14]. This method does not permit sugarcane to attain better growth due to poor aeration, lodging and less interception of solar radiation and mutual competition. At present, the demand for sugar is consistently increasing and it is estimated that by 2020, the total sugar requirement of our country would be nearly 625 mt (Sundara, 1998) [15]. On the other hand there has been continuous decrease in area under sugarcane crop and average size of land holdings of Indian farmers owing to increase in human population. Therefore, to meet the demand sugar the only option is to increase the crop productivity on the available land. It can enhanced substantially by growing sugarcane with specific technology *viz* Wider row spacing provides greater scope for overall growth and development of individual plant. The high cane yield was obtained in paired trench plantation than conventional planting (Singh *et al.*, 2012) [13] Sugarcane stores a higher percent of sucrose when nitrogen is limited for 6 to 8 weeks prior to harvest (Miller *et al.*, 2006) [7].

In India recommended application of nitrogen can be as high as 300 kg/ha. The maximum stripped cane and sugar yield were recorded when nitrogen at 252 kg ha⁻¹ was applied in two equal splits (Hemalatha, 2015) [4]. Hence keeping all these aspect in view investigation was conducted.

Material and Methods

The field experiment was conducted at Regional Research Station, Karnal (29° 43' North, 76° 58' East) of CCS Haryana Agricultural University during spring 2017. The climate of area is sub-tropical with mean maximum temperature ranging between 34-40 °C in summer and mean minimum temperature ranging between 4-6 °C in winter. Most of the rainfall is received during the months of July to September and few showers during December to late spring. The soil of the experimental field was clay loam, with, pH 7.86, EC 0.12 ds m⁻¹ and low organic carbon, low in available nitrogen, medium in available phosphorus and potassium. The experiment was laid out in split plot design with four methods of planting in main plot *i.e.* Conventional planting at 75 cm (M₁), Half ridge open furrow irrigation planting at 75 cm (M₂), Wide bed and furrow paired row planting 35: 105 cm (M₃) and Wider planting at 120 cm (M₄) with six different nitrogen levels in sub plot *viz.*, control, 75, 100, 125, 150 and 175 kg N ha⁻¹. Healthy and good quality two budded setts of the mid maturing variety CoH167 which were free from insect- pest and disease were planted on 16th March 2017 and harvested on 27th February 2018 when plants had almost matured. In M₁- conventional method seed sets were planted at vatter covered with by tractor operated plankar. In M₂- half ridge open furrow irrigation method, the same practice of making furrow at 75 cm distance with depth 20-25 cm are followed as conventional method. Except dry sowing of treated seed setts are partially covered with less soil with help kasola followed by light irrigation given in the half of the furrow depth. The similar practice of sowing is followed in M₃- wider planting at 120 cm. While in wide bed and furrow paired row planting (trench plantation technique) 'U' shaped 35 cm broad and 20-25 cm deep trenches are opened. Then treated cane setts are placed at bottom in paired row of 35 cm intra row distance. Then setts are covered with soil left in between two row. The distance between two row sets is 105 cm known as inter row distance. In this method the centre to centre distance between two set of rows is 140 cm. The recommended dose of fertilizer for sugarcane *viz.* 50 kg P₂O₅ ha⁻¹, 50 kg K₂O ha⁻¹ and 25 kg ha⁻¹ zinc sulphate were applied at the time of planting and one third dose of nitrogen (as per different treatment) was applied by placement method at time of planting through urea, respectively. Remaining dose of nitrogen as per treatment was applied in two split doses after 2nd irrigation and remaining after 4th irrigation respectively. Various yield and yield attributing characters *viz.*, number of millable canes, length of cane (cm), single cane weight (g) and diameter of cane (cm) and cane yield was recorded at harvest and expressed in t ha⁻¹. The economics of different treatments was calculated at prevailing market price.

Results and Discussion

Yield attributes and yield were significantly affected by different planting methods and nitrogen levels. Among

planting methods, wide bed and furrow paired row planting (M₃) produced significantly higher number of millable cane, cane length, cane weight, cane yield and green top yield than conventional planting (M₁), half ridge open furrow irrigation planting at 75 cm (M₂), and wider planting at 120 cm (M₄). However, number of internodes and cane girth did not differ significantly among various planting methods. The higher cane production obtained in wide bed and furrow paired row planting due to deeper plantation, more moisture availability, better root establishment and better intercultural operations there by proper utilization of nutrients. This method provides better light interception and proper aeration due to the wider space available between set of rows having border effect which facilitating non lodging and better uptake of nutrients ultimately provides proper growth environment for crop which resulted into higher yield. These results are confiding with Singh *et al.* (2015) [12], Prem *et al.* (2017) [9], Katiyar *et al.* (2013) [6] and Gupta *et al.* (2004) [3], Roodagi *et al.* (2001) [10] and Prabhakar *et al.* (2014) [8]. The different nitrogen levels significantly influences the yield attributing characters and yields of sugarcane. Significantly higher yield attributes *viz.* number of millable cane, cane length, number of internodes, cane weight, cane girth and green top yield were recorded with 175 kg N ha⁻¹ as compared to lower dose of nitrogen 0, 75, 100, 125 kg N ha⁻¹, however, it did not differ significantly with 150 kg N ha⁻¹ which might be due to continuous uptake of nutrient under different levels of nitrogen led to more sprouting of tillers and proper growth and development of more number of millable cane (Shukla, 2005) [11]. However lower cane yield at 175 kg N ha⁻¹ over recommended dose of nitrogen 150 kg N ha⁻¹ might be due to lodging in conventional and half ridge open furrow irrigation planting method. Similar results were recorded by Asokan *et al.*, (2005) [2] and Inoue *et al.* (2009) [5].

Economics

The maximum gross return Rs. 304114 ha⁻¹ was obtained from wide bed and furrow paired row planting which is due to high cane yield followed by Rs. 281513, Rs. 279767 and Rs.248109 ha⁻¹ from wider planting, half ridge open furrow irrigation planting and conventional planting method, respectively. The highest gross return Rs. 331069 ha⁻¹ was obtained with application of 150 kg N/ha whereas lowest gross return Rs. 201848 ha⁻¹ was obtained at control. Similarly maximum net return Rs. 184039 ha⁻¹ was obtained from wide bed and furrow paired row planting followed by Rs. 164056, Rs. 159692 and Rs.128035 ha⁻¹ from wider planting, half ridge open furrow irrigation planting and conventional planting method, respectively. The highest net return Rs. 211006 ha⁻¹ was also obtained with application of 150 kg N/ha whereas lowest gross return Rs. 83885 ha⁻¹ was obtained at control.

The wide bed and furrow paired row planting method recorded maximum B:C ratio 2.53 followed by 2.40, 2.33 and 2.07 in wider planting, half ridge open furrow irrigation and conventional method of planting, respectively. The higher net returns and B:C ratio were obtained with each successive increase in nitrogen application upto 150 kg N/ha (rec.) and the maximum net return of Rs. 211006 and B:C 2.76 was obtained at 150 kg N/ha (rec.).

Table 1: Effect of different methods of planting and levels of nitrogen on yield attributing characters and yield of sugarcane crop

Planting Methods		NMC ($\times 1000\text{ha}^{-1}$)	Cane length (cm)	No. of internodes	Cane wt.(kg)	Cane girth (cm)	Cane yield (t/ha)	Green top yield (tha^{-1})
M ₁	Conventional planting at 75 cm	87.8	241.7	19	0.89	2.3	76.0	5.3
M ₂	Half ridge open furrow irrigation planting at 75 cm	94.7	249.8	20	0.93	2.4	86.1	6.0
M ₃	Wide bed and furrow paired row planting (35: 105 cm)	101.7	257.6	21	0.94	2.4	93.6	6.5
M ₄	Wider planting at 120 cm	92.1	237.8	18	0.93	2.4	86.7	5.6
CD (P = 0.05)		4.1	4.9	NS	0.01	NS	3.5	0.26
Nitrogen Levels (kg /ha)								
N ₁	0 (Control)	74.9	225.4	16	0.84	2.3	62.3	3.5
N ₂	75	84.1	235.1	18	0.91	2.3	76.0	4.8
N ₃	100	90.5	241.8	20	0.93	2.4	82.9	5.6
N ₄	125	99.1	252.5	20	0.95	2.4	92.4	6.6
N ₅	150	107.2	261.9	21	0.96	2.5	101.8	7.3
N ₆	175	108.8	263.1	22	0.96	2.4	98.7	7.5
CD (P = 0.05)		5.9	7.6	1.0	0.02	0.1	6.2	0.45

Table 2: Effect of different methods of planting and levels of nitrogen on economics of sugarcane production

Methods of planting		Cost of Cultivation	Gross Return	Net return	B:C
M ₁	Conventional planting at 75 cm	120075	248109	128035	2.07
M ₂	Half ridge open furrow irrigation planting at 75cm	120075	279767	159692	2.33
M ₃	Wide bed and furrow paired row planting (35: 105 cm)	120075	304114	184039	2.53
M ₄	Wider planting at 120 cm	117457	281513	164056	2.40
Levels of nitrogen (Kg /ha)					
N ₁	0 (Control)	117964	201848	83885	1.71
N ₂	75	119013	246632	127619	2.07
N ₃	100	119359	269449	150090	2.26
N ₄	125	119711	300314	180604	2.51
N ₅	150	120063	331069	211006	2.76
N ₆	175	120411	320940	200529	2.67

Conclusion

Results of study reveals that sugarcane planting with wide bed and furrow paired row planting, half ridge open furrow irrigation planting and wider planting methods improved growth, yield and yield attributes and nutrients uptake than conventional planting. Results obtained with wide bed and furrow paired row planting proved to be most promising method which gave more net return and benefit cost ratio. The highest productivity and net return were obtained at 150 kg Nha^{-1} .

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