RESEARCH ARTICLE Agricultural Scinece Digest, Volume 39 Issue 4: 324-327 (October-December 2019)

Growth, Nutrient Use Efficiency and Quality of Spring Sugarcane (*Saccharum officinarum L.*) under Different Planting Method and Nitrogen Level

Kuldeep Singh, Ran Singh Rinwa, Parveen Kumar and Sarita Rani

10.18805/ag.D-5020

ABSTRACT

A field experiment was conducted at Regional Research Station, Karnal, CCS Haryana Agricultural University during spring 2017 to study on different planting method and nitrogen level on growth parameter and nitrogen use efficiency 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 (M_1), half ridge open furrow irrigation planting at 75 cm (M_2), wide bed and furrow paired row planting (M_3) and wider planting (M_4) at 120 cm and six different nitrogen levels *viz*. control (N_1), 75 (N_2), 100 (N_3), 125 (N_4), 150 (N_5), 175 kg N ha^{-1} (N_6). Germination count was significantly affected by planting methods at 30 and 45 DAP, however, it was found to be non significant among nitrogen levels. Neither the planting methods nor the nitrogen levels had any significant effect on nutrient use efficiency, brix, pol, juice purity and commercial cane sugar. Significantly higher sugar yield (11.9 t/ha) was recorded in wide bed and furrow paired row planting which was 22.7, 8.2, and 6.3 per cent higher than conventional, wider planting and half ridge open furrow method, respectively. Lower sugar yield (9.7 t/ha) was recorded in conventional method. Among nitrogen levels, sugar yield increases with successive increase in nitrogen application upto recommended dose of 150 kg N/ha.

Key words: Growth parameters, Nitrogen use efficiency, Planting methods, Quality, Sugarcane.

INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) is an important commercial crop, which is extensively grown in tropical and sub- tropical regions of India as cash crop and plays a pivotal role in both agricultural and industrial economy of the country as it is a renewable natural agricultural resource and provides sugar, besides biofuel, fibre and co-products with ecological sustainability. Bagasse, the main by-product of sugar mills, is used as raw material in the paper industry and as a fuel for power generation. In India, it is grown in an area of 4.73 million hectares with total production of 376.9 million tonnes of cane with average productivity of 68 tonnes per hectare second after Brazil (Sugartech, 2019). In Haryana, 1.14 lakh ha of area is under sugarcane cultivation with total production of 9.63 million tonnes and average productivity is 84.4 t/ha (Sugartech, 2019).Generally, in north India sugarcane is planted with conventional method at 60-75cm. This method does not permit sugarcane to attain better growth due to poor aeration, lodging and less interception of solar radiation and mutual competition. Although this method is less time consuming but germination percentage is 30 to 35 per cent less that results in lower cane yield (Singh *et al.,* 2009). The growth and yield of sugarcane decrease due to nitrogen deficiency as it is required in many critical processes indicating plant growth such as leaves expansion and tiller or sucker production, especially in the formation of plant protein, but excess nitrogen can lead to prolonged vegetative growth and reduced sugar yield and quality (Bell, 2014). 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). At the same time, there has been continuous decrease in area under sugarcane crop and average size of land holdings of Indian farmers. Therefore, to meet the increasing sugar demand the only option is to increase the crop productivity on the available land by growing it with specific technology *viz* wider row spacing and paired trench plantation than conventional planting provides greater scope for overall growth and development of individual plant. (Singh *et al.,* 2012). 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 $kgha^{-1}$ was applied in two equal splits (Hemalatha, 2015). Keeping all these aspect in view present investigation was conducted.

Department of Agronomy, CCS Haryana Agricultural University, Hisar-125004, Haryana, India.

Corresponding author: Kuldeep Singh, Department of Agronomy, CCS Haryana Agricultural University, Hisar-125 004, Haryana, India. e-mail:kuldeepvartia73@gmail.com

How to cite this article: K. Singh, R.S. Rinwa, P. Kumar and S. Rani (2019). Growth, Nutrient Use Efficiency and Quality of Spring Sugarcane (*Saccharum officinarum* L.) Under Different Planting Method and Nitrogen Level, Agricultural Science Digest. 39(4): 324-327.

Source of support: Nil

Conflict of interest: None

Submitted: 17-08-2019 **Accepted:** 27-09-2019 **Published:** 09-12-2019

MATERIALS 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, half ridge open furrow irrigation planting at 75 cm, wide bed and furrow paired row planting 35: 105 cm and wider planting at 120 cm with six different nitrogen levels in sub plot *viz*., control, 75, 100, 125, 150 and175 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 conventional method seed setts were planted at vatter covered with by tractor operated plankar. In 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 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 setts is 105 cm known as inter row distance. In this method the centre to centre distance between two setts of rows is 140 cm. The recommended dose of phosphorous, potassium and zinc for sugarcane (50 kg P_2O_5 ha^{-1}, 50 kg K_2O 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. The furrows were treated with chlorpyriphos 20 EC@ 625 ml/ha at time of planting and coragen @ 375 ml /ha was drenching in all the plots during first week planting and to control of weed manual hoeing was done at the time of second and forth irrigation. Sugarcane crop was planted by counting two buds setts. The germination percentage was determined by counting the total number of germinated buds divided by total number of buds planted and multiplied by 100 to express in percent. Cane quality parameter *viz.* Brix %, Pol % and Purity % of five randomly selected striped cane from each plot were analysed. Brix percentage was recorded directly by using a brix hydrometer for juice extracted from randomly harvested cane, which is depicted as total soluble solid in juice. Sucrose percentage was estimated as pol percentage which is determined by Polari meter and calculated from Schimitz's table. Juice purity is the ratio between pol or sucrose per cent and corrected brix value expressed on per cent bases. Commercial cane sugar percentage (CCS %) was calculated with the help of brix and pol readings recorded in laboratory using following formula.

$$CCS\ \% = [S - 0.4\ (B-S)] \times 0.73$$

Where,

S = Sucrose per cent in juice (Pol %) and

B = Brix per cent in juice

The sugar per hectare (CCS) was calculated by using following formula

Commercial cane sugar percent (t/ha) =

$$\frac{\text{CCS\% at harvest} \times \text{cane yield (Tonne)}}{100}$$

Nitrogen use efficiency can be expressed in different way such as per cent utilization of nitrogen (apparent recovery), economic yield per unit applied (agronomic efficiency) or

Table 1: Effect of planting methods and nitrogen levels on germination percentage and juice quality parameters of sugarcane.

Treatment	Germination %		Brix %	Pol %	Purity %	CCS %	Sugar Yield (t/ha)
	30 DAP	45 DAP					
Planting methods							
Conventional planting at 75 cm	37.3	45.7	21.0	18.5	88.2	12.7	9.7
Half ridge open furrow irrigation planting at 75cm	42.2	60.1	21.5	18.4	87.3	12.9	11.2
Wide bed and furrow paired row planting (35: 105 cm)	43.1	62.1	21.2	18.8	87.5	12.7	11.9
Wider planting at 120 cm	41.8	60.6	21.3	18.5	87.2	12.8	11.0
CD (P = 0.05)	0.40	2.2	NS	NS	NS	NS	0.73
Nitrogen levels (kg /ha)							
0 (Control)	39.7	55.7	21.5	18.6	86.9	12.7	7.9
75	40.3	56.3	21.2	18.3	86.7	12.6	9.6
100	40.7	56.5	21.4	18.8	87.7	12.9	10.7
125	41.3	57.5	21.1	18.4	87.6	12.7	11.7
150	42.0	58.3	21.2	18.5	87.2	12.7	12.9
175	42.5	58.4	21.1	18.8	89.1	13.1	12.9
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	0.94

biomass production in relation to nitrogen uptake (physiological efficiency) as indicated below:

$$\frac{\text{N uptake in ferilised plot (kg ha}^{-1}\text{)} - \text{N uptake in controlled plot (kg ha}^{-1}\text{)}}{\text{Ferilised N applied}}$$

Agronomic NUE =

$$\frac{\text{Yield in ferilised plot (kg ha}^{-1}\text{)} - \text{Yield in controlled plot (kg ha}^{-1}\text{)}}{\text{Ferilised N applied}}$$

Physiological efficiency =

$$\frac{\text{Yield in ferilised plot (kg ha}^{-1}\text{)} - \text{Yield in controlled plot (kg ha}^{-1}\text{)}}{\text{N uptake in ferilised plot (kg ha}^{-1}\text{)} - \text{N uptake in controlled plot (kg ha}^{-1}\text{)}}$$

Results and Discussion

Sugarcane growth was measured in term of germination count, plant height and numbers of tillers. Germination count was significantly affected by planting methods at 30 and 45 DAP, however, it was found to be non significant among nitrogen levels. At 30 and 45 DAP, significantly higher germination count was recorded under wide bed and furrow paired row planting (35: 105 cm) over conventional planting (75 cm), although it did not differ significantly from the half ridge open furrow irrigation planting at 75 cm and wider planting at 120 cm at 45 days after planting. The highest germination percentage could be ascribed due to adequate soil moisture under wide bed and furrow paired row planting (35: 105 cm). Similar results were also reported by Prem *et al.* (2017) and Prabhakar *et.al.* (2014).Maximum plant height was observed under wide bed and furrow paired row planting as compared to other methods at 90,120,150 and 180 days after planting. This could be due to the fact that narrow row spacing between paired rows results in more competition among the plants for sun light there by using proper available moisture. Chattha *et al.* (2007) and Roodagi *et al.* (2001) also reported significant plant height under paired row planting geometry over flat planting. Among nitrogen levels, plant height of sugarcane crop increased progressively with increase in nitrogen level. Application of 175 kg N ha^{-1} being

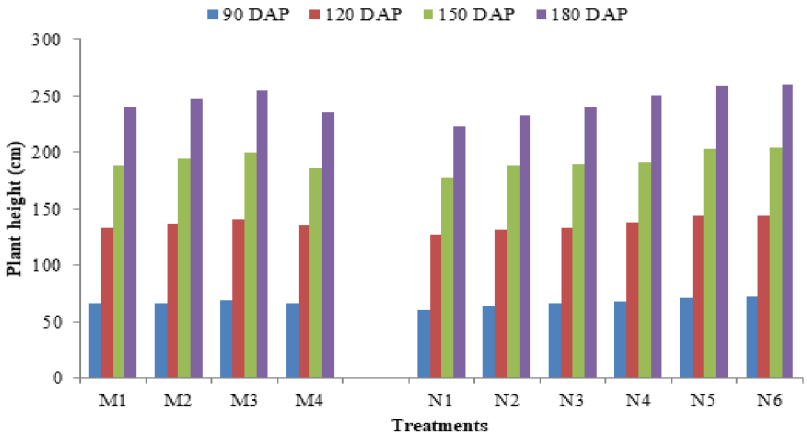


Fig 1: Effect of planting methods and nitrogen levels on plant height of sugarcane.

Table 2: Effect of planting methods and nitrogen levels on nitrogen use efficiency of sugarcane.

Treatment	Agronomic NUE (kg/kg)	Apparent NUE(kg/kg of N applied)	Physiological NUE (kg/kg of absorbed)s
Planting Method			
Conventional planting at 75 cm	183.2	82.8	238.2
Half ridge open furrow irrigation planting at 75 cm	225.7	104.1	250.6
Wide bed and furrow paired row planting (35: 105 cm)	281.0	107.2	288.7
Wider planting at 120 cm	191.1	93.0	218.6
CD (P = 0.05)	NS	NS	NS
Nitrogen Level (Kg /ha)			
0 (Control)			
75	182.6	78.3	300.7
100	206.7	92.4	230.9
125	240.7	103.4	248.2
150	263.7	112.0	242.7
175	207.7	97.9	222.4
CD (P = 0.05)	NS	NS	NS

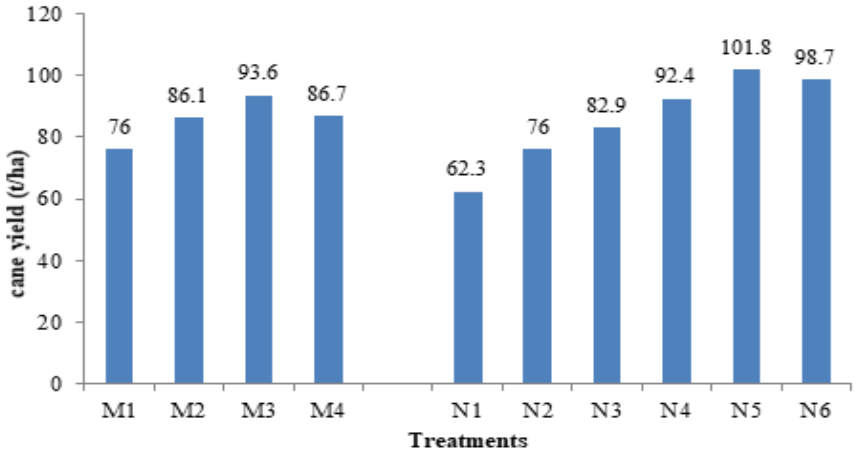


Fig 2: Effect of planting methods and nitrogen levels on sugarcane yield.

statistically at par with 150 kg N ha^{-1} produced the tallest plant at 90, 120, 150 and 180 DAP, respectively. The significantly lower height was recorded under control at all growth stages (Fig 1). Similar results were reported by Dev *et al.,* (2011). Neither the planting methods nor the nitrogen levels had any significant effect on brix, pol, juice purity and commercial cane sugar. Significantly higher sugar yield (11.9 t/ha) was recorded in wide bed and furrow paired row planting which was 22.7, 8.2, and 6.3 % higher than conventional, wider planting and half ridge open furrow method, respectively. Lower sugar yield (9.7 t/ha) was recorded in conventional method. Among nitrogen levels, sugar yield increases with successive increase in nitrogen application upto recommended dose of 150 kg N/ha. The similar sugar yield was reported at 150 and 175 kg N/ha which was 63.3, 34.4, 20.6 and 10.3 % higher than control, 75, 100 and 125 kg N/ha (Table1). Similarly, influence of planting methods and nitrogen levels on agronomic, apparent and physiological nutrient use efficiency in sugarcane was found to be non significant (Table 2). Significantly higher cane yield (93.6 t/ha) was recorded in wide bed and furrow paired row planting (M_3) over other methods *viz*., conventional planting (76.0 t/ha), half ridge open furrow irrigation planting (86.1 t/ha) and wider planting (86.7 t/ha). Although the cane yield under half ridge open furrow irrigation planting (M_2) was statistical at par with wider planting (M_4). The lower cane yield (76.0 t/ha) was obtained in conventional planting at 75 cm (M_1). Moreover, cane yield increases by 23.2 % in M_3, 14.1 % M_4 and 13.3 % in M_2 methods of planting with respect to conventional method of planting (M_1). Higher cane yield (101.8 t/ha) was recorded at 150 kg/ha dose of nitrogen application which was statistically at par with 175 kg/ha level of nitrogen applied. The lower cane yield (62.3 t/ha) was recorded at control (Fig 2).

REFERENCES

Anonymous. (2019). Sugar Statistics. Cooperative Sugar. 50: 36.

Bell, M. J., Moody, P., Salter, B., Connellan, J., & Garside, A. L. (2014). Agronomy and physiology of nitrogen use in Australian sugarcane crops. In: A review of nitrogen use efficiency in sugarcane: Sugar Research Australia, M. J. Bell (Ed.). eLibary. Completed projects final reports. Retrieved from https://elibrary.sugarresearch.com.au

Chattha, M. U., Ali, A.and Bilal, M. (2007). Influence of planting techniques on growth and yield of spring planted sugarcane (Saccharum officinarum L.). Pakistan Journal of Agricultural Sciences. 44(3): 452-455.

Dev, C.M. Meena, R. N., Kumar, Ashok and Mahajan, G. (2011). Earthing up and nitrogen level in sugarcane ratoon under subtropical Indian condition.Indian Journal of Sugarcane Technology. 26(1): 1-5

Hemalatha, S. (2015).Impact of nitrogen fertilization on quality of sugarcane under fertigation. International Journal of Research and Scientific Innovation. 2 (3): 37-39.

Prabhakar, K., Sagar, G. K., Chari, M. S., Reddy, C. K. K. and Sekhar, S. C. (2014).Effect of planting geometry and nitrogen application through fertigation on production and quality of sugarcane. Agricultural Science Digest. 34 (3): 223 – 225.

Prem, G., Kumar, R., Singh, V. D., Kumar, A., Choudhary, A., and Afzal, A. (2017). Effect of planting methods on cane yield, water productivity and economics of spring planted sugarcane (Saccharum officinarum L.) in Ambala (Haryana). International Journal of Agricultural Engineering. 10(1): 186-190.

Roodagi, L. I., Itnal, C. J. and Chetti, M. B. (2001). Impact of intercropping and planting method on growth and yield of sugarcane.Karnataka Journal of Agricultural Sciences. 14(2): 305-310.

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

Singh, K., Bhullar, M. S., Singh, K. and Uppal, S. K., (2009). Effect of planting techniques for spring planted sugarcane. Journal of Research, Punjab Agricultural University. 46(3/4): 137-139.

Sundara, B. P. (1998). Sugarcane Cultivation, Vikas Publishing House.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this license, visit http://creativecommons.org/ licenses/by/4.0/.© The Author(s) 2019

ISSN: 0976-0547 (Online), 0253-150X (Print), Naas Rating: 4.21