RESEARCH PAPER | International Journal of Agricultural Engineering | Volume 10 | Issue 1 | April, 2017 | 186-190
e ISSN–0976–7223 ■ Visit us : *www.researchjournal.co.in* ■ **DOI: 10.15740/HAS/IJAE/10.1/186-190**

Effect of planting methods on cane yield, water productivity and economics of spring planted sugarcane (*Saccharum officinarum* L.) in Ambala (Haryana)

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Received : 28.02.2017; **Revised :** 19.03.2017; **Accepted :** 27.03.2017

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■ **ABSTRACT :** An experiment was conducted at farm of Krishi Vigyan Kendra-Ambala to assess the impact of different planting methods of sugarcane *i.e.* planting methods *viz*., T_1-conventional planting (60 cm row spacing), T_2-paired row trench plantation method (60:120 cm spacing) and T_3-paired row ridge and furrow plantation method (100:120 cm spacing) on cane yield, water productivity and economics. The cane yield in conventional planting (T_1) was 77.53 t ha^{-1}, 82.50 t ha^{-1} in paired row trench plantation technique (T_2), and 86.20 t ha^{-1} in paired row ridge and furrow plantation technique (T_3), which was significantly higher in T_3 than in (T_1) and (T_2). The water productivity was 2.82 in T_1, 3.37 in T_2 and 3.79 in T_3, respectively. The gross return in farmer practice, paired row trench and modified paired row plantation method was 175150.00 Rs. ha^{-1}, 186450 and 194812 Rs. ha^{-1}, respectively. Simultaneously, the BCR was high in paired row trench plantation (2.70) and paired row ridge and furrow plantation method (2.90) than 2.30 in conventional planting.

■ **KEY WORDS :** Sugarcane planting methods, Yield, Water productivity, Economics

■ **HOW TO CITE THIS PAPER :** Prem, Guru, Kumar, Ramesh, Singh, Vikram D., Kumar, Amit, Choudhary, Rakesh and Ahmad, Afzal (2017). Effect of planting methods on cane yield, water productivity and economics of spring planted sugarcane (*Saccharum officinarum* L.) in Ambala (Haryana). *Internat. J. Agric. Engg.*, **10**(1) : 186-190, **DOI: 10.15740/HAS/IJAE/10.1/186-190.**

India is one of the largest sugarcane producers in the world after Brazil with an area of 4.5 and 8.6 m ha and productivity of 67.8 and 79.5 t ha^{-1}, respectively Anonymous (2015). Being an important cash crop, it ranks third in the list of most cultivated crops after paddy and wheat. Sugarcane is planted in both tropical (south) and sub-tropical (north) region of India with total production of 294.6 million tonnes and productivity of 66.8 tonnes per hectare (Singh *et al.*, 2013). Sugarcane requires about 25-32°C temperature for germination. This temperature requirement is met twice in north Indian conditions, *i.e.*, in October (autumn) and February-March (spring). Subtropical north while comprising 60 per cent of total cane area contributes only 48 per cent to total cane.

The average cane productivity in subtropical north zone is 54.7 t ha^{-1} and 56.4 t ha^{-1} in comparison to 81.9 t ha^{-1} and 80.8 t ha^{-1} in tropical south zone (2009-10 and 2010-11) (Anonymous, 2011). In Haryana, sugarcane is grown in 1.6 lakh ha and average productivity ranges between 55-68 t ha^{-1}. Among sugarcane growing districts, Yamuna Nagar, Kurukshetra, Ambala and

Karnal contribute 60 per cent of sugarcane production in Haryana (Kamboj *et al.*, 2008). Most of the farmers prefer spring planting of sugarcane in Ambala, as autumn planting achieve comparatively less germination and yield due to late harvesting of paddy. Spring cane is planted in February-March. March is the best time for cane planting in Punjab and Haryana. The low productivity of sugarcane could be attributed to extremes of weather prevailing in the region. Due to very hot and dry weather in April to June and cold touching zero degree and often combined with frost in December to January, the active growth of sugarcane is restricted and resulting in poor stalk yield.

By adopting good package of practices, the cane yield can be increased in general and establishment method in particular. But conventional method of planting of sugarcane at 60-75 cm spacing restricts the cane yield to a considerable extent (Yadav, 1993) due to less number of millable canes per clump. The farmers of different regions, growing cane with different planting methods as well as geometry. The various planting methods of sugarcane are such as flat bed method with different row to row spacing, paired row trench plantation with vatter and dry sowing followed by irrigation and ridge and furrow sowing followed by irrigation along with different row to row spacing. In Ambala flat-bed planting was most common among the farmers.

In this method, furrows of depth 20-25 cm are opened with tractor drawn ridger at a distance of 50-60 cm. After sowing, the furrows are covered with soil and the field is levelled by heavy planking. It is essential that there should be adequate moisture in the field at the time of planting. While in the paired row trench plantation technique, 'U' shaped 30 cm broad and 20-25 cm deep trenches are opened. Then cane setts are placed at the bottom of the trenches, which are covered with the soil left in between two rows. The distance between the paired row sets is 90 cm, which is known as inter row distance. While the distance in between the rows, known as intra-row distance was 30 cm. In this method the centre to centre distance between two set of rows is 120 cm. The planting geometry in this technique may be known as 30:90:30 cm or 60:120 cm. Paired row planting has proved advantageous over flat planting in giving higher yield in north India (Gupta *et al*., 2004).

In ridge and furrow method, the same practice of making furrow has been followed except, after sowing the seed setts are not fully covered by soil rather than less soil put on the setts with the help of spade. Then light irrigation has been given in the furrows after the sowing. Sugarcane, being a high water demanding crop, receives great setback due to unpredictable behaviour of monsoon in sub tropical India. Thus it was imperative to find efficient use of water through irrigation. Keeping above in view, the present study was undertaken to compare different sugarcane planting methods and geometry to evaluate yield, water productivity and cost benefit ratio.

METHODOLOGY

Field experiment was conducted at the farm of Krishi Vigyan Kendra-Ambala (30º30´13" N and 76º92´70" E) during year 2011. The climate of the area is semiarid, with an average annual rainfall of 1100 mm, minimum temperature of 0 to 4ºC in January, and maximum temperature of 38-42º C in June. About 75-80 per cent of rainfall is received during July to September and rest of the period the crop performance is depend on irrigation. The experimental soil (0-15 cm) was silt loam in texture, with, pH 8.4, $EC_{1:2}$ 0.4 dS m^{-1}, low in organic carbon (0.38%) and available nitrogen N (121 kg ha^{-1}), medium in available phosphorus, P (12.5 kg ha^{-1}) and medium in potassium, K (134.50 kg ha^{-1}). The experiment consisting of three planting methods *viz*., T_1-conventional planting (60 cm row spacing), T_2-paired row trench plantation method (60:120 cm spacing) and T_3-paired row ridge and furrow plantation method (100:120 cm spacing) was conducted with three replications.

The variety CoS-8436 (mid-season variety) was planted on 20-03-2011 and harvested on 10-03-2012. Recommended dose of fertilizer was 150 kg N, 50 kg P and 50 kg K per ha^{-1}. Full dose of phosphorus, potassium and one third dose of nitrogen were applied as basal through single super phosphate, muriate of potash and urea, respectively. Remaining dose of nitrogen was applied in two split doses on second and forth irrigation, respectively. Three budded setts of variety CoS-8436 were used for planting. In T_1-conventional planting the seed setts were covered with by tractor operated plankar. In T_2-paired row trench plantation method the seed setts were covered manually by soil left between rows.

In T_3-paired row ridge and furrow plantation method, the seed setts were covered with 5 cm soil with the help of spades manually. Irrigation was given to T_2

and T_3 just after planting. While in T_1 the irrigation was given after 50-60 per cent germination of the planted cane. Subsequent irrigations were scheduled in each plot according to irrigation required by the crop. The total rainfall received during the crop period was 819.50 mm out of which 735.90 mm was received during June to September. Data were recorded on morphological 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}.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Yield and yield attributes :

The millable canes (000 ha^{-1}) were 91.50, 96.60 and 100.33 in conventional planting (T_1), paired row trench plantation technique (T_2) and paired row ridge and furrow plantation method (T_3), respectively. Among all the treatments, millable canes were significantly higher under T_3 than T_2 and T_1. It was also significantly higher under T_2 than T_1. Anonymous (2014) also reported that after putting small amount of soil on the setts and followed by half ridge irrigation *i.e.* ridge and furrow method, improves germination, which in results increases the cane yield. The cane length was significantly higher under T_2 and T_3 than T_1, which was 200.00 cm, 198.00 cm and 193.00 cm in T_3, T_2 and T_1, respectively. Roodagi *et al.*, 2001 also observed higher plant height in paired row planting method at all growth stages than in normal planting method. The cane diameter was at par among T_2 (2.61 cm) and T_3 (2.63 cm), which was significantly higher than T_1 (2.50 cm). The cane weight varied from 860.33 g under T_1, 873.33 g in T_2 and 879.33 g in T_3, respectively. It was also significantly higher in T_2 and T_3 than T_1, while it was at par among T_2 and T_3. The differences in cane weight were due to variations in cane length and diameter of the cane (Table 1).

The cane yield in conventional planting (T_1) was 77.53 t ha^{-1}, 82.50 t ha^{-1} in paired row trench plantation technique (T_2), and 86.20 t ha^{-1} in paired row ridge and furrow plantation technique (T_3). The cane yield in T_3 was significantly higher than in conventional planting (T_1) and paired row trench plantation technique (T_2). Singh *et al.* (2012) also reported high cane yield in paired row trench plantation than conventional planting method, which was attributed to more number of millable canes, cane length and cane diameter. The higher cane yield in T_3 than T_2 and T_1 and in T_2 than T_1 was attributed to more number of millable cane and cane weight due to border effect which provides better light interception and proper aeration and ease in crop management practices due to wider spacing between set of rows. Haryana Kisan Ayog's report on conservation agriculture reported that paired row planting is best suited for tractor based intercultural operations. Katiyar *et al.* (2013) also observed high cane yield in trench planting method as compared to farmer practice planting method. Roodagi *et al.* (2001) observed similar results in paired row

Table 1 : Yield components (millable cane, cane length, diameter of cane, cane weight and cane yield)

Treatments	Millable canes (000 ha^{-1})	Cane length (cm)	Diameter of cane (cm)	Cane weight (g)	Cane yield (t ha^{-1})
T_1	91.50	193.00	2.50	860.33	77.53
T_2	96.60	198.00	2.61	873.33	82.50
T_3	100.33	200.00	2.63	879.66	86.20
C.D. (P=0.05)	3.270	2.68	0.04	13.258	2.828
S.E. $\pm$	0.811	0.66	0.01	3.289	0.701

Table 2 : Quantity of irrigation water applied and water productivity

Treatments	Irrigation water applied (ha-cm)	Total water input (ha-cm)	Water productivity (q $ha\text{-}cm^{-1}$)
T_1	277.83	359.78	2.82
T_2	245.49	327.44	3.37
T_3	229.11	311.06	3.79
C.D. (P=0.05)	NS	NS	NS
S.E. $\pm$	18.688	18.688	0.239

NS=Non-significant

Table 3 : Economics of different planting methods of sugarcane

Treatments	Seed rate (q ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	BCR
T_1	87.00	76000	175150	99150	2.30
T_2	80.00	70000	186450	116450	2.70
T_3	78.00	68000	194812	126812	2.90

Fig. 1 : Seed set placement and irrigation application in paired row ridge and furrow plantation method of sugarcane

planting. In addition to this Prabhakar *et al.* (2014) also observed that paired row planting (75/105 cm) produced significantly higher cane girth, cane weight, millable cane population and cane yield over normal planting (90 cm) in both the years during 2009-10 and 2010-11.

Water productivity :

Here we have determined the water productivity as the function of crop yield to irrigation water applied in the growing season. The numbers of irrigations given were 11 in T_1 and 13 in both the T_2 and T_3. The irrigation water applied (ha-cm) was 277.83 in conventional planting (T_1), 245.49 in paired row trench plantation (T_2) and 229.11 in modified plantation method (T_3) (Table 2). However, it was significantly at par among all the planting methods. But saving of 32.00 and 48 ha-cm in T_2 and T_3 than T_1, respectively is not the small quantity. The modified plantation technique (T_3) also saves 16.00 ha-cm as compared to paired row trench plantation technique (T_2). The water productivity was 2.82 in T_1, 3.37 in T_2 and 3.79 in T_3, respectively. Here we observed that in conventional planting due to irrigation given to whole field requires more time to irrigate per unit area as compared to paired row trench and paired row ridge and furrow plantation technique. We also have observed that irrigation in rows requires less quantity of water despite more number of irrigations. This results in increase in water productivity in paired row trench and paired row ridge and furrow plantation methods.

Economics :

In paired row trench and paired row ridge and furrow plantation method with ease in crop management practices such as weeding and propping etc. not only reduced cost of cultivation but also increases the cane yield. The cost of cultivation (Rs. ha^{-1}) was 76000.00 in T_1, 70000.00 in T_2 and 68000.00 in T_3, respectively (Table 3). The paired row trench (T_2) and paired row ridge and furrow plantation method (T_3) have 10 to 12 per cent less cost of cultivation. Nine to twelve per cent less seed rate per hectare was also the reason for less cost of cultivation. The gross return in farmer practice, paired row trench and modified paired row plantation method was 175150.00 Rs. ha^{-1}, 186450 and 194812 Rs. ha^{-1}, respectively. Due to less cost of cultivation and higher cane yield in paired row trench and paired row ridge and

furrow plantation method as compare to conventional planting the BCR was also high in paired row trench (2.70) and paired row ridge and furrow plantation method (2.90) than 2.30 in conventional planting.

Conclusion :

Good establishment method, which leads to good germination, and ease in doing crop management practices are key factors to increase the yield and save irrigation water. In this experiment we have seen that due to wider row to row spacing in paired row trench plantation (T_2) and paired row ridge and furrow plantation (T_3), all the yield attributes were performed better than conventional method of planting (T_1). We have to change our mind set by adopting newer growing methods to improve yield and increase return by reducing cost of cultivation. In the newer methods one of the most important natural resources *i.e*. water can also be saved.

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