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Influence of Planting Methods and Nitrogen Levels on Nutrient Uptake and Soil Fertility in Spring Planted Sugarcane

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A B S T R A C T

A field experiment was conducted at Regional Research Station, Karnal, CCS Haryana Agricultural University during spring 2017-18. The experiment was laid out 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). The results revealed that different planting methods fail to exert any significant influence on the nitrogen, phosphorus and potassium content (%) in cane, green top and whole plant. Application of different levels of nitrogen results significant increase in nitrogen concentration and uptake in cane and plant with increasing the dose of nitrogen except green top. The significantly higher N content (0.33% in cane, 0.69% in sugarcane plant) was recorded with the application 175 kg N/kg over control which was at par with 150 kg N/ha. The different level of nitrogen application had non-significant effect on P and K content in cane, green top as well as plant. However, significantly higher uptake of N, P and K was observed in wide bed and furrow paired row planting than conventional planting. Planting methods did not bring any significant variation in respect of available nutrients (N, P and K) in the soil, however, Increasing trend of available nitrogen was observed with increasing dose of nitrogen. The significantly higher available nitrogen (148.5kg/ha) was obtained with application of 175 kg N/ha over control.

Introduction

Sugarcane (*Saccharum officinarum* L.) an important agro-industrial commercial crop and plays a pivotal role in national economy. It is extensively grown in tropical and sub- tropical regions of India as cash crop. 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 (Anonymous. 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 (Anonymous. 2019). Although, in north India planting of sugarcane with conventional method at spacing of 60-75 cm is less time consuming but results in 30-35 percent lower germination, resulting in lesser plant population and lower cane yield as

compared to wider row spacing and paired trench plantation (Singh *et al.*, 2009, Singh *et al.*, 2012). Management of soil fertility especially for N is essential for good crop growth and higher production. Sugarcane also known as heavy feeders is a long duration nutrients exhaustive crop that depletes the soil fertility. A crop having yield of 100 tonnes per hectare removes 207 kg N, 30 kg P_2O_5 and 233 kg K_2O from the soil (Jagtap *et al.*, 2006). Therefore, proper fertilization is an essential for sugarcane production to secure good cane quality and quantity. Nitrogen constitutes only a fraction of one percent of total dry matter of a mature sugarcane plant, as it is an essential element of bio-molecules such as amino acids, proteins, nucleic acids, phyto-hormones and a number of enzymes and coenzymes. Nitrogen is mainly involved in the initial growth processes, such as replication of chromosomes, synthesis of deoxyribonucleic acids and nuclear protein. Nitrogen strongly stimulates growth, canopy expansion and interception of solar radiation in sugarcane. Excess application of nitrogen also decreases the sugar content of cane. Keeping these points in view, the present investigation was carried out to study the Influence of planting methods and nitrogen levels on nutrient uptake and soil fertility in spring planted sugarcane.

Materials and Methods

The field experiment was conducted during spring 2017-18 at Regional Research Station, Karnal (29º 43' North, 76º 58' East) of CCS Haryana Agricultural University. The climate of area is sub-tropical with mean maximum temperature ranging between 34-40º C in summer and mean minimum temperature ranging between 4-6º 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(0.40%), low in available nitrogen(158 kg/ha), medium in available phosphorus(11 kg/ha) and potassium(197 kg/ha). 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 were planted on 16th March 2017 and harvested on 27th February 2018 when plants had almost matured. In conventional method seed sets 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 were placed at bottom in paired row of 35 cm intra row distance. Then setts were 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 phosphorus (50 kg P_2O_5) through DAP (Diammonium phosphate), potash (50 kg K_2O) through MOP (muriate of potash) and zinc 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.

Plant and soil analysis

Plant analysis

The plant samples taken at harvest were used for analyzing nutrients present in the plant. The plant samples were powdered in a micro Willey mill and were analyzed for concentration of different nutrients (N, P and K) present in the plant parts. Total Nitrogen in plant was determined by Colorimetric or Nessler's method (Lindner, 1944) and expressed in per cent. Total Phosphorus in plant aliquot was determined by Vanado-molybdophosphoric yellow colour method (koening and Johnson, 1942). Potassium content in plant sample (leaves and cane separately) was determined by flame photometer method (Jackson, 1967). Nutrient uptake of each nutrient was computed as:

$$Nutrient\ uptake = \frac{Nutrient\ content\ (\%)\ X\ cane\ plant\ yield(t/ha)}{100}$$

Soil analysis

Representative soil samples from 0 to 15 cm depth were collected from each experimental plot at harvest. Soil samples thus collected were air dried under shade, powdered with wooden mallet and passed through 2 mm sieve and analyzed for nitrogen, phosphorus and potassium content. Available nitrogen was determined by alkaline permanganate method as outlined by Subbiah and Asija (1959).

Available phosphorus was determined by Bray's method as outlined by Jackson (1967). Available potassium was determined by neutral normal ammonium acetate solution using flame photometer as outlined by Jackson (1967).

Results and Discussion

Nutrient content and uptake in cane

Planting methods fails to exert any significant effect on N, P and K content (%) in cane. The N content (%) progressively increased in cane with application of nitrogen dose. The highest N content (0.33 %) was recorded in treatment received 175 kg N/ha (N_6) being at par with 150 kg N/ha (N_5) was significantly superior over other dose of nitrogen. The application of nitrogen level has no significant effect on P and K content (%). The nutrient uptake in cane was influenced significantly by different planting methods. Significantly highest nutrient uptake was recorded in wide bed and furrow paired row planting (M_3) which was statistically similar with half ridge open furrow irrigation planting (M_2) and wider planting (M_4) but was significantly higher over conventional method at 75 cm (M_1) in respect of N and P uptake. Among different levels of nitrogen the maximum N uptake (320.6 kg/ha) was observed at 175 kg N/ha (N_6) being at par with 150 kg N/ha applied and was significantly higher than other nitrogen treatment. These results are in conformity with Narayanamurti *et al.,* (1997), Rana and Singh (2003) and Bhullar *et al.,* (2002) (Table 1).

Nutrient content and uptake in green top

Neither the planting methods nor the nitrogen levels had any significant effect on nutrient content in green top of sugarcane plant. Significantly higher N, P and K uptake was recorded under wide bed and furrow paired row planting method as compared to other methods of planting except P uptake where it did not differ significantly from half ridge open furrow irrigation planting at 75 cm. Significantly lowest nutrient uptake was recorded under conventional planting at 120 cm. These finding were in line with Bhullar *et al.,* (2002) (Table 2).

Table.1 Effect of planting methods and nitrogen levels on nutrients content (%) and their uptake in cane

Treatments		Nutrient content in cane			Nutrients uptake by cane (kg/ha)		
Planting Methods		N %	P %	K %	N	P	K
M_1	Conventional planting at 75 cm	0.29	0.027	0.352	228.2	20.5	268.4
M_2	Half ridge open furrow irrigation planting at 75 cm	0.31	0.031	0.351	266.3	26.3	302.0
M_3	Wide bed and furrow paired row planting (35: 105 cm)	0.30	0.032	0.350	280.4	28.6	325.0
M_4	Wider planting at 120 cm	0.30	0.031	0.355	261.3	25.8	308.6
CD (P = 0.05)		NS	NS	NS	33.7	2.6	19.2
Nitrogen Levels (kg /ha)							
N_1	0 (Control)	0.26	0.032	0.360	165.4	19.2	223.9
N_2	75	0.29	0.032	0.349	218.7	23.7	265.8
N_3	100	0.30	0.031	0.350	249.4	25.6	290.9
N_4	125	0.30	0.028	0.348	282.0	26.1	321.6
N_5	150	0.31	0.028	0.353	318.1	28.5	359.1
N_6	175	0.33	0.031	0.352	320.6	28.7	344.7
CD (P = 0.05)		0.024	NS	NS	23.0	4.4	28.6

Table.2 Effect of planting methods and nitrogen levels on nutrient content (%) and their uptake in green top of sugarcane

Treatments		Nutrient % in top			Nutrients uptake by top (kg/ha)		
Planting Methods		N %	P %	K %	N	P	K
M_1	Conventional planting at 75 cm	0.34	0.025	0.43	18.5	2.3	23.1
M_2	Half ridge open furrow irrigation planting at 75 cm	0.34	0.030	0.44	20.9	2.8	26.0
M_3	Wide bed and furrow paired row planting (35: 105 cm)	0.35	0.033	0.43	22.9	3.0	28.1
M_4	Wider planting at 120 cm	0.34	0.031	0.44	19.3	2.6	24.7
CD (P = 0.05)		NS	NS	NS	1.0	0.02	1.7
Nitrogen Levels (kg /ha)							
N_1	0 (Control)	0.31	0.032	0.44	10.7	1.6	15.3
N_2	75	0.33	0.031	0.43	16.1	2.3	21.0
N_3	100	0.34	0.030	0.43	19.2	2.6	24.1
N_4	125	0.35	0.029	0.43	23.3	2.9	28.4
N_5	150	0.36	0.028	0.44	26.1	3.2	31.7
N_6	175	0.36	0.031	0.43	26.9	3.4	32.2
CD (P = 0.05)		NS	NS	NS	2.61	0.33	2.4

Table.3 Effect of planting methods and nitrogen levels on nutrient content (%) and their uptake in sugarcane plant

Treatments		Nutrient % in plant			Nutrients uptake by plant (kg/ha)		
Planting Methods		**N %**	**P %**	**K %**	**N**	**P**	**K**
M_1	Conventional planting at 75 cm	0.640	0.071	0.786	246.6	22.7	291.5
M_2	Half ridge open furrow irrigation planting at 75 cm	0.652	0.078	0.784	287.3	29.1	328.0
M_3	Wide bed and furrow paired row planting (35: 105 cm)	0.646	0.079	0.783	303.3	31.6	353.1
M_4	Wider planting at 120 cm	0.637	0.077	0.792	280.6	28.4	333.4
CD (P = 0.05)		NS	NS	NS	34.2	2.8	20.9
Nitrogen Levels (kg /ha)							
N_1	0 (Control)	0.574	0.080	0.802	176.2	20.8	239.3
N_2	75	0.624	0.078	0.782	234.9	26.0	286.9
N_3	100	0.646	0.078	0.782	268.6	28.2	315.1
N_4	125	0.661	0.073	0.779	305.4	29.0	350.1
N_5	150	0.671	0.073	0.789	344.2	31.7	390.8
N_6	175	0.687	0.076	0.785	347.5	32.1	376.9
CD (P = 0.05)		0.04	NS	NS	23.5	4.7	30.9

Table.4 Effect of planting methods and nitrogen levels on available nitrogen, phosphorus, potassium in soil at harvest

Treatment		Available Nutrient (Kg/ha)		
Planting Methods		**N**	**P**	**K**
M_1	Conventional planting at 75 cm	146.0	10.8	183.4
M_2	Half ridge open furrow irrigation planting at 75 cm	144.9	10.5	189.3
M_3	Wide bed and furrow paired row planting (35: 105 cm)	143.1	10.9	184.5
M_4	Wider planting at 120 cm	143.7	11.1	190.1
CD (P = 0.05)		NS	NS	NS
Nitrogen Levels (Kg /ha)				
N_1	0 (Control)	139.7	10.8	179.6
N_2	75	142.6	11.1	180.8
N_3	100	140.2	10.9	186.6
N_4	125	147.7	10.7	187.7
N_5	150	147.8	10.5	190.1
N_6	175	148.5	10.9	196.0
CD (P = 0.05)		7.1	N5	9.23

Nutrient content and uptake in sugarcane plant

Planting methods did not differ significantly in respect of nutrient content in sugarcane plant; however planting methods differ significantly in respect of nutrient uptake. Increasing levels of nitrogen had significant effect on the N content in sugarcane plant but differences are non significant in respect of P and K content. The maximum 303.3 kg ha^{-1}, 31.6 kg ha^{-1}, 353.1 kg ha^{-1} uptake of N, P and K uptake respectively was observed in wide bed and furrow paired row planting which is 23%, 39.2% and 21.1% higher over conventional planting method. The results are in agreement with Bhullar *et al.,* (2002) and Zarekar *et al.,* (2018). The remarkable influence was noticed on N, P, and K nutrient uptake over the control owning to level of nitrogen. The highest uptake of nutrient in cane plant was recorded 347.5, 32.1, and 376 kg/ha of N, P and K, respectively. Sinha *et al.,* (2017) and Dev *et al.,* (2013) also noticed increase uptake of nitrogen by sugarcane (Table 3).

Soil fertility status at harvest

The planting methods did not have any significant influence on nutrient availability in respect of N, P and K at harvest. In spite of non significant effects, the maximum 146 kg/ha available nitrogen was retained under conventional planting and minimum 143.1 kg/ha available nitrogen was recorded in wide bed and furrow paired row. Increasing trend of available nitrogen was observed with increasing dose of nitrogen. The significant higher (148.5kg/ha) available nitrogen was obtained with application of fertilizer 175 kg N/ha over control (Table 4). The difference in available N in soil might be due to difference in cane yield under different planting methods. Higher the cane yield more will be uptake and vice-versa. Among N levels, the highest available nitrogen obtained at 175 kg N/ha might be due to mineralization and solubilization of nutrients and application of maximum nitrogen. The P and K status of the soil after harvest of the crop remained unaffected either by methods of planting or levels of nitrogen application except availability of K in soil increased significantly with application of 175 kg N ha^{-1} over control which might be due to addition of available pool after harvest of the crop. The results are in confirmation with Jha *et al.,* (2015).

In conclusion, nutrient uptake by sugarcane crop in respect of N, P and K was recorded significantly higher under wide bed and furrow paired row planting over conventional planting. Among nitrogen levels, nitrogen concentration and uptake increases in cane and plant with increasing dose of nitrogen except green top.

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