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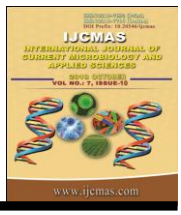

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Effect of Different Establishment Techniques and Planting Geometry on Nutrient Content, Uptake and Soil Fertility Status after Harvest of Sugarcane

Maruthi, D. Krishnamurthy*, Y.M. Ramesh, B.M. Chittapur and Ashokkumar Gaddi

University of Agricultural Sciences, Raichur - 584 104, Karnataka, India

**Corresponding author*

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A B S T R A C T

A Field experiment was carried out in a black clay [the soil was slightly alkaline pH (8.23), low in EC (0.20 dSm^{-1}) and organic carbon (0.43%), low in available nitrogen (166.8 kg ha^{-1}), high in available phosphorus (55.0 kg ha^{-1}) and available potassium (300.5 kg ha^{-1})] to study the effect of Effect of different establishment techniques and planting geometry on uptake of nutrients and soil fertility status after harvest of sugarcane at Experimental block, Agricultural Research Station, Dhadesugur which falls under Northern Dry Zone of Karnataka (Zone-III) during 2016-17. Planting of two eye budded setts with dual row planting of sugarcane recorded numerically higher N and K uptake (337.4, 79.1 and 341.6 kg ha^{-1}, respectively) followed by two eye budded setts with paired row planting (308.9, 72.4 and 310.1kg ha^{-1}, respectively) and two eye budded setts with wide row planting (289.5, 69.1 and 297.7 kg ha^{-1}, respectively). Lower uptake was noticed in three eye budded setts with normal row planting (221.3, 54.6 and 240.3 kg ha^{-1}, respectively). Under different establishment techniques and planting geometries, growing sugarcane did not significantly influence the available soil nutrients at harvest. However, three eye budded setts with normal planting recorded numerically higher N, P and K availability followed by chip bud setts with wide row planting. Lower N, P and K availability was recorded in two eye budded setts with dual row planting.

Introduction

Sugarcane (*Saccharum officinarum* L.) is an important commercial crop and it provides sugar, bio-fuel and manure besides many by products. In the world, there are 115 countries cultivating sugarcane with a sugar production of 1331.2 m t which is three fourth of the total sugar production of the world (Anon., 2015b) and remaining sugar is derived from sugar beet (21.5%). Globally, sugarcane is cultivated in an area of 24.5 m ha with a production of 1850 m t and a productivity of 75.5 t ha^{-1} (Anon, 2015). In India, sugarcane is grown in Maharashtra, Karnataka, Gujarat, Tamil Nadu, Uttar Pradesh, Punjab, Haryana and Bihar. India is the world's second largest producer of sugarcane in terms of area (5.3 m ha) of world's total sugar production (27.1 m t). In Karnataka, it is cultivated in an area of about 0.50 m ha with a production of 47 m t and a productivity of 94.0 t ha^{-1} (Anon., 2015a). In Tunga Bhadra Project (TBP) command area, sugarcane is an important commercial crop

after rice and cotton. Traditionally three budded cane setts were using for planting which consumes a lot of cane for planting alone and hence, greater financial burden for the grower from the beginning. Of late many techniques have been evolved for planting at different places like two budded setts, single eye budded setts, bud scoops and transplanting which require less planting material and hence more economical. However, these materials respond differentially to planting geometry to produce profitable yields and cane cultivars respond differentially to these methods. Some of the planting systems are evolved specifically for the purpose of convenience of cultural operations such as irrigation, wind damage management and suitability to machine harvesting.

The primary components of cane yield are cane population and weight of individual cane. Cane population per unit area is directly affected by planting density which changes rapidly with the closer spacing or with the increase in seed rate. Thus, yield level can be increased substantially by manipulating certain cultural practices like spacing, planting material *etc*. The adaption of optimum spacing, suitable planting pattern/ crop geometry, sett size and sett rate will go a long way in increasing yield and quality of sugarcane. The information on testing of different planting material under various planting techniques on nutrient uptake and soil fertility under TBP command area is lacking and needs to be worked out. It is, therefore, necessary to standardize the suitable planting techniques with spacing/ plant geometry that may improve the productivity and sustainability of sugarcane. Hence, the present study was planned and executed accordingly.

Materials and Methods

A Field experiment was carried out in a black clay [the soil was slightly alkaline pH (8.23), low in EC (0.20 dSm^{-1}) and organic carbon (0.43%), low in available nitrogen (166.8 kg ha^{-1}), high in available phosphorus (55.0 kg ha^{-1}) and available potassium (300.5 kg ha^{-1})] to study the effect of Effect of different establishment techniques and planting geometry on uptake of nutrients and soil fertility status after harvest of sugarcane at Experimental block, Agricultural Research Station, Dhadesugur which falls under Northern Dry Zone of Karnataka (Zone-III) during 2016-17. The station is situated between 15º41' N latitude, 76º 53' E longitude and at an altitude of 380 meters above mean sea level. The composite soil samples from 0 to 15 cm depth were collected before planting and at harvest. Soils were air dried in shade, powdered and passed through 2 mm sieve and analysed for pH, EC, OC, available N, P_2O_5 and K_2O_5 by following the methods described by Jackson (1973) and Lindsay and Norvel (1978). The experiment comprised of ten treatments *viz*. T_1-Single eye budded setts with wide row planting (120 cm furrow), T_2: Single eye budded setts with paired row planting (60 cm- 120 cm- 60 cm), T_3: Single eye budded setts with dual row planting (30 cm- 150 cm- 30 cm), T_4: Two eye budded setts with wide row planting (120 cm), T_5: Two eye budded setts with paired row planting (60 cm- 120 cm- 60 cm), T_6: Two eye budded setts with dual row planting (30 cm- 150 cm- 30 cm), T_7: Bud chip seedlings with wide row planting (120 cm furrow), T_8: Bud chip seedlings with paired row planting (60 cm- 120 cm- 60 cm), T_9: Bud chip seedlings with dual row planting (30 cm- 150 cm- 30 cm) and T_{10}: Three eye budded setts with conventional planting (90 cm). The experiment was laid out in randomized complete block design (RCBD) with three replications. The sugarcane variety 2003-V-46 was planted on 1st of February, 2016. Fertilizer was applied @ 250 kg N, 100 kg P_2O_5 and 125 kg K_2O ha^{-1} in the form of Urea, DAP, and SOP, respectively. The entire dose of P, K, and 1/3rd of N were applied as a

basal dose at the time of planting, while remaining N was applied in two splits, 1/3rd at the start of tillering and 1/3rd before earthing up by side dressing. The crop was harvested manually after its maturity on 29th of February, 2017. Recommended packages of practices were adopted for crop production. The analysis and interpretation of data were done using the Fisher's method of analysis and variance technique as given by Gomez and Gomez (1984).

Results and Discussion

Nutrient content and uptake by sugarcane

Nitrogen content and uptake: The data on nitrogen content in leaf and cane of sugarcane as influenced by establishment techniques and planting geometries did not differ significantly (Table 1). However, the data on uptake of nitrogen by sugarcane as influenced by the establishment techniques and planting geometries was differed significantly. Among the treatments, growing of sugarcane with two eye budded setts with dual row planting (30 cm-150 cm -30 cm) recorded significantly maximum uptake of nitrogen in leaf, cane and plant (133.2, 204.2 and 337.4 kg ha^{-1}, respectively) and it was on par with the two eye budded setts with paired row (60 cm-120 cm-60 cm) planting (120.1, 188.8 and 308.9 kg ha^{-1}, respectively) and two eye budded setts with wide row (120 cm) planting (111.2, 178.1 and 289.5 kg ha^{-1}, respectively).

However, uptake of nitrogen in leaf, cane and plant was on par with planting of sugarcane with single eye budded setts and bud chip seedling with different planting geometries. Whereas, planting of sugarcane with three budded setts (conventional planting) recorded significantly lower uptake of nitrogen in leaf, cane and plant (78.1, 143.2 and 221.3 kg ha^{-1}, respectively). Similar findings were reported by Patel (2003).

Phosphorus content and uptake: The data on nutrient content of phosphorus in sugarcane was not differed as influenced by the establishment techniques and planting geometries (Table 2). Results indicated that growing of sugarcane with two eye budded setts with dual row planting (30 cm-150 cm - 30 cm) recorded significantly higher uptake of phosphorus in leaf, cane and plant (24.1, 55.0 and 79.1 kg ha^{-1}, respectively) and it was on par with the two eye budded setts with paired row (60 cm-120 cm-60 cm) planting (21.4, 51.0 and 72.4 kg ha^{-1}, respectively) and two eye budded setts with wide row (120 cm) planting (20.6, 48.4 and 69.1 kg ha^{-1}, respectively).

However, uptake of phosphorus in leaf, cane and plant was on par with planting of sugarcane with single eye budded setts and bud chip seedling with different planting geometries. Whereas, planting of sugarcane with three budded setts (conventional planting) recorded significantly lower uptake of phosphorus in leaf, cane and plant (15.8, 38.8 and 54.6 kg ha^{-1}, respectively). Similar findings were reported by Patel (2003).

Potassium content and uptake: Potassium content in leaf and cane did not differ significantly (Table 3). The data on uptake of potassium in sugarcane as influenced by the establishment techniques and planting geometries were differed significantly.

Growing of sugarcane with two eye budded setts with dual row planting (30 cm-150 cm - 30 cm) recorded significantly maximum uptake of potassium in leaf, cane and plant (160.5, 181.0 and 341.6 kg ha^{-1}, respectively) and it was on par with the two eye budded setts with paired row (60 cm-120 cm-60 cm) planting (142.3, 167.7 and 310.1 kg ha^{-1}, respectively) and two eye budded setts with wide row (120 cm) planting (138.2, 159.5 and 297.7 kg ha^{-1}, respectively).

Table.1 Nitrogen content and uptake of sugarcane as influenced by different establishment techniques and planting geometries at harvest

Treatments	Nitrogen content (%)		Nitrogen uptake (kg ha^{-1})		
	Leaf	Cane	Leaf	Cane	Total
T_1: Single eye budded setts with wide row planting (120 cm furrow)	1.1	0.4	91.2	161.9	253.2
T_2: Single eye budded setts with paired row planting (60 cm-120 cm-60 cm)	1.1	0.4	96.0	166.9	263.0
T_3: Single eye budded setts with dual row planting (30 cm-150 cm-30 cm)	1.1	0.4	96.7	169.0	265.7
T_4: Two eye budded setts with wide row planting (120 cm)	1.2	0.4	111.2	178.1	289.4
T_5: Two eye budded setts with paired row planting (60 cm-120 cm-60 cm)	1.2	0.4	120.1	188.8	308.9
T_6: Two eye budded setts with dual row planting (30 cm-150 cm-30 cm)	1.2	0.4	133.2	204.2	337.4
T_7: Bud chip seedling with wide row planting (120 cm furrow)	1.1	0.4	84.5	148.0	232.5
T_8: Bud chip seedling with paired row planting (60 cm-120 cm-60 cm)	1.1	0.4	86.9	153.1	240.0
T_9: Bud chip seedling with dual row planting (30 cm-150 cm-30 cm)	1.1	0.4	87.6	154.6	242.3
T_{10}:Three eye budded setts with conventional planting (90 cm)	1.0	0.4	78.1	143.2	221.3
S.Em.±	**0.1**	**0.0**	**11.3**	**9.3**	**13.7**
C.D. (P=0.05)	**NS**	**NS**	**33.8**	**27.5**	**40.7**

NS: Non Significant

Table.2 Phosphorus content and uptake of sugarcane as influenced by different establishment techniques and planting geometries at harvest

Treatments	Phosphorus content (%)		Phosphorus uptake (kg ha^{-1})		
	Leaf	Cane	Leaf	Cane	Total
T_1: Single eye budded setts with wide row planting (120 cm furrow)	0.2	0.1	17.6	43.5	61.2
T_2: Single eye budded setts with paired row planting (60 cm-120 cm-60 cm)	0.2	0.1	18.2	45.0	63.3
T_3: Single eye budded setts with dual row planting (30 cm-150 cm-30 cm)	0.2	0.1	18.6	45.3	64.0
T_4: Two eye budded setts with wide row planting (120 cm)	0.2	0.1	20.6	48.4	69.0
T_5: Two eye budded setts with paired row planting (60 cm-120 cm-60 cm)	0.2	0.1	21.4	51.0	72.4
T_6: Two eye budded setts with dual row planting (30 cm-150 cm-30 cm)	0.2	0.1	24.1	55.0	79.1
T_7: Bud chip seedling with wide row planting (120 cm furrow)	0.2	0.1	16.2	40.5	56.8
T_8: Bud chip seedling with paired row planting (60 cm-120 cm-60 cm)	0.2	0.1	16.8	42.0	58.9
T_9: Bud chip seedling with dual row planting (30 cm-150 cm-30 cm)	0.2	0.1	17.0	42.3	59.4
T_{10}:Three eye budded setts with conventional planting (90 cm)	0.2	0.1	15.8	38.8	54.6
S.Em.±	**0.0**	**0.00**	**0.9**	**1.5**	**1.9**
C.D. (P=0.05)	**NS**	**NS**	**2.8**	**4.4**	**5.4**

NS: Non Significant

Table.3 Potassium content and uptake of sugarcane as influenced by different establishment techniques and planting geometries at harvest

Treatments	Potassium content (%)		Potassium uptake (kg ha^{-1})		
	Leaf	Cane	Leaf	Cane	Total
T_1: Single eye budded setts with wide row planting (120 cm furrow)	1.4	0.3	119.8	146.6	266.5
T_2: Single eye budded setts with paired row planting (60 cm-120 cm-60 cm)	1.4	0.3	123.8	150.9	274.8
T_3: Single eye budded setts with dual row planting (30 cm-150 cm-30 cm)	1.4	0.3	124.8	151.6	276.4
T_4: Two eye budded setts with wide row planting (120 cm)	1.4	0.3	138.2	159.5	297.7
T_5: Two eye budded setts with paired row planting (60 cm-120 cm-60 cm)	1.4	0.3	142.3	167.7	310.1
T_6: Two eye budded setts with dual row planting (30 cm-150 cm-30 cm)	1.4	0.3	160.5	181.0	341.6
T_7: Bud chip seedling with wide row planting (120 cm furrow)	1.4	0.3	112.7	137.9	250.6
T_8: Bud chip seedling with paired row planting (60 cm-120 cm-60 cm)	1.4	0.3	115.7	141.8	257.5
T_9: Bud chip seedling with dual row planting (30 cm-150 cm-30 cm)	1.4	0.3	117.4	142.5	259.9
T_{10}:Three eye budded setts with conventional planting (90 cm)	1.4	0.3	108.2	132.1	240.3
S.Em.±	**0.0**	**0.0**	**6.2**	**5.2**	**9.7**
C.D. (P=0.05)	**NS**	**NS**	**18.3**	**15.3**	**28.8**

NS: Non Significant

Table.4 Chemical properties of soil influenced by different establishment techniques and planting geometries after Harvest of sugarcane

Treatments	pH	Electrical conductivity (dS m^{-1})	Organic carbon (%)	Available nutrients (kg ha^{-1})		
				N	P_2O_5	K2O
T_1: Single eye budded setts with wide row planting (120 cm furrow)	8.1	0.3	0.4	170.0	38.7	270.2
T_2: Single eye budded setts with paired row planting (60 cm-120 cm-60 cm)	8.2	0.4	0.4	169.2	40.2	271.5
T_3: Single eye budded setts with dual row planting (30 cm-150 cm-30 cm)	8.2	0.4	0.4	169.1	38.4	268.9
T_4: Two eye budded setts with wide row planting (120 cm)	8.4	0.4	0.4	167.2	38.3	267.3
T_5: Two eye budded setts with paired row planting (60 cm-120 cm-60 cm)	8.3	0.4	0.4	165.0	38.2	267.0
T_6: Two eye budded setts with dual row planting (30 cm-150 cm-30 cm)	8.4	0.4	0.4	163.8	38.1	267.0
T_7: Bud chip seedling with wide row planting (120 cm furrow)	8.1	0.4	0.4	173.7	42.1	271.1
T_8: Bud chip seedling with paired row planting (60 cm-120 cm-60 cm)	8.3	0.3	0.4	173.4	42.0	267.0
T_9: Bud chip seedling with dual row planting (30 cm-150 cm-30 cm)	8.2	0.3	0.4	171.7	41.1	271.9
T_{10}:Three eye budded setts with conventional planting (90 cm)	8.1	0.3	0.4	174.8	42.6	272.6
S.Em.±	**0.1**	**0.0**	**0.0**	**3.5**	**1.6**	**1.8**
C.D. (P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

NS: Non Significant

However, uptake of potassium in leaf, cane and plant was on par with planting of sugarcane with single eye budded setts and bud chip seedling with different planting geometries.

Whereas, planting of sugarcane with three budded setts (conventional planting) recorded significantly lower uptake of potassium in leaf, cane and plant (108.2, 132.1 and 240.3 kg ha^{-1}, respectively). Similar findings were reported by Patel (2003).

Changes in N, P and K content in soil

The data on chemical properties of soil after harvest of sugarcane *viz*., pH, EC, OC, available nitrogen, phosphorus and potassium were not differed significantly as influenced by the establishment techniques and planting geometries (Table 4).

Similar findings were reported by Patel (2003).

The results of the investigation showed that, planting of two eye budded setts with dual row planting of sugarcane recorded numerically higher N and K uptake (337.4, 79.1 and 341.6 kg ha^{-1}, respectively) followed by two eye budded setts with paired row planting (308.9, 72.4 and 310.1kg ha^{-1}, respectively) and two eye budded setts with wide row planting (289.5, 69.1 and 297.7 kg ha^{-1}, respectively).

Lower uptake was noticed in three eye budded setts with normal row planting (221.3, 54.6 and 240.3 kg ha^{-1}, respectively).

Under different establishment techniques and planting geometries, growing sugarcane did not significantly influence the available soil nutrients at harvest. However, three eye budded setts with normal planting recorded numerically higher N, P and K availability followed by chip bud setts with wide row planting. Lower N, P and K availability was recorded in two eye budded setts with dual row planting.

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