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Effect of Row Spacing and Nutrient Management on Growth, Yield and Nutrient Uptake of Sugarcane Seed Cane

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ABSTRACT

A field experiment was conducted at Agricultural Research Station, Perumallapalle of Acharya N. G. Ranga Agricultural University, to study the effect of row spacing and nutrient management on growth, yield and nutrient uptake of sugarcane seed. The spacings adopted were 40 cm (S_1), 60 cm (S_2) and 80 cm (S_3) and the nutrient levels were 120-75-75 (N_1), 160-100-100 (N_2), 200-125-125 (N_3) and 240-150-150 kg N-P_2O_5-K_2O ha^{-1} (N_4) respectively. Varied spacings and nutrient management practices as well as their interaction significantly influenced the growth, yield and nutrient uptake of sugarcane seed cane crop. Highest seed cane yield, nutrient uptake and germination percentage was recorded when sugarcane was planted at row spacing 40 cm in combination with 240-150-150 kg N-P_2O_5-K_2O ha^{-1}.

Key words : Nutrient levels, Seed cane, Spacing, Sugarcane, Uptake.

Sugarcane (*Saccharam Spp.*), is the important commercial crop in the world economy and it has very great economic impact particularly on rural India. Sugarcane is a prime supplier of raw materials for sweeteners like sugar, jaggery, khandasari and also for many by-products.

The average productivity of sugarcane in India is quite low as compared to many other sugarcane growing countries of the world. With the increasing population of India, the demand for sugar and other sweetening agents is also increasing. To meet the sugar requirement of these ever increasing populations, it is essential that sugarcane production is to be stepped up. Sugarcane is a vegetatively propagated crop, so there are chances of many diseases being carried to the next crop through the seed cane that are used from the main crop aged more than 10 months. Normally the present practice is, the top one third portion of the main crop is used as seed material for planting which was attacked by pests and diseases and results in low germination due to over matured buds and low final yields of the main crop. In order to overcome the above problem and to obtain higher main crop yields, raising of short crop for seed purpose and use of young 6-8 months aged crop with immature sound buds was beneficial.

Among the various management practices to sugarcane seed crop, mineral nutrition and spacing has profound role in increasing the productivity. Sah (2000) reported that seed cane resulted 50% higher germination, 43.3% more shoot population, 39.8% higher cane yield and benefit cost ratio and also proved the economic superiority of seed cane production technologies over the traditional practices.

MATERIAL AND METHODS

The experiment was conducted at Agricultural Research Station, Perumallapalle of Acharya N. G. Ranga Agricultural University, during *Kharif*, 2011. The experiment was laid in a split plot design replicated thrice with the variety 2005 T 16 with three row spacings 40 cm (S_1), 60 cm (S_2) and 80 cm (S_3) in main plot and four nutrient levels 120-75-75 (N_1), 160-100-100 (N_2), 200-125-125 (N_3) and 240-150-150 (N_4) kg N-P_2O_5-K_2O ha^{-1} respectively in sub-plots. Nitrogen and potassium was applied in four equal splits at 30, 60, 90 and 150 DAP and phosphorus as basal dressing. The soil of the experimental field was clayey loam in texture with pH 7.4 and 0.43% organic carbon. The available nitrogen, phosphorus and potassium were 209 kg ha^{-1}, 29.0 kg ha^{-1} and 255 kg ha^{-1}, respectively.

Crop was harvested at 6 months age and the cane yield was recorded. Representative plant samples were taken from each treatment and setts

Table 1. Dry matter production (t ha^{-1}) and Plant height (cm) of sugarcane seed crop at harvest as influenced by spacing and nutrient levels.

Treatments	Plant height					Dry matter production				
	N_1	N_2	N_3	N_4	Mean	N_1	N_2	N_3	N_4	Mean
S_1	171.0	186.0	187.7	198.0	186.4	77.0	82.3	85.0	86.3	82.6
S_2	176.3	182.7	189.3	192.3	185.2	69.0	70.3	72.0	81.3	73.2
S_3	170.3	172.3	179.3	181.0	175.8	49.6	61.3	64.0	69.0	61.0
Mean	172.6	180.3	186.1	190.4		65.2	71.3	73.6	78.8	
		SE m±		CD (P=0.05)			SE m±			CD (P=0.05)
S		1.5		5.8			0.1			0.4
N		0.8		2.3			1.5			4.6
N at S		3.0		4.7			3.0			7.2
S at N		1.9		6.7			3.1			7.4

were separated and analysed for N, P and K content and uptake was calculated to per hectare by multiplying with total dry matter production. The harvested setts were planted in the field to study the germination percentage.

The data recorded on various parameters of crop was subjected to statistical scrutiny by the method of analysis of variance as outlined by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Growth parameters

Highest plant height and dry matter production was recorded with the spacing of 40 cm (S_1) which was significantly higher than other spacings. Shorter plant stature and lesser dry matter production was observed with the spacing of 80 cm (S_3) (Table 1).

Plants of tallest stature and highest dry matter production were observed with 240-150-150 kg N-P_2O_5-K_2O ha^{-1} (N_4). The shortest plants with lesser dry matter production were recorded under the fertilizer schedule of 120-75-75 kg N-P_2O_5-K_2O ha^{-1} (N_1). Closer spacing of 40 cm was advantageous over other spacings in producing taller plants with more internodal length. This might be due to competition for solar radiation and air (Raghu *et al.,* 2006). Highest dry matter production with 240-150-150 kg N-P_2O_5-K_2O ha^{-1} (N_4) might be due to availability of more nutrients especially nitrogen which favours luxurious vegetative growth of the crop (Narayanamurthi *et al*., 1997).

The interaction effect of 40 cm (S-$_1$) in combination with 240-150-150 (N_4) kg N-P_2O_5-K_2O ha^{-1} (N_4) recorded tallest plants with higher dry matter production, while wider row spacing of 80 cm (S_3) in combination with 120-75-75 kg N-P_2O_5-K_2O ha^{-1} (N_1) resulted short statured plants with lesser dry matter production.

Seed cane yield

Spacing exerted significant influence on seed cane yield of sugarcane (Table 2). The spacing of 40 cm (S_1) recorded significantly higher seed cane yield than the seed cane yield that resulted from 60 (S_2) spacings. Significantly lesser seed cane yield was associated with 80 cm (S_3) spacing. Seed cane yield was significantly higher at closer inter-row spacing evidently due to higher number of seed

Table 2. Seed cane yield (t ha^{-1}) of sugarcane seed crop at harvest as influenced by spacing and nutrient levels.

Treatments	Seed cane yield				
	N_1	N_2	N_3	N_4	Mean
S_1	84.0	85.0	96.0	99.0	91.4
S_2	62.0	73.0	80.5	72.0	71.9
S_3	55.0	60.0	63.0	69.0	61.8
Mean	67.0	72.8	80.3	79.8	
		SE m±		CD (P=0.05)	
S		1.0		3.0	
N		1.9		5.9	
N at S		1.9		6.6	
S at N		2.9		8.7	

canes as compared to wider row spacing. At wider row spacing, lowest cane yield might be due to lowest number of millable canes (Chitakala Devi *et al*., 2005).

Among the nutrient levels, 200-125-125 kg N-P_2O_5-K_2O ha^{-1} (N_3) recorded highest seed cane yield which was on a par with the seed cane yield that obtained from 240-150-150 kg N-P_2O_5-K_2O ha^{-1} (N_4) and both were significantly superior to two lower nutrient levels tested. The treatment with 120-75-75 kg N-P_2O_5-K_2O ha^{-1} (N_1) recorded significantly lower seed cane yield. The split application of vital plant nutrients viz., N, P & K in rational proportions in accordance with the stages of the crop requirement up to 150 DAP might have ensured constant and steady supply of these nutrients for effective crop uptake which would have positive impact on economic shoot population, cane length, individual cane weight and ultimately on seed cane yield (Indirajith and Natarajan, 2011).

The interaction effect between the spacing and nutrient levels were significant in influencing the seed cane yield. The interaction effect of closer spacing of 40 cm (S_1) in combination with 240-150-150 kg N-P_2O_5-K_2O ha^{-1} (N_4) recorded highest seed cane yield compared to all other interactions and lower seed cane yield was recorded under the combination of 80 cm (S_3) with 120-75-75 kg N-P_2O_5-K_2O ha^{-1} (N_1).

Nutrient uptake by seed cane at harvest

Nitrogen uptake

Significant influence on nitrogen uptake by sugarcane seed cane was observed with varied spacings (Table3). The highest nitrogen uptake by sugarcane seed cane crop was registered with 40 cm (S_1) which was significantly higher than 60 cm (S_2) and 80 cm (S_3). While lesser value of nitrogen uptake was registered with 80 cm (S_3) spacing. This might be due to higher dry matter production at closer spacing, compared to an increase in N content (Asokan *et al*., 2005).

Nitrogen uptake was significantly influenced by nutrient levels. With regard to the nutrient levels tested, the treatment with 240-150-150 kg N-P_2O_5-K_2O ha^{-1} (N_4) resulted in highest uptake of nitrogen, which was significantly higher than the treatment 200-125-125 (N_3) and 160-100-100 kg N-P_2O_5-K_2O ha^{-1} (N_2). The lowest value of nitrogen uptake of seed cane was recorded with 120-75-75 kg N-P_2O_5-K_2O ha^{-1} (N_1).

The interaction effect between the treatments was significant and closer spacing of 40 cm (S_1) with higher nutrient level of 240-150-150 kg N-P_2O_5-K_2O ha^{-1} (N_4) resulted in highest uptake of nitrogen than the other interaction effects.

Phosphorus and Potassium uptake

The highest phosphorus and potassium uptake by sugarcane seed cane crop was registered with 80 cm (S_3) and this was followed by 60 cm (S_2). The lowest uptake of phosphorus and potassium was recorded with 40 cm (S_1) (Table 3). Unlike nitrogen uptake, the wider spacing of 80 cm recorded highest phosphorus and potassium uptake, might be due to higher nutrient content in dry matter.

Table 3. Nutrient uptake (kg ha^{-1}) by sugarcane seed cane crop at harvest as influenced by spacing and nutrient levels.

Treatments	Nitrogen					Phosphorus					Potassium				
	N_1	N_2	N_3	N_4	Mean	N_1	N_2	N_3	N_4	Mean	N_1	N_2	N_3	N_4	Mean
S_1	149.5	157.8	186.6	236.8	182.7	16.9	17.9	38.3	41.0	28.5	37.9	41.1	56.3	66.7	50.6
S_2	145.1	152.8	173.2	220.6	172.9	17.0	39.8	40.6	58.3	38.9	39.8	56.0	63.8	73.4	58.3
S_3	129.9	142.0	148.2	208.4	157.1	21.2	43.3	49.4	59.5	43.3	40.7	58.5	66.5	75.2	60.2
Mean	141.5	150.8	169.4	221.9		18.4	33.6	42.7	52.9		39.4	51.8	62.2	71.8	
		SE m±		CD (P=0.05)			SE m±		CD (P=0.05)			SE m±		CD (P=0.05)	
S		2.7		10.6			0.5		2.3			0.6		2.6	
N		2.3		7.1			0.3		3.1			1.4		4.2	
N at S		5.4		12.9			1.0		2.4			1.3		3.1	
S at N		4.5		10.8			0.6		1.4			2.2		5.2	

Table 4. Germination percentage (%) at 25, 30 and 45 DAP of sugarcane seed crop after harvest as influenced by spacings and nutrient levels.

Treatments	25 DAP					30 DAP					45 DAP				
	N_1	N_2	N_3	N_4	Mean	N_1	N_2	N_3	N_4	Mean	N_1	N_2	N_3	N_4	Mean
S_1	48.4	50.0	50.8	57.1	51.6	62.4	65.0	67.0	76.3	67.7	64.3	67.9	69.0	75.5	69.2
S_2	47.6	48.7	48.9	48.4	48.4	62.0	64.4	65.0	66.8	64.6	63.9	67.2	67.0	68.6	66.7
S_3	44.4	44.0	45.1	45.8	44.8	58.6	58.8	60.9	64.6	60.7	61.2	62.3	64.6	67.1	63.8
Mean	46.8	47.6	48.3	50.4		61.0	62.7	64.3	69.2		63.1	65.8	66.9	70.4	
		SE m±		CD (P=0.05)			SE m±		CD (P=0.05)			SE m±		CD (P=0.05)	
S		0.2		1.3			0.2		0.7			0.5		1.9	
N		0.1		0.5			0.3		0.8			0.3		0.8	
N at S		0.4		1.2			0.4		1.4			1.0		1.8	
S at N		0.4		1.4			0.5		1.4			0.7		2.3	

The highest phosphorus and potassium uptake was registered with the treatment 240-150-150 kg N-P_2O_5-K_2O ha^{-1} (N_4) which was significantly higher than the treatment 200-125-125 kg N-P_2O_5-K_2O ha^{-1} (N_3). The next best treatment was 160-100-100 kg N-P_2O_5-K_2O ha^{-1} (N_2) which was significantly superior to the treatment 120-75-75 kg N-P_2O_5-K_2O ha^{-1} (N_1). The lower phosphorus and potassium uptake was recorded with 120-75-75 kg N-P_2O_5-K_2O ha^{-1} (N_1). Highest phosphorus and potassium content in the plant might be due to application of higher dose of nutrients which favours higher uptake by the cane (More *et al*., 1995).

The interaction effect of 80 cm (S_3) in combination with level 240-150-150 kg N-P_2O_5-K_2O ha^{-1} (N_4) resulted in highest uptake of phosphorus and potassium than the other treatments.

Germination percentage of seed cane after harvest

The germination percentage of sugarcane seed cane significantly influenced due to spacings, nutrient management practices and as well as by their interactions. The similar trend was followed at 25, 30 and 45 DAP. (Table4)

The germination percentage of sugarcane seed cane crop with 40 cm (S_1) was significantly superior to the other spacings tested. The lowest germination percentage was recorded with 80 cm (S_3).

With regard to nutrient management practices, the treatment 240-150-150 kg N-P_2O_5-K_2O ha^{-1} (N_4) registered significantly higher germination percentage than the germination percentage of the treatments 200-125-125 (N_3) and 160-100-100 kg N-P_2O_5-K_2O ha^{-1} (N_2). The lower germination percentage was observed with 120-75-75 kg N-P_2O_5-K_2O ha^{-1} (N_1). The germination percentage of setts showed positive correlation with increase in level of nitrogen and number of splits was reported by Singh *et al* (2001).

The interaction effect between the wider spacing 40 cm (S_1) in combination with higher nutrient level 240-150-150 kg N-P_2O_5-K_2O ha^{-1} (N_4) registered higher germination percentage than the other treatments. The lowest germination percentage was recorded with 80 cm (S_3) in combination with 120-75-75 kg N-P_2O_5-K_2O ha^{-1} (N_1).

The present investigation revealed that row spacing of 40 cm (S_1) and nutrient level 240-150-150 kg N-P_2O_5-K_2O ha^{-1} was best in realizing seed cane yield, nutrient uptake with high germination percentage.

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