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Effect of different paired row spacings and nutrient levels on soil fertility, sugarcane productivity and juice quality

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ABSTRACT

A field experiment was conducted to study the effect of different paired row spacing and nutrient levels on soil fertility, cane yield and juice quality at Regional Agricultural Research Station, Anakapalle from 2007 to 2010. Pooled data for three years revealed that, irrespective of the spacing, plots which received pressmud cake @ 12 t/ha along with chemical fertilizers resulted in the higher organic carbon content and available nutrient status of the soil compared to those applied with chemical fertilizers alone. There was no particular trend with respect to spacing, however, 60/120 cm spacing recorded comparatively higher nutrient content due to more biomass addition leading to higher accumulation of organic matter content in soil. The highest per cent juice sucrose (21.35) and CCS (13.90) was observed in 100 % recommended dose of chemical fertilizer along with press mud cake @ 12 t/ha in 60/120 cm spacing, whereas the lowest juice sucrose (18.26 %) and CCS (12.68 %) was observed in 30/150 cm spacing with 150 % RDF. Among different paired row spacing, 60/120cm recorded higher yield than other two spacing. The treatment T4 (which received 150 % RDF + press mud cake @ 12 t/ha) recorded the highest cane (89.29 t/ha) and sugar (12.11 t/ha) yields. However, this treatment was at par with 100 % RDF + press mud cake @ 12 t/ha. Thus, soil fertility and cane productivity was improved in all the manure treated plots, irrespective of the spacing.

Key words: Paired row spacing, Nutrient level, Soil fertility, Cane yield etc.,

Paired row planting technique in sugarcane has been proved successful in many sugar factory areas by giving higher cane yield with better juice quality. Paired row spacing facilitates mechanization of various field operations and thus helps in reducing the cost of sugarcane production which is the need of the hour for increasing the margin of profit. Improving profitability of sugarcane farming is further possible through appropriate nutrient management techniques. Since chemical fertilizers have become costly and expected to be more costly in future, emphasis should be laid on increasing nutrient use efficiency and thereby reducing the quantum of fertilizers to be applied. Combined use of chemical fertilizers and organic manures improves the overall availability of nutrients through their synergistic effects. Hence, the present study was undertaken to identify the appropriate paired row spacing and its matching nutrient level.

MATERIALS AND METHODS

A field experiment was conducted at Regional Agricultural Research Station, Anakapalle, Andhra Pradesh on sugarcane variety '93 A 145' from 2007 to 2010, to study the effect of different paired row spacing and nutrient levels on soil fertility and crop productivity. The experimental soils were neutral in reaction (pH: 7.25), non saline (EC: 0.28 dS/m), low organic carbon (0.49%), as well as available nitrogen (210 kg/ha) and medium in available phosphorus (41.40 kg/ha) and potassium (275 kg/ha). The treatments included three paired row spacing (S1: 30/120 cm, S2: 30/150 cm and S3: 60/120 cm) in main plots and four nutrient levels (T1 : 100 % recommended dose of fertilizers (RDF) N, T2 : 150% RDF N, T3 : 100% RDF N + 12 t/ha press mud cake and T4 : 150% RDF N fertilizers + 12 t/ha press mud cake in sub plots. The experiment was conducted in split-plot design with 3 replications. A common dose of P_2O_5 @ 100 kg/ha and K_2O @ 120 kg/ha was applied uniformly to all the plots. Press mud cake was applied as basal along with chemical fertilizers. Recommended the doses of fertilizer (N) as per the treatments were applied at 45 and 90 DAP, while P and K were applied at the time of planting. Soil samples from surface (15 cm depth) were collected at grand growth stage (270 days after planting). Chemical analysis of soil samples was done as per the procedure described by Tandon (1973). Juice analysis was carried out prior to harvesting and Juice quality was determined as per the method suggested by Meade and Chen (1971). Observations on stalk population were recorded at grand growth stage and number of millable canes (NMC) and cane yield were recorded at harvesting. Sugar yield was computed from the cane yield multiplied with % CCS. In order to compare the effect of various treatments on yield and soil fertility status, Analysis of Variance (ANOVA) was performed using standard

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procedures for Split Plot design (Chandel 2002).

RESULTS AND DISCUSSION

Soil Nutrient status

Pooled data for three years revealed that, irrespective of the spacing, plots which received press mud cake @ 12 t/ha along with chemical fertilizers resulted in the higher soil organic carbon and available nutrients compared to chemical fertilizers alone (Table 1). This might be due to direct incorporation of organic matter in to the soil which leads to better root growth and addition of more plant residues on realizing higher cane yields in these treatments. Among different nutrient levels, the plots with 150% RDF N + PMC (12 t/ha) gave higher soil organic carbon (0.61%), available nitrogen (242 kg/ha), available phosphorus (51.02 (kg/ha) and available potassium (316 kg/ha). The continuous addition of organic manures along with chemical fertilizers may stimulate mineralization and immobilization of plant nutrients thereby affecting their amounts in different organic and inorganic forms in soil (Sihag *et al.* 2005). There was no particular trend with respect to paired row spacing; however, 60/120 cm spacing recorded comparatively high nutrient content which might be

Table 1 Effect of different paired row spacing and nutrient levels on soil nutrient status at grand growth stage

Treatments (M/S)	S1 (30/120 cm)	S2 (30/150 cm)	S3 (60/120 cm)
pH	**7.25**		
T1: 100 % RDF N	7.74	7.53	7.62
T2: 150% RDF N	7.71	7.67	7.53
T3: 100% RDF N +PMC (12 t/ha)	7.42	7.35	7.39
T4 : 150% RDF N +PMC (12 t/ha)	7.50	7.51	7.32
Electrical Conductivity (d S/m)	0.280		
T1: 100 % RDF N	0.191	0.107	0.221
T2: 150% RDF N	0.358	0.179	0.160
T3: 100% RDF N +PMC (12 t/ha))	0.188	0.245	0.159
T4 : 150% RDF N +PMC (12 t/ha)	0.249	0.248	0.389
Organic Carbon (%)	0.49		
T1: 100 % RDF N	0.52	0.51	0.52
T2: 150% RDF N	0.55	0.56	0.56
T3: 100% RDF N +PMC (12 t/ha)	0.59	0.57	0.60
T4 : 150% RDF N +PMC (12 t/ha)	0.61	0.61	0.62
CD (0.05) S	0.041		
S x T	NS		
Available N (kg/ ha)	**210**		
T1: 100 % RDF N	214	210	216
T2: 150% RDF N	223	221	220
T3: 100% RDF N +PMC (12 t/ha)	233	230	236
T4 : 150% RDF N +PMC (12 t/ha))	240	241	245
CD (0.05) S	14		
S x T	18		
Avail. P_2O_5 (Kg/ ha)	**41.40**		
T1: 100 % RDF N	42.70	42.37	41.75
T2: 150% RDF N	44.22	43.72	42.38
T3: 100% RDF N +PMC (12 t/ha)	48.38	49.67	51.00
T4 : 150% RDF N +PMC (12 t/ha)	49.67	50.67	52.72
CD (0.05) S	3.66		
S x T	4.82		
Available K_2O (Kg/ha)	**275**		
T1: 100 % RDF N	287	276	288
T2: 150% RDF N	294	288	309
T3: 100% RDF N +PMC (12 t/ha)	297	305	313
T4 : 150% RDF N +PMC (12 t/ha)	310	314	324
CD (0.05) S	19		
S x T	21		

Table 2 Effect of different paired row spacings and nutrient levels on juice quality.

Treatments (M/S)		S1 (30/120 cm)	S2 (30/150 cm)	S3 (60/120 cm)
% Juice sucrose				
T1: 100 % RDF N		20.03	19.43	19.73
T2: 150% RDF N		19.42	18.26	19.80
T3: 100% RDF N +PMC (12 t/ha)		20.35	19.22	21.35
T4 : 150% RDF N +PMC (12 t/ha)		19.06	20.01	18.53
CD (0.05)	S	--		
	S x T	**NS**		
CV (%)		**9.5**		
% CCS				
T1: 100 % RDF N		13.91	13.49	13.70
T2: 150% RDF N		13.49	12.68	13.75
T3: 100% RDF N +PMC (12 t/ha)		14.13	13.35	13.90
T4 : 150% RDF N +PMC (12 t/ha $^{-1}$)		13.24	13.83	13.56
CD (0.05)	S	--		
	S x T	**NS**		
CV (%)		**7.60**		

Table 3 Effect of different paired row spacings and nutrient levels on Shoot population at grand growth stage

Treatments	shoot population counts ('000/ha)			NMC ('000/ha)		
	S1 30/120 cm	S2 30/150 cm	S3 60/120 cm	S1 30/120 cm	S2 30/150 cm	S3 60/120 cm
T1: 100% RDF N	76.699	72.120	73.823	70.560	68.350	70.120
T2: 150% RDF N	80.996	72.092	73.870	74.445	68.750	70.540
T3:100% RDF N+PMC (12 t/ha)	80.748	74.914	75.419	74.125	70.845	72.480
T4 :150% RDF N+PMC(12 t/ha)	81.870	76.592	75.711	75.225	71.550	72.680
CD (0.05)						
S		4.012			3.560	
SxT		5.050			4.680	
C.V (%)		11.0			10.6	

Table 4 Effect of different paired row spacings and nutrient levels on cane yield and sugar yield

Treatments	Cane yield (t/ha)			Sugar Yield (t/ha)		
	S1 (30/120 cm)	S2 30/150 cm)	S3 (60/120 cm)	S1 (30/120 cm)	S2 (30/150 cm)	S3 (60/120 cm)
T1: 100% RDF N	76.62	77.71	77.82	10.66	10.48	10.66
T2: 150% RDF N	79.64	78.93	81.16	10.74	10.01	11.16
T3: 100% RDF N +PMC(12 t/ha)	84.36	84.19	85.49	11.92	11.24	11.88
T4 :150% RDF N +PMC(12 t/ha)	87.32	86.64	89.29	11.56	11.98	12.11
CD (0.05)						
S		5.2			0.86	
SxT		6.1			1.12	
C.V (%)		8.5			9.0	

due to more biomass production leading to higher accumulation of organic matter content in soil. Combined application of organic manures with inorganic fertilizers significantly increases the soil organic carbon due to addition of organic matter through manures than chemical fertilizers alone. This corroborates with the findings of Singh *et al.* (2001). Though pH and EC tended to decrease in manured plot from initial value, the decrease was not significant. Decrease in pH in manured plots was attributed to increase in partial pressure of CO_2 and organic acids (Prasad *et al.* 2010) due to organic matter decomposition.

Juice quality

In case of quality parameters i.e per cent juice sucrose and CCS, though there was non significant differences among different spacing, better juice quality was observed in press mud cake added plots than in chemical fertilizers alone. The highest per cent juice sucrose (21.35) and CCS (13.90) was

observed with 100 % recommended dose of chemical fertilizer along with press mud cake @ 12 t/ha in 60/120 cm spacing, whereas the lowest juice sucrose (18.26 %) and percent CCS (12.68 %) was observed with 30/150 cm spacing with 150 % RDF. This might be due to utilization of assimilated nitrogen in cane and conversion of reducing sugars to recoverable sugars and the decrease in juice quality with an increase in nitrogen dose was observed due to the hydration and succulence of plant tissue. These findings are supported with that of Swamy (1989).

NMC, Cane and Sugar yields

The results (table 4) revealed that the cane and sugar yields increased with increasing levels of chemical fertilizers. Among different paired row spacing, 60/120 cm recorded better yields than other two spacing. The treatment T4 (which received 150 % RDF + press mud cake @ 12 t/ha) recorded the highest cane (89.29 t/ha) and sugar (12.11 t/ha) yields. However, this treatment was at par with 100 % RDF + press mud cake @ 12 t/ha, whereas recommended dose of chemical fertilizers recorded 77.82 and 10.66 t/ha of cane and sugar yields, respectively. Data on stalk population at grand growth and number of millable canes (NMC) at harvest also followed the similar trend. The increase in cane yield with increase in nitrogen application in its sugarcane was due to the increase in yield attributing character viz., NMC. This is due to the fact that integrated use of inorganics and organics gives markedly higher productivity besides bringing out a general improvement in soil fertility status than that of chemical fertilizers alone.

Soil fertility and cane productivity were improved in all the manure treated plots, irrespective of the spacings. Integrated use of chemical fertilizers and organic manures resulted in markedly higher cane productivity besides bringing general improvement in soil fertility status than chemical fertilizers alone (Singh *et al*., 1995). The study showed that integrated use of organic manures and inorganic fertilizers produced higher and sustainable crop yield and maintained the soil fertility. Among different paired row spacing, 60/120 cm performed better in both cane and sugar yields.

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