

# Research Article PLANTING GEOMETRY AND INTERCROPPING IN SUGARCANE

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**Abstract**- An attempt was made on "Planting geometry and intercropping of sugarcane" at Agronomy Farm, College of Agriculture, Pune, Dist Pune, Maharashtra during 2008 to 2009 to find out suitable planting patterns for sugarcane to minimize the cost of production, to study the performance of intercropping in sugarcane and to study the effect of planting geometry and intercropping on growth, yield and quality of sugarcane during *Suru* season. Four levels of planting distance *viz*.90 x 30 cm single row planting, 90-180 x 30 cm paired row planting, 180 x 30 cm single row planting and 120 cm single row planting with sugarcane planter in main plots and two treatment *i.e.*, Sugarcane + groundnut and Sole sugarcane in sub plots laid out in strip plot design with three replications.

The *suru* sugarcane planted in 90-180 x 30 cm paired row planting was recorded significantly the highest plant height (312.12 cm), number of leaves (7.69), millable cane height (276.70 cm), cane yield (131.95 t ha<sup>-1</sup>), CCS yield (19.21 t ha<sup>-1</sup>), cane equivalent yield (143.91 t ha<sup>-1</sup>) and number of millable cane (92.78 '000'-<sup>1</sup>) for 90 x 30 cm single row planting and it was found at par with 180 x 30 cm single row planting with respect to germination per cent, length of internodes per plant, cane weight and number millable cane for 90-180 x 30 cm paired row planting. Significantly the highest brix (22.25), Sucrose (20.61%) and CCS (14.56%) and non significant with respect to purity (%). The number of tillers, dry matter per plant, number of internodes, and girth of cane (cm) found to be non significant. The significantly higher interaction of cane equivalent yield was found in90-180 X 30 cm paired row (152.96 t ha<sup>-1</sup>) in sugarcane + groundnut intercrop than rest of treatment. The gross monetary returns (Rs 165496 ha<sup>-1</sup>), net monetary returns (Rs 112125 ha<sup>-1</sup>) and B:C ratio (3.10) significantly higher at paired planting of 90-180 x 30 cm spacing than rest of treatments. The sugarcane planted with groundnut registered significantly higher gross monetary returns (Rs 151354), net monetary returns (Rs 96092) and B:C (2.74) ratio than sole sugarcane. The significantly higher interaction of net monetary returns was found in90-180 X 30 cm paired row (120628 t ha<sup>-1</sup>) in sugarcane + groundnut intercrop than rest of treatment.

Keywords- Sugarcane, Intercrop, Economics, Groundnut and Planting geometry.

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## Introduction

Sugarcane (Saccharum officinarum Linne.) is an important commercial crop of the country occupying around 4.60 million hectares of land and spread over in most of the Indian states with annual cane production of around 289.6 million tones and productivity of 62.80 t ha<sup>-1</sup>. Maharashtra state has established its supreme position in the Indian sugar industry by contributing 35 per cent of total sugar production (4.6 million tones). The area under this crop in state was 5.7 million hectares with the production of 57.04 million tones and productivity of 74.10 t ha-1. The recovery of sugar during 2008-2009 in Maharashtra was 11.44 per cent, which was the highest in the country [1]. It indicates the importance and hold of sugar industry in the state. Intercropping is viable agronomic practice for stepping up the production as well as productivity of a system from a unit area during a cropping period. Twenty five per cent of the total sugarcane area in Maharashtra is replaced in each year in suru season, It provides any opportunity to adopt intercropping to obtain additional income to the farmer. Intercropping in spring sugarcane with legume is guite a common practice and has been recognized as potential system to enhance the productivity of sugarcane based cropping systems. Non legume intercrops deplete more soil nutrient and bring economic reduction in sugarcane vield. Hence, there is need for better management and the selection of suitable intercrop for local conditions necessitate for harnessing maximum benefits and sustaining soil health. Intercropping in sugarcane is localized depending on soil environment and market demands. It was reported that intercropping does not affect sugarcane yield or quality. With the introduction of high tillering and high yielding varieties of sugarcane, it is possible to maintain the cane population and final cane yield even at relatively wider row spacing. Further, the total productivity of such wider row planting systems can be greatly enhanced by intercropping with suitable intercrop. Therefore, increasing the row spacing of sugarcane from the present recommended spacing of 90 to 120 cm would greatly facilitate not only easy management of intercropping without any competition effects, but also provide enough scope for intercrops to get higher productivity, especially under frequently irrigated tropical climatic regions. [2]. With this background, the present investigation was undertaken during 2008-2009 to study the response of sugarcane *cv*. Co 86032 to different planting patterns and intercrop with the objectives to find out suitable planting patterns for sugarcane to minimize the cost of production, to study the performance of intercropping in sugarcane and to study the effect of planting patterns and intercropping on growth, yield and quality of sugarcane during *Suru* season.

## Materials and Methods

A field experiment was conducted on "Planting geometry and intercropping of Sugarcane (Var. Co-86032)" at Agronomy Farm, College of Agriculture, Pune, Dist Pune, Maharashtra during 2008 to 2009 to find out suitable planting geometry for sugarcane to minimize the cost of production, to study the performance of

International Journal of Agriculture Sciences ISSN: 0975-3710&E-ISSN: 0975-9107, Volume 10, Issue 3, 2018 intercropping in sugarcane and to study the effect of planting geometry and intercropping on growth, yield and quality of sugarcane during *Suru* season. Four levels of planting distance *viz.* 90 x 30 cm single row planting, 90-180 x 30 cm paired row planting, 180 x 30 cm single row planting and 120 cm single row planting with sugarcane planter in main plots and two treatment i.e. Sugarcane + groundnut and Sole sugarcane in sub plots laid out in strip plot design with three replications. The statistical analysis of the data was done by statistical method known as "Analysis of variance" appropriate for the strip plot design [5].

The soil of the experimental site was medium black. Planting of sugarcane (Co-86032) was done during first week of January. The dibbling of groundnut (TPG 41) was done in single row on ridge on both side of the ridges in between the pair row planting and wide row planting. The intra row spacing of 15 cm was maintained. The recommended fertilizer dose of 250 kg N/ha, 115 kg P<sub>2</sub>O<sub>5</sub>/ha and 115 kg K<sub>2</sub>O/ha was applied to sugarcane. Nitrogen was applied in 4 splits at planting (10%), tillering (40%), grand growth stage (10%) and earthing up (40%). Phosphorus and Potassium were applied in 2 splits at planting (50%) and

earthing up (50 %). All the recommended plant protection measures were undertaken during the course of investigation. Data were recorded at harvest for yield and quality characters. The juice analysis was done by sampling five canes from each plot at harvest.

## **Results and Discussion**

## Effect of planting geometry of Sugarcane

The data regarding growth and yield attributes are presented in [Table-1] revealed that the effect of *suru* sugarcane planted in 90-180 x 30 cm paired row planting was recorded significantly the highest plant height (312.12 cm), number of leaves (7.69), millable cane height (276.70 cm), cane yield (131.95 t ha<sup>-1</sup>), CCS yield (19.21 t ha<sup>-1</sup>) and cane equivalent yield (143.91 t ha<sup>-1</sup>). Significantly higher germination per cent (75.21), length of internodes per plant (20.13 cm) and cane weight (1.45 kg) were observed in 90-180 x 30 cm paired row planting, however it was found at par with 180 x 30 cm single row planting.

Table-1 Growth and yield attributing parameters of Sugarcane.														
Planting geometry	Germi (%)	Plant height (cm)	No of leaves	No of tillers	Dry matterplant <sup>.1</sup>	No of I'nodes	Length of I'nodes (cm)	Girth (cm)	Mill. Cane height (cm)	NMC ('000' ha <sup>.</sup> 1)	Cane weightcane <sup>.1</sup> (kg)	Cane yield (t ha <sup>-1</sup> )	CCS yield (t ha⁻¹)	Cane equi. yield (t ha <sup>-1</sup> )
90 x 30 cm single row planting	71.22	300.63	7.39	8.89	549.49	22.49	19.06	8.70	263.07	92.78	1.11	102.55	14.51	118.91
90-180 x 30 cm paired row planting	75.71	312.12	7.69	9.25	552.00	23.18	20.13	8.92	276.70	91.02	1.45	131.95	19.21	143.91
180 x 30 cm single row planting	75.36	306.39	7.57	9.17	553.49	23.01	19.76	8.96	271.29	59.99	1.42	85.17	11.63	106.04
120 cm single row planting with sugarcane planter	68.78	303.94	7.50	8.99	551.16	22.89	19.37	8.87	267.26	86.06	1.37	117.91	17.13	127.55
SE <u>+</u>	0.31	0.63	0.03	0.02	1.78	0.63	0.12	0.02	1.08	1.16	0.01	1.36	0.16	2.19
CD at 5 %	1.06	2.19	0.09	NS	NS	NS	0.42	NS	3.73	4.02	0.04	4.70	0.57	7.59
							Intercrop							
Sugarcane + groundnut	72.39	304.85	7.51	9.02	548.49	22.78	19.48	8.89	268.59	81.65	1.31	106.67	15.16	131.61
Sole sugarcane	73.14	306.69	7.57	9.12	554.58	23.00	19.69	8.84	270.57	83.26	1.36	112.15	16.09	116.59
SE <u>+</u>	0.35	0.47	0.01	0.03	1.39	0.40	0.10	0.02	0.74	0.89	0.01	1.49	0.22	0.99
CD at 5 %	NS	1.53	0.04	NS	NS	NS	NS	NS	NS	NS	0.04	4.87	0.73	3.25
Interaction														
SE <u>+</u>	0.69	0.94	0.02	0.07	2.78	0.79	0.20	0.04	1.49	1.79	0.02	2.99	0.45	1.99
CD at 5 %	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	8.95
Mean	72.77	305.77	7.54	9.07	551.54	22.89	19.58	8.86	269.58	82.46	1.34	109.39	15.62	124.10

The higher plant height might be due toproper orientation and establishment of plants in wider rows. The paired row plant grows rapidly due to availability of light, space and moisture. [3]. reported significantly the highest plant height in paired planting of 90-180 x 30 cm. The higher number leaves could be attributed to the fact that more area of land per shoot was available for growth and development under pair row planting as compared to single row planting. The higher dry matter production due to higher number of leaves per shoot available for the purpose of photosynthesis production under paired row planting. Also the dry matter per plant was reduced significantly at wider paired row planting. The higher cane weight in paired row planting might be due to increase in number of internodes and length of internodes, millable height of cane, respectively. The single cane weight under wider row spacing increased as compared to closer row spacing, similar findings were reported by several workers [4].In paired row planting, main factors contributing towards cane yield was number of internodes and length of

internodes, millable height of cane and weight of cane. Similar results were also reported by [7]. [6 and 2]. Also observed that millable cane population was the highest under normal row spacing (90 cm) and was reduced under wider row spacing of 150 cm.

The data on quality parameters of sugarcane presented in [Table-2] recorded that planting of sugarcane in 90-180 x 30 cm paired row significantly the highest brix (22.25), Sucrose (20.61%) and CCS (14.56%) and non significant with respect to purity (%).The number of tillers, dry matter per plant, number of internodes, and girth of cane (cm) found to be non significant.

### Effect of Intercrop:

The sole sugarcane was recorded significantly the highest plant height (306.69 cm), number of leaves (7.57), cane weight (1.36 kg cane<sup>-1</sup>), cane yield (112.15 t ha<sup>-1</sup>), and CCS yield (16.09 t ha<sup>-1</sup>). The sugarcane + groundnut intercrop was

recorded higher cane equivalent yield (131.61t ha<sup>-1</sup>) However, it was found at par with sole sugarcane (116.59t ha<sup>-1</sup>).The germination (%), number of tillers, dry matter per plant, number of internodes, length of internodes, girth of cane (cm), millable cane height (cm) and number of millable cane ('000' plant<sup>-1</sup>) found to be non significant.

and brix (c), Sucrose (%) and purity (%) found to be non significant [Table-2].The plant height and spread found to be non significant at all the period of observation [Table-3]. The yield and yield contributing characters like filled podes plant<sup>-1</sup>, unfilled podes plant<sup>-1</sup>, pod weight plant<sup>-1</sup>, kernel weight plant<sup>-1</sup>, dry pod weight (q ha<sup>-1</sup>) also found to be non significant [Table-4].

The intercrop of sole sugarcane was found significantly the highest CCS (14.30 %)

Table-2 Quality param	eters in sugarcar	ne as influenced b	y various treat	ments				
Tractment		Quality parameters						
rreatment	Brix (c)	Sucrose (%)	CCS (%)	Purity (%)				
Planting geometry								
90 x 30 cm single row planting	21.08	19.87	14.15	94.24				
90-180 x 30 cm paired row planting	22.25	20.61	14.56	92.62				
180 x 30 cm single row planting	21.33	19.45	13.65	91.23				
120 cm single row planting with sugarcane planter	22.00	20.50	14.53	93.19				
SE <u>+</u>	0.18	0.04	0.08	0.88				
CD at 5 %	0.62	0.15	0.29	NS				
	Intercro	р						
Sugarcane + groundnut	21.67	20.03	14.15	92.47				
Sole sugarcane	21.68	20.18	14.30	93.16				
SE <u>+</u>	0.07	0.05	0.04	0.26				
CD at 5 %	NS	NS	0.13	NS				
Interaction								
SE <u>+</u>	0.13	0.09	0.08	0.51				
CD at 5 %	NS	NS	NS	NS				
Mean	21.67	20.11	14.22	92.82				

Table-3 Mean plant height and spread (cm) of groundnut as influenced periodically by various treatments

Planting geometry	Days after planting					
Plant height	24	42	56	70	84	at harvest
90 x 30 cm single row planting	5.74	8.28	11.26	17.37	23.17	25.78
90-180 x 30 cm paired row planting	5.80	8.34	11.47	17.94	23.93	26.40
180 x 30 cm single row planting	5.80	8.33	11.39	17.88	23.81	26.23
120 cm single row planting with sugarcane planter	5.78	8.31	11.34	17.79	23.76	26.05
SE <u>+</u>	0.11	0.09	0.12	0.08	0.10	0.10
CD at 5 %	NS	NS	NS	NS	NS	NS
General Mean	5.78	8.31	11.37	17.74	23.67	26.12
	Pla	nt Spread				
90 x 30 cm single row planting	11.12	14.87	19.53	25.07	30.02	30.02
90-180 x 30 cm paired row planting	11.13	14.89	19.70	25.74	32.51	32.51
180 x 30 cm single row planting	11.13	14.89	19.68	25.94	32.47	32.47
120 cm single row planting with sugarcane planter	11.13	14.87	19.59	25.78	32.18	32.18
SE <u>+</u>	0.04	0.10	0.08	0.19	0.12	0.11
CD at 5 %	NS	NS	NS	NS	NS	NS
General Mean	11.13	14.88	19.63	25.63	31.80	31.79

**Table-4** Mean yield and yield contributing characters of groundnut as influenced by various treatments

	Filled pods /	Un	Pod weight /plant	Kernel weight	Dry pod yield
Treatment	plant	filled pods/plant	(g)	/plant(g)	(q/ha)
90 x 30 cm single row planting	14.18	3.78	28.88	18.02	09.93
90-180 x 30 cm paired row planting	16.70	4.34	30.58	20.33	13.76
180 x 30 cm single row planting	16.43	4.25	30.59	19.89	13.07
120 cm single row planting	14.99	4.01	29.36	18.44	11.10
with sugarcane planter					
SE <u>+</u>	0.07	0.08	0.07	0.09	0.13
CD 5%	NS	NS	NS	NS	NS
General Mean	15.57	4.10	29.83	19.17	11.96

#### Effect of interaction

The interaction between the planting pattern and intercrop was found to be non significant for all the growth and quality parameters except cane equivalent yield of sugarcane.

The significantly higher interaction of cane equivalent yield was found in 90-180 X 30 cm paired row (152.96 t ha<sup>-1</sup>) in sugarcane +groundnut intercrop than rest of treatment [Table-5].

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## Economic evaluation of sugarcane

Economic evaluation of sugarcane in terms of cost of cultivation, gross monetary returns, net monetary and B: C ratio is furnished in [Table-5].

## Table-5 Economics of sugarcane (Rs ha-1) as influenced by various treatments

Treatments	Gross Monetary returns (Rs/ha)	Cost of production (Rs/ha)	Net Monetary returns (Rs/ha)	B:C					
Planting geometry									
90 x 30 cm single row planting	136742	56019	80723	2.44					
90-180 x 30 cm paired row planting	165496	53372	112125	3.10					
180 x 30 cm single row planting	121946	51701	70245	2.35					
120 cm single row planting with sugarcane planter	146679	52536	94143	2.79					
SE <u>+</u>	2521	132	2497	0.05					
CD at 5 %	8726	457	8641	0.16					
	Intercrop								
Sugarcane + groundnut	151354	55262	96092	2.74					
Sole sugarcane	134078	51552	82526	2.60					
SE <u>+</u>	1146	80	1136	0.02					
CD at 5 %	3738	261	3705	0.07					
Interaction									
SE <u>+</u>	2292	160	2272	0.04					
CD at 5 %	NS	NS	10223	NS					
Mean	142716	53407	89309	2.67					

Effect of plantings geometry

The operational cost required for planting of sugarcane at 90 x 30 cm single row

planting and 90-180 x 30 cm pared row planting were Rs 56019 and Rs 53372 ha<sup>-1</sup>, respectively. The operational cost required in paired planting was 4.73 per cent less as compared to single row planting (90 x 30 cm). The gross monetary returns (Rs 165496 ha<sup>-1</sup>), net monetary returns (Rs 112125 ha<sup>-1</sup>) and B:C ratio (3.10) significantly higher at paired planting of 90-180 x 30 cm spacing than rest of treatments. The sugarcane planted at a spacing of 120 cm single row with sugarcane planter ranked second in terms of gross and net monetary returns, and benefit cost ratio. The planting of cane at 90-180 x 30 cm recorded 21.02 per cent higher monetary returns over 90 x 30 cm, 35.71 per cent over 180 x 30 cm and 12.83 per cent over 120 cm with sugarcane planter.

## Effect of intercrop

The sugarcane planted with groundnut registered significantly higher gross monetary returns (Rs 151354), net monetary returns (Rs 96092) and B:C (2.74) ratio than sole sugarcane.

The combined effect of planting patterns and intercrop clearly indicates that significantly higher net monetary returns (Rs 120628 ha<sup>-1</sup>) were obtained from paired row planting of sugarcane at 90-180 x 30 cm accommodating two rows of groundnut in skip row as an intercrop than rest of combinations. The sugarcane + groundnut intercropping recorded 16.41 per cent higher than sole sugarcane in paired row planting.

## Effect of interaction

The significantly higher interaction of net monetary returns was found in 90-180 X 30 cm paired row (120628 t ha<sup>-1</sup>) in sugarcane + groundnut intercrop than rest of treatment [Table-6].

Table-6 Interaction effect between planting geometry and intercrop on net monetary returns (Rs ha-1) and cane equivalent yield (t ha-1).

Tractment	Intercrop						
rreatment	Sugarcane + groundnut	Sole sugarcane	Sugarcane + groundnut	Sole sugarcane			
Planting geometry							
90 x 30 cm single row planting	83576	77871	123.04	114.77			
90-180 x 30 cm paired row planting	120628	103622	152.96	134.86			
180 x 30 cm single row planting	79220	61271	115.50	96.58			
120 cm row planting with sugarcane planter	100945	87341	134.94	120.15			
SE <u>+</u>	2272		1.99				
CD at 5 %	10223		8.95				

## Conclusion

The sugarcane planted at a wider row spacing of  $180 \times 30$  cm minimizes the cost of production. Intercropping of two rows of groundnut in paired row planting of sugarcane proved most productive system and considering the net monetary returns in paired row planting of sugarcane at 90-180 x 30 cm associated with groundnut found to be most remunerative. Hence, it is concluded that intercropping of sugarcane + groundnut (2: 2) in paired row planting at 90-180 x 30 cm proved most profitable.

## Application of research:

- 1. The perfect plant geometry of sugarcane makes help in increasing cane and CCS yield of sugarcane
- Intercropping of groundnut in paired row planting of sugarcane at 90-180 x 30 cm most productive system
- 3. Increasing farmer production with maintenance of soil fertility

## Research Category: Intercropping in Sugarcane

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## Conflict of Interest: None declared

**Ethical approval:** This article does not contain any studies with human participants or animals performed by any of the authors.

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