JOURNAL OF PURE AND APPLIED MICROBIOLOGY, June 2017. Vol. **11**(2), p. 1175-1181

Influence of Planting Patterns and Intercropping on Growth and Yield of *suru* sugarcane (*Saccharum officinarum* L.)

K.C. Ombase[1], K.D. Mevada[2], R.B.Kadu[3], P.G. Gamar[4] and H.L. Ghadage[5]

[1]SRA, College of Agriculture, Pune, Maharashtra, India.
[2]Department of Agronomy, BACA, AAU, Anand, Gujarat, India.
[3]JRA, Central Sugarcane Research Station, Padegaon, Maharastra, India.
[4]Department of Agronomy, BACA, AAU, Anand, Gujarat, India.
[5]College of Agriculture, Pune, Maharashtra, India.

http://dx.doi.org/10.22207/JPAM.11.2.65

(Received: 10 April 2017; accepted: 03 June 2017)

A field experiment was carried out at Agronomy Farm, College of Agriculture, Pune (Maharashtra) during spring season of 2011-12 to find out the effect of different planting methods along with intercropping on growth and yield of *suru* sugarcane (*Saccharum officinarum* L.) Var. Co 86032. The experiment was comprising of four planting patterns 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 x 30 cm single row planting with sugarcane planter as main plots and two intercropping systems *viz.,* sugarcane + groundnut and sole sugarcane, laid out in strip plot design with three replications in medium deep black, well drained, clayey textured soils with alkaline reaction (pH 7.6). The field capacity and permanent wilting point values were 36.07 and 18.45 per cent, respectively. The bulk density was 1.21 g cm^{-3}. In single row planting system, single line of groundnut (TPG 41) was sown in inter-row space of sugarcane on one side of ridge and in paired row planting and in wide row planting two rows of groundnut was sown in inter-row space of sugarcane. Results revealed that intercropping of two rows of groundnut in paired row planting of sugarcane (2:2) was proved to be the most productive system with significantly the highest cane equivalent yield (152 96 t ha^{-1}). The treatment combination of paired row planting of sugarcane at 90-180 x 30 cm associated with groundnut in 2:2 ratio was also found to be the most remunerative.

Keywords: CEY, intercropping, planting pattern, *Suru* sugarcane**.**

The population per unit area and distance between cane rows play a significant role in influencing the yield. Wide row sugarcane planting technology is spreading fast particularly in tropical states (Sundara, 2002) to facilitate mechanical harvesting of the crop. The larger interspaces between the wide spaced sugarcane rows can be utilized by the intercrops for better exploitation of the natural resources like light, soil moisture, nutrients and carbon dioxide. Sugarcane is generally planted as sole crop in spring season. The slow establishment of sugarcane during the initial period and adoption of comparatively wider row spacing offers vast scope for intercropping. Temporal differences can be best exploited by using species or varieties of intercrops that are sufficiently early maturing and harvested before they compete with cane may provide ample opportunity for intercropping of summer crops, particularly in *suru* season which replaced at the rate of 25% in Maharashtra each year (Verma and Yadav, 1986),.

* To whom all correspondence should be addressed.
E-mail: amt_kd@yahoo.com

Intercropping in spring sugarcane with legume is quite a common practice and has been recognized as potential system to enhance the productivity of sugarcane based cropping systems (Anon. 2015). There is need for better management and the selection of suitable intercrop for local conditions necessitate for harnessing maximum benefits and sustaining soil health. 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. 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. (Shahi, 2002). In light of this back ground, present experiment was conducted to find out the effect of planting pattern and intercropping with groundnut on growth and yield of *suru* sugarcane var. Co-86032.

MATERIALS AND METHODS

The field experiment was conducted at Agronomy Farm, College of Agriculture, Pune during spring season of 2011-12 to find out the influence of different planting patterns along with intercropping on growth and yield of *suru* sugarcane (*Saccharum officinarum* L.) Var. Co-86032 on medium deep black, well drained, clayey textured soils found low in available N (143 kg ha^{-1}), medium in available P (16.5 kg ha^{-1}), high in available K (416 kg ha^{-1}), moderately high organic carbon content (0.72 %) with low EC (0.24 dSm^{-1}) and alkaline in reaction (pH 7.6) with 36.07 % field capacity, 18.45 % permanent wilting point and 1.21 g cm^{-3} bulk density.

The experiment was laid out in strip plot design with three replications. The treatment was consisted of four planting patterns *viz.,* 90 x 30 cm single row planting (P_1), 90-180 x 30 cm paired row planting (P_2), 180 x 30 cm single row planting (P_3) and 120 x 30 cm single row planting with sugarcane planter (P_4) as main plots and two intercropping systems *viz.,* sugarcane + groundnut (I_1) and sole sugarcane (I_2). In single row planting system, single line of groundnut (TPG 41) was sown in inter-row space of sugarcane on one side of ridge, whereas, in paired row as well as in wide row planting two rows of groundnut was sown in inter-row space of sugarcane. The recommended dose of 250:115:115 kg N, P_2O_5 and K_2O ha^{-1} to spring sugarcane and 25 kg N and 50 kg P_2O_5 ha^{-1} to groundnut was applied through urea, single super phosphate and muriate of potash, respectively. In sugarcane nitrogen was given in four splits. The I^{st} 10 per cent (25 kg N ha^{-1}) at the time as planting, 2^{nd} 40 per cent (100 kg N ha^{-1}) after 45 DAP at tillering stage, 3^{rd} 10 per cent (25 kg N ha^{-1}) after 90 DAP at light earthing up and remaining 40 per cent (100 kg N ha^{-1}) after 120 DAP at the time of final earthing up. The P_2O_5 and K_2O fertilizers were applied in two equal splits i.e. 50 % as a basal dose at planting and remaining 50% as top dressing at final earthing up. 40 % of recommended fertilizer (25-50-00 kg NPK ha^{-1}) was applied to groundnut separately as an intercrop i.e. 10 kg N ha^{-1} in two equal splits at planting and one month after planting and full dose of 20 kg P_2O_5 ha^{-1} was applied as basal dose.

RESULTS AND DISCUSSION

Effect of planting patterns

Data depicted in fig.1 showed that the initial plant population of sugarcane was not affected extensively due to different treatments of planting patterns, but the maximum plant population was observed at 90 x 30 cm single row planting (26379 ha^{-1}) as compared to other planting patterns. But planting pattern had perceptible influence on survival percentage and significantly higher survival percentage (75.71 %) was observed in paired row planting of 90-180 x 30 cm (Table-1). It was also further revealed that significantly the highest plant height (312.12 cm), number of leaves $plant^{-1}$ (7.69), length of internodes (20.13 cm) and millable cane height (276.70 cm) of sugarcane were recorded in 90-180 x 30 cm paired row planting (P_2) at harvest. This could be attributed to more availability of light, space and moisture under paired row planting which might lead to more availability of land per shoot for growth and development under pair row planting as compared to single row planting resulted in to higher number of leaves per shoot available for the purpose of photosynthesis production under paired row planting (More, 2003). Nevertheless, periodical

number of tillers clump^{-1} (Fig.2), dry matter accumulation, mean girth of cane and number of internodes plant^{-1} (Table-1) were not affected markedly due to different planting patterns. Similar results were also reported by Raskar and Bhoi (2003) and Gulati *et al*. (2015).

Yield attributes shown in table-2 revealed that number of millable cane (927800 ha^{-1}) was found significantly higher under P_1 i.e. single row planting with 90 x 30 cm , however, it was found at par with P_2 i.e .paired row planting of 90-180 x 30 cm spacing (91020 ha^{-1}). Chaudhari *et al*. (2014) and Kumawat and Dahima (2016) 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.

Conversely, being at par with 180 x 30 cm single row (P_3), appreciably higher average cane weight (1.45 kg plant^{-1}) was recorded under paired row planting of 90-180 x 30 cm spacing (P_2). 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. An outright increase in cane yield (131.95 t ha^{-1}), commercial cane sugar (19.21 t ha^{-1}) yield and cane equivalent yield (143.91 t ha^{-1}) was reported in paired row planting of 90-180 x 30 cm spacing (P_2). 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 findings were reported by More (2003) and Anon. (2015).

Different planting patterns of sugarcane did not exert any significant influence on the yield and yield attributes of groundnut as an intercrop indicating non-detrimental impact of sugarcane on growth and development of groundnut (Table-3).

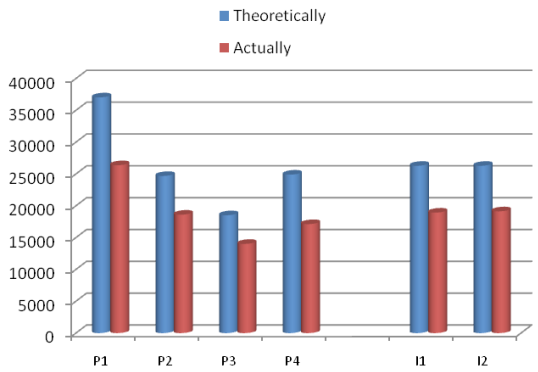

Fig. 1. Initial plant count of sugarcane as influenced by various treatments

Effect of intercrop

Intercropping of sugarcane with groundnut had remarkable influence on survival percentage, plant height and number of leaves plant^{-1} of sugarcane and remarkably less survival percentage (72.39%), plant height (304.85 cm) and number of leaves plant^{-1} (7.57) were reported when sugarcane was intercropped with groundnut (I_1) compared to sole sugarcane (I_2). Numbers of tillers per clump, mean girth of cane, number of internodes per plant, length of internodes, millable cane height as well as number of millable canes ha-1 were not influenced significantly due to intercrops.

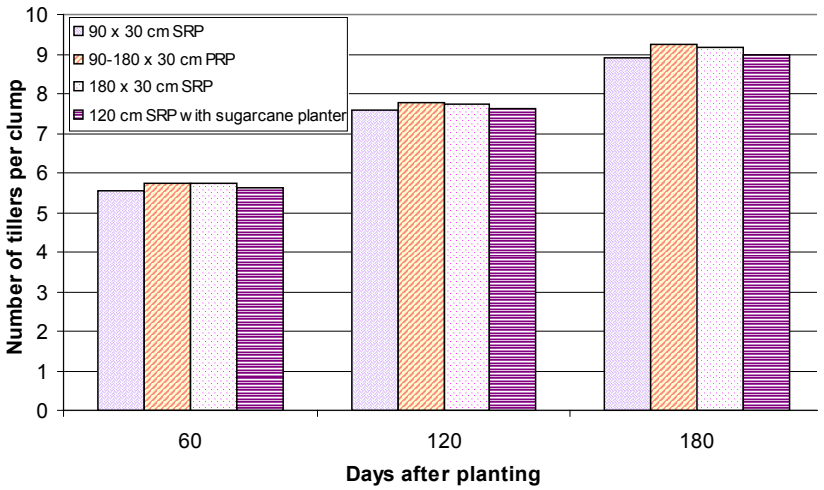

Fig. 2. Mean number of tillers per clump of sugarcane as influenced by planting patterns

Table 1. Ancillary observations of sugarcane at harvest as affected by different treatments

Treatments	Survival %	Plant Height (cm)	Number of leaves plant^{-1}	Dry matter accumulation (g)	Girth (cm)	Number of Internodes plant^{-1}	Length of Internodes (cm)	Millable cane height (cm)
Planting patterns								
P_1 : 90 x 30 cm single row	71.22	300.63	7.39	549.49	8.70	22.49	19.06	263.07
P_2 :90-180 x 30 cm paired row	75.71	312.12	7.69	552.00	8.92	23.18	20.13	276.70
P_3 :180 x 30 cm single row	75.36	306.39	7.57	553.49	8.96	23.01	19.76	271.29
P_4:120 cm single row with sugarcane planter	68.78	303.94	7.50	551.16	8.87	22.89	19.37	267.26
SEm ±	0.31	0.63	0.03	1.78	0.02	0.63	0.12	1.08
CD at 5 %	1.06	2.19	0.09	NS	NS	NS	0.42	3.73
Intercrops								
I_1 :Sugarcane + Groundnut	72.39	304.85	7.51	548.49	8.89	22.78	19.48	268.59
I_2 :Sole Sugarcane	73.14	306.69	7.57	554.58	8.84	23.00	19.69	270.57
SEm ±	0.35	0.47	0.01	1.39	0.02	0.40	0.10	0.74
CD at 5 %	1.13	1.53	0.04	4.56	NS	NS	NS	NS
Interaction								
SEm ±	0.69	0.94	0.02	2.78	0.04	0.79	0.20	1.49
CD at 5 %	NS	NS	NS	NS	NS	NS	NS	NS
Mean	72.77	305.77	7.54	551.54	8.86	22.89	19.58	269.58

The dry matter accumulation per plant in sugarcane at harvest (554.58 g) was significantly more in sole planted sugarcane than groundnut intercropped cane. The differences in weight of individual cane (1.36 kg cane^{-1}), mean cane yield (112.15 t ha^{-1}) and CCS (16.09 t ha^{-1}) were differed significantly due to intercrops and it was found maximum with sole sugarcane than groundnut intercropped cane. The cane yield decreased by 4.89 per cent with intercropping of groundnut compared with sole sugarcane. Contrary to this, significantly higher cane equivalent yield (131.61tha^{-1}) was recorded by groundnut intercropped sugarcane than sugarcane alone (116.59 t ha^{-1}) and it was 12.88 per cent higher than sole planting of sugarcane. This might be owing to additional yield obtained

Table 2. Yield attributes, yield and Cane equivalent yield of sugarcane as affected by different treatments

Treatment	NMC[1] ('000' ha^{-1})	ACW[2] (kg)	Cane yield (t ha^{-1})	CCS[3] yield (t ha^{-1})	CEY[4] (t ha^{-1})
Planting patterns					
P_1 : 90 x 30 cm single row	92.78	1.11	102.55	14.51	118.91
P_2 :90-180 x 30 cm paired row	91.02	1.45	131.95	19.21	143.91
P_3 :180 x 30 cm single row	59.99	1.42	85.17	11.63	106.04
P_4:120 cm single row with sugarcane planter	86.06	1.37	117.91	17.13	127.55
SEm +	1.16	0.01	1.36	0.16	2.19
CD at 5 %	4.02	0.04	4.70	0.57	7.59
Intercrops					
I_1 :Sugarcane + Groundnut	81.65	1.31	106.67	15.16	131.61
I_2 :Sole Sugarcane	83.26	1.36	112.15	16.09	116.59
SEm +	0.89	0.01	1.49	0.22	0.99
CD at 5 %	NS	0.04	4.87	0.73	3.25
Interaction					
SEm +	1.79	0.02	2.99	0.45	1.99
CD at 5 %	NS	NS	NS	NS	8.95
Mean	82.46	1.34	109.39	15.62	124.10

[1]Number of milleable canes, [2]Average cane weight,
[3]Commercial cane sugar, [4]Cane equivalent yield

Table 3. Ancillary observations of Groundnut as influenced by various treatments of sugarcane planting patterns

Treatment	Plant height (cm)	Plant spread (cm)	Filled pods / plant	Un filled pods/ plant	Pod weight /plant (g)	Kernel weight /plant (g)	Dry pod yield (q/ha)
P_1 : 90 x 30 cm single row	25.78	30.02	14.18	3.78	28.88	18.02	9.93
P_2 :90-180 x 30 cm paired row	26.40	32.51	16.70	4.34	30.58	20.33	13.76
P_3 :180 x 30 cm single row	26.23	32.47	16.43	4.25	30.59	19.89	13.07
P_4:120 cm single row with sugarcane planter	26.05	32.18	14.99	4.01	29.36	18.44	11.10
SEm +	0.10	0.11	0.07	0.08	0.07	0.09	0.11
CD 5%	NS	NS	NS	NS	NS	NS	NS
General Mean	26.12	31.79	15.57	4.10	29.83	19.17	11.17

Table 4. Interaction effects of planting patterns and intercrop on cane equivalent yield

Treatment	cane equivalent yield (t ha^{-1})	
	Sugarcane + groundnut	Sole sugarcane
Planting patterns		
P_1 : 90 x 30 cm single row	123.04	114.77
P_2 :90-180 x 30 cm paired row	152.96	134.86
P_3 :180 x 30 cm single row	115.50	96.58
P_4 :120 cm single row with sugarcane planter	134.94	120.15
SEm ±	1.99	
CD at 5 %	8.95	

Table 5. Economics of sugarcane as influenced by various treatments

Treatments	Gross Monitory returns (‘ ha^{-1})	Cost of cultivation (‘ ha^{-1})	Net realization (‘ ha^{-1})	B:C
Planting patterns				
P_1 : 90 x 30 cm single row	136742	56019	80723	2.44
P_2 :90-180 x 30 cm paired row	165496	53372	112125	3.10
P_3 :180 x 30 cm single row	121946	51701	70245	2.35
P_4:120 cm single row with sugarcane planter	146679	52536	94143	2.79
SEm ±	2521	132	2497	0.05
CD at 5 %	8726	457	8641	0.16
Intercrops				
I_1 :Sugarcane + Groundnut	151354	55262	96092	2.74
I_2 :Sole Sugarcane	134078	51552	82526	2.60
SEm ±	1146	80	1136	0.02
CD at 5 %	3738	261	3705	0.07
Interaction				
SEm ±	2292	160	2272	0.04
CD at 5 %	NS	NS	NS	NS
Mean	142716	53407	89309	2.67

Table 6. Interaction effect between planting patterns and intercrop on net realization (‘ ha^{-1})

Treatment	Intercrop	
	Sugarcane + groundnut	Sole sugarcane
Planting patterns		
P_1 : 90 x 30 cm single row	83576	77871
P_2 :90-180 x 30 cm paired row	120628	103622
P_3 :180 x 30 cm single row	79220	61271
P_4 :120 cm single row with sugarcane planter	100945	87341
SEm ±	2272	
CD at 5 %	10223	

from groundnut and attractive price of their pods in market. These results corroborated the findings of Kumar *et.al,* (2006).

Interaction effect

The combined effect (Table-4) of planting patterns and intercrop clearly indicates that significantly maximum sugarcane equivalent yield (152.96 t ha^{-1}) and higher net monetary returns (‘ 120628 ha^{-1}) were obtained from paired row planting at 90-180 x 30cm (P_2) accommodating two rows of groundnut in skip row as an intercrop (I_1) over rest of the combinations. The sugarcane + groundnut intercropping recorded 13.42 per cent higher CEY over sole sugarcane in paired row planting.

Economics

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 ‘ 56019 and ‘ 53372 ha^{-1}, respectively. The gross monetary returns (‘165496 ha^{-1}), net monetary returns (‘ 112125 ha^{-1}) and B:C ratio (3.1) were significantly higher at paired planting of 90-180 x 30 cm spacing (P_2) than rest of the treatments. 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.

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

The combined effect of planting patterns and intercrop clearly indicated that sugarcane + groundnut intercropping in paired row planting recorded 16.41 per cent higher than sole sugarcane in paired row planting.

CONCLUSIONS

In light of the above discussion it can be concluded that intercropping of two rows of groundnut in paired row planting of sugarcane at 90-180 x 30 cm spacing was proved to be the most productive system. Considering the net monetary returns in paired row planting of sugarcane at 90-180 x 30 cm associated with groundnut in 2:2 ratio was found to be most remunerative.

REFERENCES

1. Anonymous. Annual Report, Research Review committee (RRC), M. P. K.V., Rahuri, 2015 pp . 74-79.
2. Anonymous. Reseach Report, Vasantdada Sugar Institute (VSI) Manjari, Pune, 2015 pp : 113-118.
3. Chaudhari, P. M., Ombase, K. C., Thorave, D. S., Ghodke, S. K. and Pawar, S. M. . Evaluation of plantinng geometry and different varieties on growth and yield of *spring* planted sugarcane. *International Journal of Current Research,* 2014*;* **6**(12) : 10394-10396.
4. Gulati, J. M., Jitendra Behra, Jena, S. N. and Subhrasini Lenka. Effect of planting methods on growth pattern and productivity of sugarcane varieties.*Indian Journal of Agriculture Research*, 2015; **49**(3) : 222-228.
5. Kumar, S. Rana, N.S. Singh, R. and Singh, A.. Production potential of spring sugarcane as influenced by intercropping of dual purpose legumes under *tarai* conditions of Uttarakhand. Indian. *J. Agron.* 2006; **51**(4):271-273.
6. Kumawat, P. D. and Dahima, N. U.. Effect of sugarcane (*saccharum officinarum* l.) Varieties and row spacing on growth, yield and quality of Sugarcane. *Progressive Agriculture*. 2016; **16**(1) : 88-92.
7. Mahadevaswamy, M.. Studies on intercropping of onion in wide spaced sugarcane. *Ph.D. Thesis,* 2001, Tamil Nadu Agricultural University, Coimbatore.
8. More, S.M.. Study on the effect of row spacing, planting system and intercropping on growth, yield, quality and economics of *suru* sugarcane (cv. Co 86032) and its ratoon under drip irrigation. *Ph.D. Thesis*, 2003, Mahatma Phule Krishi Vidyapeeth, Rahuri
9. Raskar, B.S. and Bhoi, P.G.. Yield attributes of sugarcane as influenced by intra-row spacings, fertilizer levels and planting materials. *Indian Sugar,* 53: 5: 327-331
10. Shahi, H.N. 2002. Sugarcane crushing prize cause concern. The Hindu, Survey of Indian agriculture, 2003, pp. 119-124
11. Sundara, B.. Influence of varieties, seed and fertilizer rates and planting patterns on sugarcane grown under wide row spacing. *Indian Sugar,* 2002, LII (5):341-348
12. Verma, R.S. and Yadav, R.L. , Growth and yield of sugarcane and potato in companion cropping system. *J.Agric.Sci.Camb*., 1986; 125-231.