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Performance of tropical sugar beet cultivars in intercropping with sugarcane at different row proportions

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Abstract

The field experiment was carried out during 2010-11 at Agricultural Research Station (ARS), Madhurakhandi (Dist. Bagalkot), University of Agricultural Sciences, Dharwad to evaluate tropical sugar beet cultivars (Cauvery, Shubhra, Magnolia and Calixta) with different row proportions (1:1, 1:2 and 1:3) in sugarcane. There were seventeen treatment combinations laid out in randomised complete block design with three replications. Results indicated that sole sugarcane and sugarcane (SC) + sugar beet (SB) in 1:1 RP recorded significantly higher cane (103.56 and 98.58 (average of all cultivars) t ha⁻¹, respectively) and sugar (11.40 and 10.85 (average of all cultivars) t ha⁻¹, respectively) yield when compared to other intercropped treatments (SC + SB in 1:2 and 1:3 RP). Sole sugar beet cultivars Cauvery and Shubhra recorded significantly higher tuber (88.68 and 82.74 t ha⁻¹, respectively) and sugar (10.15 and 9.35 t ha⁻¹, respectively) yield than intercropped treatments. In intercropping system sugar beet cultivars Cauvery and Shubhra in 1:3 and 1:2 row proportions recorded significantly higher tuber and sugar yield than 1:1 RP. Sugarcane (SC) + sugar beet (SB) (cv. Cauvery) in 1:2 and 1:3 RP recorded significantly higher gross returns (Rs. 285404 and 278083 ha⁻¹, respectively) and net returns (Rs. 199087 and 187457 ha⁻¹, respectively) when compared to other treatments, but B:C was significantly higher in 1:1 RP(3.33).

Keywords: sugarcane, sugar beet, intercropping, cultivar, row proportion

Introduction

Sugar is an essential commodity and an integral part of the 'food chain' and the cheapest source of energy. More than 100 countries in the world produce sugar, 60 per cent of which comes from sugarcane growing countries while, the rest (40%) comes from sugar beet growing countries [9]. Sugarcane is cultivated in more than 110 countries and it is grown in 26.09 million hectare with a production of 1, 842 million tonnes of cane [3]. In India it is grown in an area of 4.92 million hectares with a production of 348 million tonnes and average productivity of 70.72 t ha⁻¹. Among major sugarcane growing states in India, Karnataka occupies third position in area (0.45 million hectares), third rank in production (3.78 million tonnes) and fifth position in productivity (84.07 t ha⁻¹) [4].

Sugarbeet (*Beta vulgaris* L.) belongs to the family Chenopodiaceae, is considered as the second important sugar crop all over the world after sugar cane (*Saccharum officinarum* L.). It is grown in 57 countries. Top fifteen sugarbeet producing countries are Russian Federation, Ukraine, United States of America, Germany, France, Turkey, China, Poland, Egypt, United Kingdom, Iran (Islamic Republic of), Belarus, Netherlands, Italy and Belgium. Sugarbeet is mainly produced in Europe and, to a lesser extent, in Asia and North America [10]. It contributes about 21.8 % of world sugar [2]. It is a biennial halophytic as well as Na- salts scavenger C3 plant containing up to 20 % sugar on fresh weight basis. The storage organ of this plant is usually called the root, of which 90% is actually root derived and the remaining 10% (the crown) is derived from the hypocotyls [20]. Composition wise, a freshly harvested sugarbeet root contains 75-76% water, 15-20 % sugars, 2.6% non-sugars and 4-6 % the pulp.

Processing one ton of fresh sugarbeet roots yields 121 kg sugar, 38 kg molasses (containing 18.2 kg sugar, 12.1 kg impurities and 7.8 kg water) and 50 kg of pulp.

Sugar beet being a new crop to Karnataka in order to promote its cultivation, it is often difficult to replace the existing sugarcane. One of the options is to grow it as an intercrop in sugarcane. Since sugarcane crop being relatively long duration with initial slow growth for 3-4 months which facilitates growing of intercrops with sugarcane by using temporal and spatial dimensions. This helps in effective use of both the natural and the applied nutrients thereby improving productivity and profitability of the system. Several short duration crops have been tried as intercrops in sugarcane under normal row spacing of 90 cm have proved beyond doubt the intercrops had deleterious effect on growth and yield of sugarcane in majority of the cases [17]. One of the recent agro techniques that can be employed to reduce the intercrop competition is the introduction of wide row spacing in sugarcane cultivation. Basically the concept of wide row spacing was developed to facilitate mechanical harvesting of the cane. This technique would greatly facilitate not only easy management of intercropping with minimal competition effects, but also provide enough space for greater population of intercrops to get higher productivity.

The experiments conducted in the University of Agricultural sciences, Dharwad [18], proved that the sugar beet can be cultivated in different agro-climatic zones of Karnataka under tropical condition with excellent yield potential. However, the information on growing of sugar beet as intercrop in sugarcane is meagre in the northern region of Karnataka. Many varieties of sugar beet have already emerged out and the suitability of these varieties in intercropping for northern region of Karnataka is yet to be identified. Thus, development of suitable intercropping system by evaluating the performance of sugar beet cultivars in different row proportions with wider spacing of sugarcane (150 cm) is need of the hour to increase the sugar production per unit area and net income of the farmer. Besides this, sugar beet as an intercrop in sugarcane helps to augment ethanol requirement. Research conducted by Chattha *et al.* [8] and Bahadar *et al.* [6] has clearly indicated that sugar beet with sugarcane will help to achieve the interim income per unit area, which will ultimately improve the economic status of growers and sugar industry. Thus, obviously sugar beet crop can not only be the supplement crop of sugarcane but also can be grown with the sugarcane. Keeping these points in to consideration field experiment was conducted to evaluate sugar beet cultivars (Cauvery, Shubhra, Magnolia and Calixta) with different row proportions (1:1, 1:2 and 1:3) in sugarcane.

Materials and Methods

A field experiment was conducted at Agricultural research station, Madhurakhandi (Northern dry zone of Karnataka) during the *kharif*-2010-11. The experimental location is situated at 16° 20' N latitude, 75° 20' E longitude and at an altitude of 715 meters above mean sea level. The soil of the experimental plot was black clay loam having pH and electrical conductivity of 8.27 and 0.15 ds m⁻¹, respectively. The soil was low in available nitrogen (252 kg ha⁻¹), medium in available phosphorus (36.8 kg ha⁻¹) and high in available potassium (353 kg ha⁻¹). The distribution of rainfall was normal during the crop season (512.8 mm). Other meteorological parameters such as temperature (minimum and maximum), relative humidity did not deviate much from the normal to influence the crop performance to a great extent.

The experiment consisted of sole sugarcane (T₁), sole sugar beet cv. Cauvery (T₂), sole sugar beet cv. Shubhra (T₃), sole sugar beet cv. Mangolia (T₄), sole sugar beet cv. Calixta (T₅), sugarcane (SC) + sugar beet (SB) cv. Cauvery in 1: 1 row proportion (RP) (T₆), SC + SB cv. Cauvery in 1: 2 RP (T₇), SC + SB cv. Cauvery in 1: 3 RP (T₈), SC + SB cv. Shubhra in 1: 1 RP (T₉), SC + SB cv. Shubhra in 1: 2 RP (T₁₀), SC + SB cv. Shubhra in 1: 3 RP (T₁₁), SC + SB cv. Mangolia in 1: 1 RP (T₁₂), SC + SB cv. Mangolia in 1: 2 RP (T₁₃), SC + SB cv. Mangolia in 1: 3 RP (T₁₄), SC + SB cv. Calixta in 1: 1 RP (T₁₅), SC + SB cv. Calixta in 1: 2 RP (T₁₆) and SC + SB cv. Calixta in 1: 3 RP (T₁₇). All seventeen treatments were laid out in randomised block design with three replications. The recommended dose of N, P₂O₅ and K₂O (kg ha⁻¹) for sugarcane was 250:75 :190 + FYM @ 25 t ha⁻¹ and for sugar beet 120 :60 :90+ FYM @ 10 t ha⁻¹.

The land was brought to fine tilth by initial ploughing once with tractor drawn plough and twice with cultivator. Later field was harrowed twice with bullock pairs, stubbles and weeds were removed from the field. Afterwards the raised beds (for sugar beet sowing) were formed by opening ridges and furrows at 150 cm distance (for sugarcane planting) with tractor mounted ridger and furrow opener. Sugar beet crop was sown with the onset of monsoon during June. Sugar beet seeds were sown by hand dibbling in three different row proportions on raised bed. The germination, emergence and growth of sugar beet were satisfactory which ensured better crop growth and yield. In addition, sugar beet was irrigated based on crop need at an interval of 15 days. After two months of sowing of sugar beet on the raised bed, furrows which were meant open during sugar beet sowing were reopened by bullock drawn ridge former for planting of sugarcane without affecting standing sugar beet crop (Plate-1). Sugarcane was planted in the month of September and irrigated immediately after planting and crop was irrigated at monthly interval as a result sugarcane crop growth was normal. The seed rate for sugarcane crop was 4.5 t cane setts ha⁻¹ while for sugar beet it was 3.6 kg of seeds ha⁻¹.

Full amount of recommended dose of phosphorous through diammonium phosphate and potassium through muriate of potash and 10 per cent N in sugarcane and 50 per cent N in sugar beet through urea were applied as basal. The remaining 90 per cent of nitrogen in sugarcane was top dressed with 20, 30 and 40 per cent at 6th, 10th and 14th weeks after planting, respectively. In sugar beet rest half nitrogen was top dressed at 45 DAS. All the recommended plant protection measures were undertaken during the experimentation. All the biometric observations were recorded at different stages of crop growth for both crops. Need based plant protection measures were given against pests and diseases for both sugarcane and sugar beet. The sugar beet crop matured in five months and 15 days. Matured sugar beet tubers were harvested and topped manually. At the time of harvest, pre harvest irrigation was given for easy harvest. The sugarcane crop was harvested at the age of 11 month. The quality parameters for both sugarcane and sugar beet were determined as per the method of Meade and Chen [13].

Results and Discussion

Performance of sugarcane

Sugarcane yield differed significantly due to intercropping of sugar beet cultivars in different row proportions (RP) (Table 1). Sole sugarcane recorded significantly higher cane yield (103.56 t ha⁻¹) compared to intercropped treatments (86.95 to 99.38 t ha⁻¹). However, growing of sugarcane (SC) and sugar

beet (SB) in 1:1 RP (irrespective of sugar beet cultivars) remained on par with sole sugarcane. Significantly lower sugarcane yield was recorded under 1:3 RP. Significantly lower cane yield was observed in 1:2 and 1:3 RP on account of greater competition exerted by higher population of sugar beet for various growth resources. The population of sugar beet was 66 and 100 per cent in 1:2 and 1:3 RP, respectively as compared to 1:1 R (33%). The results are in conformity with the findings of Mahadevaswamy ^[11] and Singh and Vashist ^[22], wherein they reported that cane yield obtained in sugarcane + onion in 1:1 RP was on par with sole sugarcane. Further, they reported that as the row proportions of onion increased from 1:2 to 1:4, there was significant reduction in yield of sugarcane. Results are in concurrence with the findings of Bahadar *et al.* ^[6] in sugarcane + sugar beet.

The higher cane yield in sole sugarcane and sugarcane (SC) + sugar beet (SB) in 1:1 RP (irrespective of sugar beet cultivars) was due to higher yield attributes namely number of millable canes (NMC) (85280 and 81300 (average of all cultivars) ha⁻¹, respectively) and single cane weight (1450 and 1375 (average of all cultivars) g plant⁻¹, respectively) (Table 1). The higher NMC and single cane weight in sole sugarcane and SC + SB in 1:1 RP (average of all cultivars) are the reflections of other yield attributing characters like length of internode (10.85 and 10.22cm, respectively), diameter of cane (2.63 and 2.58 cm, respectively) and number of internodes (22.94 and 22.34, respectively) at harvest. The differences in yield components in sole sugarcane and SC + SB in 1:1 RP could be traced back to significant differences with regard to total dry matter production (TDMP) (446.22 and 437.67 (average of all cultivars) g plant⁻¹, respectively) (Table 1). The higher TDMP in sole sugarcane and SC + SB in 1:1 RP (average of all cultivars) was the cumulative effect of higher growth characters such as plant height (167.87 and 160.94 cm, respectively) at harvest and leaf area index (1.82 and 1.67, respectively) at peak stage of crop. On the contrary these values were significantly lower in SC + SB intercropping involving 1:2 and 1:3 RP.

Among the different quality parameters (brix, sucrose, commercial cane sugar per cent and sugar yield) studied, significant variations were observed only in sugar yield due to intercropping of sugar beet cultivars in different row proportions (Table 1). Sole sugarcane recorded higher sugar yield (11.40 t ha⁻¹) compared to intercropped treatments. However, intercropping of SC + SB in 1:1 (average of all cultivars) (10.85 t ha⁻¹) and 1:2 RP (10.30 t ha⁻¹) recorded at par sugar yield to that of sole sugarcane. Significantly lower sugar yield was recorded in 1:3 RP (9.65 t ha⁻¹). The higher sugar yield in sole sugarcane, SC + SB in 1:1 and 1:2 RP was due to higher cane yield compared to SC + SB 1:3 RP. The results are in line with the findings of Mahadevaswamy ^[12] and Bahadar *et al.* ^[6].

Performance of sugar beet

Tuber yield of sugar beet differed significantly due to intercropping of sugar beet cultivars with sugarcane in different row proportions (Table 2). Sole cultivars Cauvery and Shubhra recorded significantly higher tuber yield (88.68 and 82.74 t ha⁻¹, respectively) than cultivar Calixta (77.53 t ha⁻¹). Significantly the lower tuber yield was recorded in cultivar Magnolia (74.67 t ha⁻¹). Similar results were also reported by Rajashekar ^[16], Balakrishnan and Selvakumar ^[7], Salimath and Lamani ^[18] and Yekkeli ^[23]. The economic yield is a function of dry matter production, efficiency to translocate photosynthates from assimilatory area of the

source (leaf) and accumulate in tuber (sink). The higher tuber yield with sole Cauvery and Shubhra cultivars was due to improvement in yield attributing characters such as tuber weight (1193 and 1138 g plant⁻¹, respectively), tuber length (40.88 and 39.79 cm, respectively) and tuber girth (29.89 and 29.12 cm, respectively) (Table 2). The differences in yield components of sugar beet could be traced back to the differences in the total dry matter production (TDMP) (Table 2). Significantly higher TDMP was recorded in sole cultivars Cauvery (230.02 g plant⁻¹) and Shubhra (227.89 g plant⁻¹) than cultivars Calixta and Magnolia. The latter cultivar recorded lower TDMP (224.49g plant⁻¹). The higher TDMP in sole cultivars Cauvery and Shubhra could also be related to higher photosynthetically active assimilatory surface area. Photosynthetic capacity of a plant depends upon plant height (Table 2) and leaf area index (Table 2) at peak stage of crop growth (120 DAS). These growth parameters enabled the plant to trap higher quantity of solar energy with higher leaf surface area to convert into chemical energy. This helps in accumulation of higher dry matter in the economic parts which in turn might have led to the higher tuber yield.

Among the intercropped treatments tuber yield increased significantly with increase in the rows of sugar beet from 1:1 to 1:3 in all the cultivars. Accordingly, significantly higher tuber yield was recorded in 1:3 RP (59.81 to 70.94 t ha⁻¹, Av. 64.77 t ha⁻¹) followed by 1:2 RP (56.12 to 66.54 t ha⁻¹, Av. 60.75 t ha⁻¹). The lowest tuber yield was recorded in 1:1 RP (33.80 to 39.94 t ha⁻¹, Av. 36.49 t ha⁻¹) (Table 2). The higher tuber yield of sugar beet in 1:3 RP was mainly due to higher plant population of sugar beet than 1:1 and 1:2 RP. The population of sugar beet in 1:3 RP was same as that of sole sugar beet (100 %) while the population of sugar beet in 1:1 and 1:2 RP was 33 and 66 %, respectively. In the present investigation, sugar beet in 1:3 RP recorded higher tuber yield although the various growth and yield attributes were significantly lower compared with sugar beet in 1:1 and 1:2 RP.

Similar to tuber yield, the sugar yield also showed significant variations among the intercropped treatments but was significantly lower compared to sole crop. Accordingly, significantly higher sugar yield was recorded in 1:3 RP (6.20 to 7.74 t ha⁻¹, Av. 6.88 t ha⁻¹) followed by 1:2 RP (5.73 to 7.18 t ha⁻¹, Av. 6.35 t ha⁻¹). The lowest tuber yield was recorded in 1:1 RP (3.26 to 4.01 t ha⁻¹, Av. 3.59 t ha⁻¹) (Table 2). The higher sugar yield of sugar beet in 1:3 RP was mainly due to higher tuber yield than 1:2 and 1:1 RP.

Economics of sugarcane + sugar beet intercropping system

The economics of intercropping of sugar beet with sugarcane depends upon the various factors such as any reduction in cane yield, yield of intercrop, cost of production and its market price. Significant differences were observed with respect to gross returns, net returns and B:C due to intercropping of sugar beet cultivars with sugarcane in different row proportions (Table 3). Among the different treatments, sugarcane (SC) + sugar beet (SB) (cv. Cauvery) in 1:2 and 1:3 RP recorded significantly higher gross returns (Rs. 285404 and 278083 ha⁻¹, respectively) and net returns (Rs. 199087 and 187457 ha⁻¹, respectively) when compared to other treatments. The net returns recorded under 1:1 RP was comparable to that of 1:2 and 1:3 RP, though the tuber yield of sugar beet was significantly lower in former treatment which was compensated by the higher cane yield. The comparable net returns in above intercropped treatments could

be attributed to variations in yield and cost of cultivation of component crops. The results corroborate the findings of Singh and Mehra ^[21], Singh and Vashist ^[22] and Sanjay Kumar *et al.* ^[19]. The B:C of sugarcane and sugar beet intercropping system showed significant variations. Intercropping of sugarcane + sugar beet (cv. Cauvery) in 1:1 and 1:2 RP recorded significantly higher B:C (3.33 and 3.31,

respectively) compared to 1:3 RP(3.07). While, significantly lower gross returns, net returns and B:C was recorded in sole sugarcane and sugar beet. The variations in B:C was due to variations in gross returns and cost of cultivation. The results obtained are in line with the work of Patil *et al.* ^[14] and Porwal *et al.* ^[15].

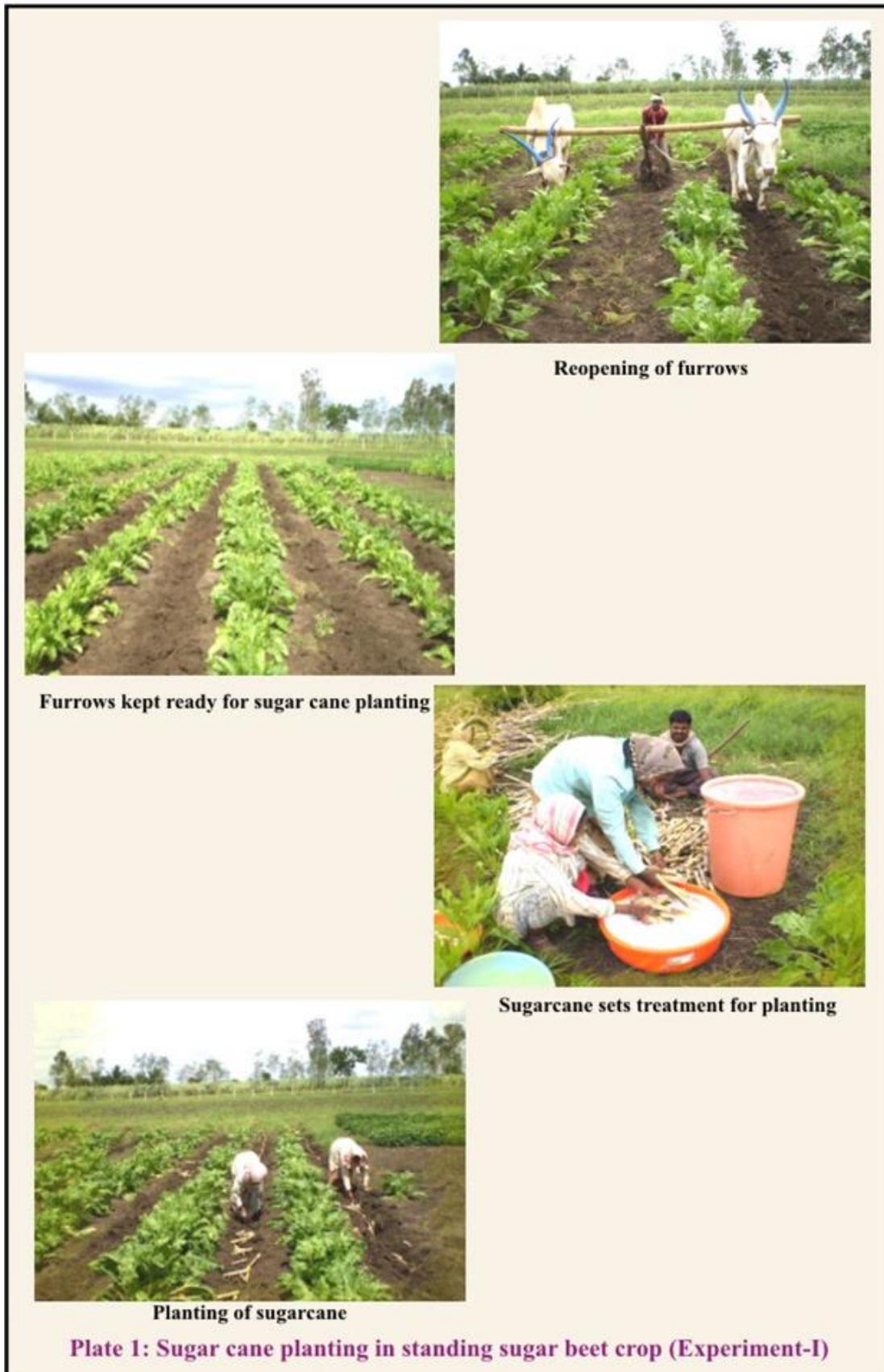


Table 1: Growth, yield and quality parameters of sugarcane as influenced by intercropping of sugar beet cultivars in different row proportions

Treatment	Growth parameters			Yield parameters and yield						Quality parameters At harvest			
	Plant height (cm) At harvest	LAI At 270 DAP	TDMP At harvest (g plant ⁻¹)	NMC's (000 ha ⁻¹)	Cane weight (g plant ⁻¹)	Length of internode (cm)	Number of internodes per plant	Diameter of cane (cm)	Cane yield (t ha ⁻¹)	Brix (%)	Sucrose (%)	CCS (%)	Sugar yield (t ha ⁻¹)
T ₁ - Sole sugarcane (SC)	167.82a	1.82a	446.22a	85.28a	1450a	10.85a	22.94a	2.63a	103.56a	19.58a	16.39a	11.03a	11.40a
T ₂ - Sole sugar beet cv. Cauvery	-	-	-	-	-	-	-	-	-	-	-	-	-
T ₃ - Sole sugar beet cv. Shubhra	-	-	-	-	-	-	-	-	-	-	-	-	-
T ₄ - Sole sugar beet cv. Magnolia	-	-	-	-	-	-	-	-	-	-	-	-	-
T ₅ - Sole sugar beet cv. Calixta	-	-	-	-	-	-	-	-	-	-	-	-	-
T ₆ - SC + SB cv. Cauvery (1:1 RP)	161.41ab	1.70a	437.30a-c	81.42ab	1390ab	10.31ab	22.50ab	2.58a-c	98.85ab	19.56a	16.29a	10.93a	10.83ab
T ₇ - SC + SB cv. Cauvery (1:2 RP)	153.16bc	1.46d	432.06b-d	76.31b-d	1280b-d	9.23c-e	21.33b-e	2.49d	93.43b-d	19.55a	16.38a	11.03a	10.29ab
T ₈ - SC + SB cv. Cauvery (1:3 RP)	144.87c	1.27e	425.41d	71.65d	1260b-d	9.10f	20.94de	2.47d	87.71d	19.53a	16.37a	11.03a	9.66b
T ₉ - SC + SB cv. Shubhra (1:1 RP)	161.16ab	1.65a-c	436.67a-d	79.20a-c	1380ab	10.24a-c	22.39a-c	2.59ab	97.89a-c	19.56a	16.38a	11.03a	10.77ab
T ₁₀ - SC + SB cv. Shubhra (1:2 RP)	152.65bc	1.48b-d	431.33b-d	76.48b-d	1260b-d	9.39b-f	21.13b-e	2.51b-d	93.25b-d	19.55a	16.36a	11.01a	10.29ab
T ₁₁ - SC + SB cv. Shubhra (1:3 RP)	146.63c	1.40de	426.35cd	72.49cd	1240cd	9.15ef	20.62e	2.49d	88.45cd	19.53a	16.37a	11.02a	9.74ab
T ₁₂ - SC + SB cv. Magnolia (1:1 RP)	160.44ab	1.66ab	438.42ab	83.47ab	1360a-c	10.14a-e	22.30a-d	2.58a-c	99.38ab	19.53a	16.35a	11.01a	10.96ab
T ₁₃ - SC + SB cv. Magnolia (1:2 RP)	152.87bc	1.39de	430.85b-d	76.59b-d	1270b-d	9.67b-f	21.61b-e	2.50cd	93.66b-d	19.53a	16.38a	11.04a	10.36ab
T ₁₄ - SC + SB cv. Magnolia (1:3 RP)	147.51c	1.23e	426.91b-d	71.84cd	1220d	9.20d-f	21.39b-e	2.48d	87.85d	19.50a	16.31a	10.97a	9.63b
T ₁₅ - SC + SB cv. Calixta (1:1 RP)	160.77ab	1.66ab	438.28ab	81.12ab	1370a-c	10.20a-d	22.17a-d	2.58a-c	98.21a-c	19.55a	16.35a	11.00a	10.82ab
T ₁₆ - SC + SB cv. Calixta (1:2 RP)	149.74bc	1.47cd	431.45b-d	76.84b-d	1270b-d	9.30b-f	21.05c-e	2.50cd	93.12b-d	19.54a	16.38a	11.03a	10.27ab
T ₁₇ - SC + SB cv. Calixta (1:3 RP)	147.32c	1.35de	425.70d	70.37d	1250cd	9.22d-f	20.52e	2.47d	86.95d	19.51a	16.35a	11.01a	9.57b
S.Em±	4.25	0.06	3.95	2.57	0.05	0.35	0.48	0.03	3.38	0.61	0.51	0.34	0.49

Means followed by common letter do not differ significantly by DMRT @ p=0.05

Note: SC: Sugarcane SB: Sugar beet RP: Row proportion

Table 2: Growth, yield and quality parameters of sugar beet cultivars as influenced by row proportions of sugar beet in intercropping with sugarcane

Treatment	Growth parameters			Yield parameters and yield				Quality parameters At harvest			
	Plant height (cm) At 120 DAS	LAI At 120 DAS	TDMP At harvest (g plant ⁻¹)	Tuber weight (g plant ⁻¹)	Tuber length (cm)	Tuber girth (cm)	Tuber yield (t ha ⁻¹)	Brix (%)	Sucrose (%)	CCS (%)	Sugar yield (t ha ⁻¹)
T ₁ - Sole sugarcane (SC)	-	-	-	-	-	-	-	-	-	-	-
T ₂ - Sole sugar beet cv. Cauvery	59.87a	7.98bc	230.02a	1193.00a	40.88a	29.89a	88.68a	22.83a	17.68a	11.40a	10.15a
T ₃ - Sole sugar beet cv. Shubhra	59.23ab	7.50de	227.89ab	1138.00ab	39.79ab	29.12ab	82.74ab	22.74a	17.52a	11.27a	9.35ab
T ₄ - Sole sugar beet cv. Magnolia	58.45a-c	7.44e	224.49b-e	1094.00a-d	38.45a-d	27.92a-d	74.67b-d	22.49a	17.26a	11.07a	8.30bc
T ₅ - Sole sugar beet cv. Calixta	58.81a-c	7.46e	225.98a-d	1116.00ab	39.12a-c	28.46a-c	77.53bc	22.63a	17.43a	11.21a	8.72bc
T ₆ - SC + SB cv. Cauvery (1:1 RP)	58.16a-c	5.03h	227.20a-c	1113.00a-c	38.18a-d	28.91ab	39.94g	21.24a	15.87a	10.02a	4.01fg
T ₇ - SC + SB cv. Cauvery (1:2 RP)	56.89a-c	7.21ef	224.23b-e	1041.00b-e	36.43a-e	27.74a-d	66.54de	22.23a	16.88a	10.76a	7.18c-e
T ₈ - SC + SB cv. Cauvery (1:3 RP)	54.97a-d	8.95a	221.37d-g	1018.00b-f	34.55c-e	26.18b-e	70.94cd	22.35a	17.03a	10.88a	7.74b-d
T ₉ - SC + SB cv. Shubhra (1:1 RP)	57.33a-c	5.02h	225.05b-d	1049.00b-e	37.24a-d	28.18a-c	37.28g	21.12a	15.68a	9.86a	3.69g

T ₁₀ - SC + SB cv. Shubhra (1:2 RP)	56.11a-c	7.06f	222.05d-f	986.00c-g	35.11b-e	27.04b-f	62.12ef	21.76a	16.41a	10.42a	6.49de
T ₁₁ - SC + SB cv. Shubhra (1:3 RP)	54.23b-d	8.20b	219.29f-h	948.00e-g	33.68de	25.68c-e	66.21de	22.11a	16.69a	10.60a	7.04c-e
T ₁₂ - SC + SB cv. Magnolia (1:1 RP)	55.44a-d	4.69h	221.64d-g	1019.00b-f	35.82b-e	26.98b-f	33.80g	20.75a	15.32a	9.60a	3.26g
T ₁₃ - SC + SB cv. Magnolia (1:2 RP)	53.87cd	6.69g	218.75f-h	952.00e-g	34.06de	25.71c-e	56.12f	21.32a	16.03a	10.16a	5.73ef
T ₁₄ - SC + SB cv. Magnolia (1:3 RP)	50.45d	7.84cd	215.75h	889.00g	31.92e	24.56e	59.81ef	21.59a	16.28a	10.33a	6.20de
T ₁₅ - SC + SB cv. Calixta (1:1 RP)	56.23a-c	4.93h	223.06c-f	1027.00b-f	36.58a-e	27.52a-e	34.92g	20.93a	15.49a	9.72a	3.40g
T ₁₆ - SC + SB cv. Calixta (1:2 RP)	55.14a-d	6.89fg	220.21e-h	972.00d-g	34.51c-e	26.27b-e	58.22ef	21.41a	16.15a	10.25a	6.01de
T ₁₇ - SC + SB cv. Calixta (1:3 RP)	53.88cd	8.11bc	217.22gh	912.00fg	32.37e	24.88de	62.13ef	21.94a	16.52a	10.48a	6.53de
S.Em±	1.73	0.12	1.67	44.44	1.66	1.06	2.96	0.93	0.70	0.45	0.61

Means followed by common letter do not differ significantly by DMRT @ p=0.05

Note: SC: Sugarcane SB: Sugar beet RP: Row proportion

Table 3: Economics of sugarcane and sugar beet intercropping system

Treatment	Economics		
	Gross returns (Rs. ha ⁻¹)	Net returns (Rs. ha ⁻¹)	B:C ratio
T ₁ - Sole sugarcane (SC)	227832e	152171c	3.01de
T ₂ - Sole sugar beet cv. Cauvery	106416f	63585d	2.48f
T ₃ - Sole sugar beet cv. Shubhra	99288f	56457d	2.32fg
T ₄ - Sole sugar beet cv. Magnolia	89604f	46773d	2.09g
T ₅ - Sole sugar beet cv. Calixta	93036f	50205d	2.17g
T ₆ - SC + SB cv. Cauvery (1:1 RP)	265394b-d	185621ab	3.33a
T ₇ - SC + SB cv. Cauvery (1:2 RP)	285404a	199087a	3.31ab
T ₈ - SC + SB cv. Cauvery (1:3 RP)	278083a-c	187457ab	3.07b-e
T ₉ - SC + SB cv. Shubhra (1:1 RP)	260094b-d	180613ab	3.27a-c
T ₁₀ - SC + SB cv. Shubhra (1:2 RP)	279694ab	193863ab	3.26a-d
T ₁₁ - SC + SB cv. Shubhra (1:3 RP)	274041a-d	183936ab	3.04c-e
T ₁₂ - SC + SB cv. Magnolia (1:1 RP)	259196cd	180098ab	3.28a-c
T ₁₃ - SC + SB cv. Magnolia (1:2 RP)	273404a-d	188233ab	3.21a-e
T ₁₄ - SC + SB cv. Magnolia (1:3 RP)	265042b-d	175641b	2.96e
T ₁₅ - SC + SB cv. Calixta (1:1 RP)	257963d	178742b	3.26a-d
T ₁₆ - SC + SB cv. Calixta (1:2 RP)	274722a-d	189319ab	3.22a-d
T ₁₇ - SC + SB cv. Calixta (1:3 RP)	265853a-d	176197b	2.97e
S.Em±	6869	6869	0.09

Means followed by common letter do not differ significantly by DMRT @ p=0.05

Note: SC: Sugarcane SB: Sugar beet RP: Row proportion

Conclusion

The study revealed that, Sole sugarcane and sugarcane + sugar beet in 1:1 RP (irrespective of sugar beet cultivars) recorded significantly higher cane and sugar yield compared to sugarcane + sugar beet in 1:2 and 1:3 RP. Sole cultivars Cauvery and Shubhra recorded significantly higher tuber and sugar yield than intercropped treatments. In intercropping system cultivars Cauvery and Shubhra in 1:3 and 1:2 row proportions recorded significantly higher tuber and sugar yield than 1:1 RP. Sugarcane + sugar beet (irrespective of sugar beet cultivars) in 1:2 and 1:3 RP recorded significantly higher gross and net returns when compared to 1:1 RP, but B:C was significantly higher in 1:1 RP.

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