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ASSESSMENT OF THE PERFORMANCE OF PRESSURIZE IRRIGATION ON YIELD AND QUALITY OF SUGARCANE RATOON CROPS

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ABSTRACT

An experiment was conducted at Sugarcane Research Institute, Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar, during the autumn season of 2018-19. In this experiment eight different treatments are used and these had a significant influence on growth parameters, yield attributes, and yield of sugarcane & intercrop. The treatment T₂ produced a higher plant population at all the growth stages which were responsible for a higher number of millable canes at harvest. Similarly, treatment T₂ showed significantly higher values of leaf area index, plant height, number of millable canes, brix, pol, and CCS percent. The data on growth parameters, yield attributes, and yield of French bean indicated that the treatment T₈ recorded higher plant height (51.2 cm), number of branches/plant at harvest (4.5), number of pods/plant (8.2), number of seeds/pod (5.0), 100- seed weight (47.8 g), and grain yield (1.75 t/ha) as compared to other treatments. Similarly, the growth parameters, yield attributes, and yield of green gram viz., plant height (68.6 cm), number of branches/plant at harvest (4.4), number of pods/plant (24.5), number of seeds/pod(12.2), 1000- seed weight (31.8 g), and grain yield (1.14 t/ ha), recorded highest values under the treatment T₈ as compared to other treatments. Planting of sole sugarcane PR with drip irrigation (T₂) produced significantly higher cane (102.1 t/ha) and sugar yield (12.3 t/ha). The results obtained from the analysis revealed that though the water requirement was comparatively higher (126.92 cm) under treatment T₂, however, water use efficiency (1382.53 kg/ha-cm) and water productivity (13.83 kg/m³) were comparatively higher under T₂ treatment, it was found to be drip irrigation were economically better than surface irrigation method.

Key words: Sugarcane, Drip irrigation, Ratooning, Micro-sprinkler irrigation, Intercrops

Introduction

Sugarcane (*Saccharum* spp. hybrid complex) is grown as a commercial crop or cash crop or energy crop (produce liquid energy like ethanol and alcohol). In the world; Brazil, India, and Cuba produces half of the total sugarcane. Out of 100% world sugar requirement, 60% can complete through sugarcane and remaining 40% through sugar beet. Besides manufacturing sugar, sugarcane is also used for preparation of alcohol, production of energy and making good quality paper and also provides employment of our increasing population (Chogatapur *et al.*, 2017). In 2024-25, total area 5.45

million ha, production 454.61 million tonnes & productivity 83416 kg / ha in India and Bihar area in sugarcane cultivation is 0.19 million ha with 12.15 million tonnes of production and 63091 kg/ ha of productivity (Agricultural Statistics at a Glance, 2024-25).

Ratooning followed by main sugarcane crop; it is raising through re-growth of the buds leftover in the underground stubbles. In sugarcane, ratooning is advisable only once because second and other subsequent ratooning is more prone to insect pests and diseases. Ratooning increases productivity and profitability by reducing the expenses of land preparation, planting material cost, setts

treatment costs, and also increases sugar recovery. The growing of sugarcane alone is less profitable in comparison to intercropping with different short life crops viz., green gram, French bean, potato and different vegetables. The intercropping gives cropping intensity in time and space dimensions both. Intercropping helps in the maintenance of soil fertility, suppression of weeds, proper labour utilization, increase productivity per unit area by efficient utilization of water, nutrients, solar energy and other growth factors. Growing of legumes with sugarcane increases the net monetary returns and after picking of pods legumes are incorporated in the soil as green manure. Legume fixes 35-130 kg N/ ha, hence the incorporation of legumes improves the nitrogen status of soil and reduced the cost of cultivation.

The water requirement of sugarcane is very high 1500-2500 mm and if there is insufficient supply of water then heavy yield reduction occurs. The irrigation water use efficiency enhanced 1.5–2.5 times through devising advance irrigation methods or modifying existing surface irrigation techniques by the scientists (Singh *et al.*, 2020). So pressurize irrigation is the most effective method under limited water availability. It can be done by adopting advanced irrigation methods like drip irrigation. Drip irrigation is an effective method for the application of water and nutrient below the surface soil to conserve water, minimize weeds and runoff water (Bhingardeve *et al.*, 2017). The drip irrigation has been shown to save over 50% of irrigation water as compared to traditional flood irrigation techniques (Raheja *et al.*, 2025). It reduced evaporation, increase water use efficiency, reduced percolation, increase growth and yield of crops.

Micro-sprinkler irrigation is gaining popularity because it requires less energy and the discharge rate of water is very low as compared to drip and sprinkler irrigation. It increases the growth and yield of crops by improving water use efficiency, nutrient use efficiency, avoids unnecessary wetting of soil near the root zone, minimizing surface runoff, and deep percolation of water.

Materials and Methods

This experiment was conducted at Sugarcane Research Institute, Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar, during the autumn season of 2018-19. The experiment was laid out in randomized block design, replicated thrice with eight different treatments viz., (T_1) sole sugarcane paired row (PR) with surface irrigation, (T_2) sole sugarcane PR with drip irrigation, (T_3) sugarcane PR + French bean (3 rows) with surface irrigation, (T_4) sugarcane PR + French bean (3 rows) – green gram (3 rows) with surface irrigation, (T_5) T_4 + residue incorporation of green gram, (T_6)

sugarcane PR with drip irrigation + French bean (3 rows) with micro-sprinkler irrigation, (T_7) sugarcane PR with drip irrigation + French bean (3 rows) – green gram (3 rows) with micro-sprinkler irrigation to both the intercrops and (T_8) T_7 + residue incorporation of green gram. The research plot was situated at the southern side of river *Burhi Gandak* at 25°59' N, 85°40' E and 52.1 meters higher to mean sea level, which falls on sub-tropical and sub-humid environment with precipitation of 1270 mm/year. The average evaporation was 1.3-7.5 mm recorded during the crop period. Generally, rainfall is taken through a south-west monsoon. The total amount of rainfall was 102.34 cm received during the crop season. It requires a 1500-2500 mm of water during the life cycle. The mean yearly temperature varies from 25 to 27°C with summer temperature of 25 to 35°C and winter temperature of 16 to 19°C. Generally, sediment brought by *Gandak* is calcareous having free calcium carbonate ranging from 20 to 40 percent. Stubble shaving of sugarcane 'CoP 112' (BO 91 × Co 62198) was done on 19.11.2018 and intercropping with two pulses namely French bean 'Utkarsh' and Green gram 'HUM- 16' were tested in succession at 30×10 cm row distance. Required inter-cultural practices are done in the experiment. The entire quantity of fertilizers (20: 45: 20 kg N-P-K/ ha) were added in soil as basal in green gram. These observations- (Plant population count, Leaf area index (LAI), Plant height, Cane diameter, Single cane weight, Number of millable canes) are recorded for growth parameters and yield attributes of sugarcane, Brix % in juice, Pol percentage in juice, Purity percentage in juice, Commercial cane sugar (CCS) percentage for Quality parameters of sugarcane. And Cane yield (t/ha), and Sugar yield (t/ha) for yield of sugarcane. Plant height at harvest (cm), Number of branches/ plant at harvest, Number of pods/ plant, Number of seeds/ pod, Test weight (g), Grain yield (q/ ha) for Growth parameters, yield attributes, and yields of intercrops. If there is the availability of a hand refractometer, the juice reading between 16 to 18% show the cane can be ready for harvest.

Result and Discussion

The entire rainfall at the time of research was 1023.4 mm of which maximum was received in July 2019 (403.0 mm). The maximum temperature (39°C) in May 2019, minimum (8.1°C) in January 2019, and maximum relative humidity ranges from 70 to 96%, lower relative humidity from 41 to 82% was found during the whole crop growing season. The results noted in experimentation have been statistically analyzed and showed with the help of appropriate tables and suitably exemplify by graphs and figures, wherever necessary.

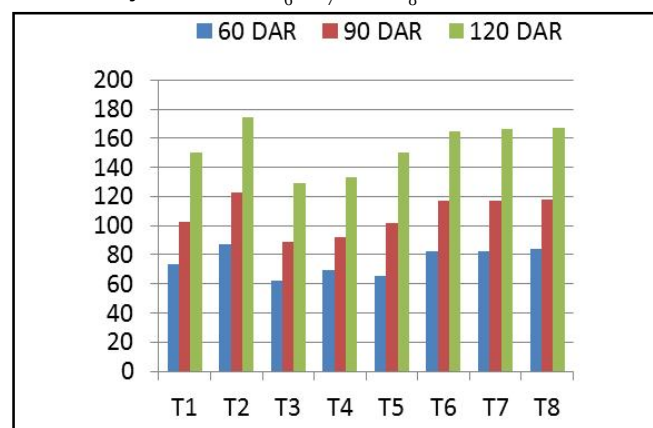
Table 1: Growth parameters and yield attributes of sugarcane as influenced by high intensity intercropping under pressurize irrigation.

Treatment	Plant population ($\times 10^3$ / ha)			Leaf area index			Plant height (cm)					Millable canes ($\times 10^3$ / ha)	Cane diam- eter (cm)	Single cane weight (g)
	60 DAR	90 DAR	120 DAR	120 DAR	180 DAR	240 DAR	150 DAR	180 DAR	210 DAR	240 DAR	300 DAR			
T ₁	73.7	102.3	149.8	1.58	2.73	3.76	134.7	160.3	192.7	222.2	244.7	102.9	2.30	845
T ₂	87.0	123.0	174.3	2.17	3.27	4.38	165.0	194.3	230.0	267.2	299.3	122.6	2.32	836
T ₃	62.4	88.7	129.5	1.41	2.23	3.22	125.3	147.7	180.3	207.9	224.3	93.8	2.22	830
T ₄	69.3	92.3	133.6	1.50	2.59	3.76	131.0	154.5	186.7	217.0	233.0	95.2	2.15	832
T ₅	65.5	101.5	150.2	1.43	2.49	3.68	133.7	159.7	191.3	221.5	239.3	96.5	2.21	836
T ₆	82.1	116.7	165.0	2.01	3.08	3.96	155.7	180.0	218.7	255.9	288.0	110.1	2.36	855
T ₇	82.3	117.3	166.3	2.08	3.11	4.02	162.0	190.3	226.7	263.5	294.7	110.9	2.31	845
T ₈	83.6	118.0	167.0	2.11	3.18	4.06	163.3	191.0	228.3	265.2	297.0	113.8	2.26	843
SEm $\pm$	3.99	5.78	7.77	0.089	0.173	0.201	7.12	9.60	10.47	11.66	10.29	5.28	0.150	39.7
CD(P=0.05)	12.1	17.6	23.6	0.27	0.52	0.61	21.6	29.1	31.8	35.4	40.3	16.0	NS	NS
CV(%)	9.1	9.3	8.7	8.63	10.55	9.01	8.4	9.7	8.8	8.4	8.7	8.7	11.48	8
Mean	75.7	107.5	155.3	1.79	2.84	3.86	146.3	172.2	206.8	240.1	265.0	105.7	2.27	840

T₁: Sole sugarcane with surface irrigation; T₂: Sole sugarcane with drip irrigation; T₃: Sugarcane + french bean with surface irrigation/ farmers' practice; T₄: Sugarcane + french bean –green gram with surface irrigation; T₅: T₄ + Residue incorporation of green gram; T₆: Sugarcane with drip irrigation + french bean with micro-sprinkler irrigation; T₇: Sugarcane with drip irrigation + french bean – green gram with micro-sprinkler irrigation to both the intercrops; T₈: T₇+ Residue incorporation of green gram

Growth parameters and yield attributes of sugarcane

The data are analysed for growth parameters and yield attributes of sugarcane is mentioned in Table 1. Data of population of plant ($\times 10^3$ / ha) were counted in each treatment during 2018-19 at monthly intervals and different treatment showed (Fig. 1) a significant difference among treatments. Treatment T₂ recorded a significantly higher number of plant population at 60 DAR (87000/ ha), at 90 DAR (123000 / ha) compared with other treatments. The effect of treatment on plant population at 120 DAR was almost the same that of obtained at 60 and 90 DAR, and the highest value of plant population (1, 74300/ ha) due to T₂ which was statistically similar to T₆, T₇ and T₈.

**Fig. 1:** Plant population ($\times 10^3$ / ha).

Bright sunshine with longer hours promotes tillering while cloudy weather condition and short day sunshine hours affect it adversely. The data on plant population count at 60, 90, and 120 DAR were noticed maximum under T₂, which was, however, on par with T₆, T₇, and T₈, while T₃ obtained minimum plant population count. Generally, the plant population was high in all the drip-irrigated treatments over surface method of irrigation. The higher plant population with drip irrigation could be attributed better micro-climate, which facilitated better photosynthesis, root aeration, and root development which resulted in the higher plant population. The present finding agrees by Resende *et al.*, (2025), and Singh *et al.*, (2019).

In general, it was noted that Leaf area index (LAI) (Fig. 2) increased from 180 to 240 DAR and it was showed a significant difference at all the stages. T₂

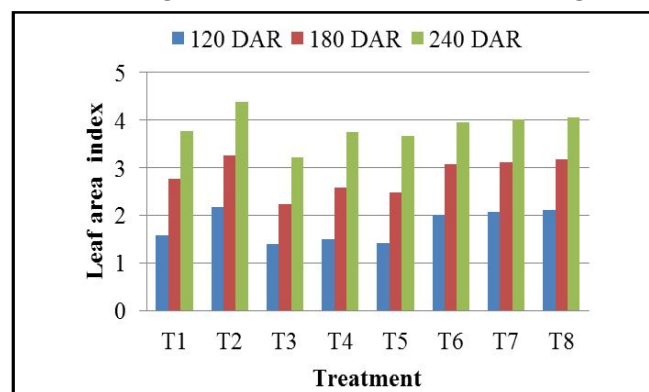
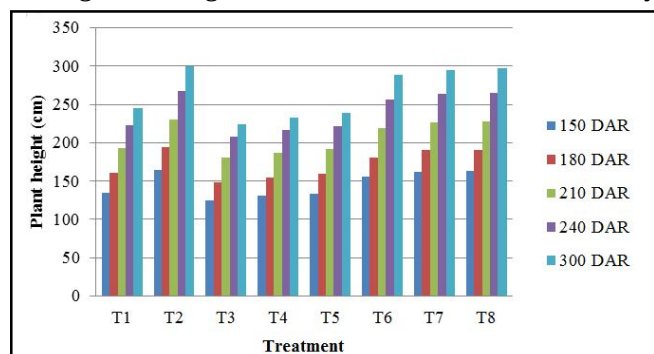
**Fig. 2:** Leaf area index.

Table 2: Growth parameters, yield attributes, and yield of French bean as influenced by high intensity intercropping under pressurized irrigation.

	Treatment	Plant height (cm) at harvest	No. of branches /Plant at harvest	No. of pods /Plant	No. of seeds /pod	100-seed weight (g)	Grain yield (t/ha)
T ₁	Sole sugarcane with surface irrigation	-	-	-	-	-	-
T ₂	Sole sugarcane with drip irrigation	-	-	-	-	-	-
T ₃	Sugarcane + french bean with surface irrigation/ farmers' practice	43.5	3.3	6.2	3.5	43.2	1.09
T ₄	Sugarcane + french bean – green gram with surface irrigation	43.8	3.4	6.7	3.6	43.5	1.19
T ₅	T ₄ + Residue incorporation of green gram	44.2	3.7	6.8	3.9	44.1	1.28
T ₆	Sugarcane with drip irrigation + french bean with micro-sprinkler irrigation	47.8	4.0	7.6	4.5	46.4	1.52
T ₇	Sugarcane with drip irrigation + french bean – green gram with micro-sprinkler irrigation to both the intercrops	48.7	4.4	8.1	4.8	47.2	1.60
T ₈	T ₇ + Residue incorporation of green gram	51.2	4.5	8.2	5.0	47.8	1.75
	SEm ±	-	-	-	-	-	-
	CD (P = 0.05)	-	-	-	-	-	-
	CV (%)	-	-	-	-	-	-
	Mean	46.5	3.9	7.3	4.2	45.4	1.4

recorded a significantly higher leaf area index at 120 DAR (2.17), 180 DAR (3.27), 240 DAR and (4.38) as compared with other treatments T₆, T₇, and T₈ and the minimum leaf area index at 240 DAR was noticed with the treatment T₃ (3.22). The treatment T₂ recorded higher plant height at 150 DAR, (165.0 cm), 180 DAR (194.3 cm) and 210 DAR (230.0 cm) as compared with other treatment T₆, T₇, and T₈. Also, the maximum cane height was noticed with treatment T₂. Similarly, the plant height at 240 and 300 DAR exhibited a significant difference in plant height and the highest being noticed with T₂ and minimum in treatment T₃. The data indicates that the plant attained almost 55.2% of plant height at 150 DAR, 65.0% of the plant height at 180 DAR, 78.0% of the plant height at 210 DAR, and 90.6% of the plant height at 240 DAR irrespective of the treatment.

The leaf area index (LAI) (Fig. 2) was also noted on three growth stages from 120 to 240 DAR on 60-day

**Fig. 3:** Plant height.

intervals. Significantly higher leaf area index was obtained from (T₂), at 120, 180, and 240 DAR over other treatments which were, however, comparable with (T₆), (T₇) and (T₈). The photosynthetic activity of plants largely depends upon the leaf area. In drip irrigation required quantity of water and nutrients matching with the crop demand and increased the photosynthetic area for better utilization of solar radiation resulting in higher leaf area. The present finding agrees with Padnabhan, *et al.*, (2017), and Koonja *et al.*, (2016). The plant height (Fig. 3) was recorded at five successive growth stages from 150 DAR to 300 DAR on 30-day intervals. The plant height was comparatively higher under (T₂), at 150, 180, 210, 240, and 300 DAR as compared to other treatments. It might

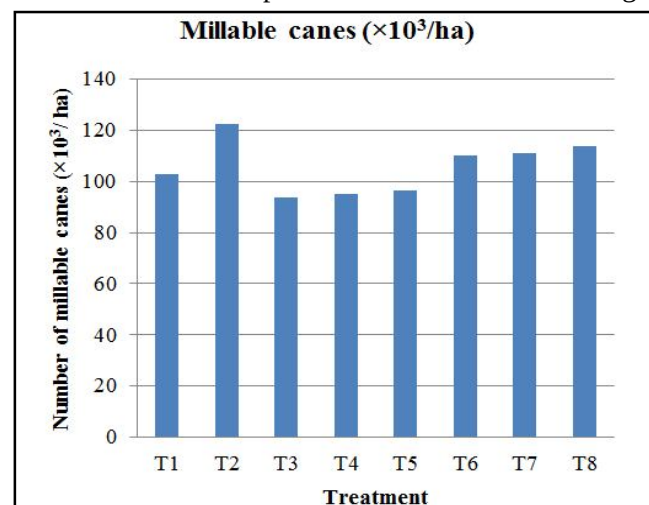
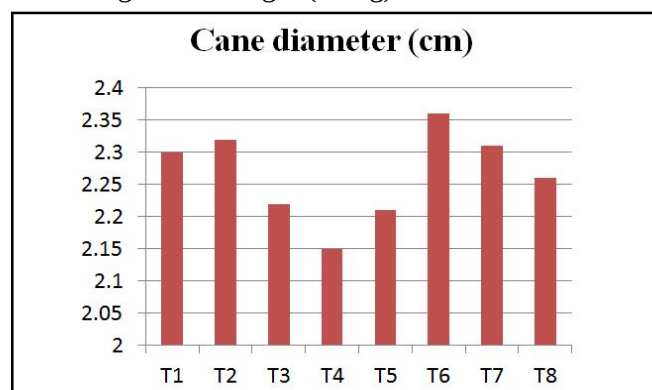
**Fig. 4:** The number of millable canes (x10³/ha).

Table 3: Growth parameters, yield attributes, and yield of green gram as influenced by high intensity intercropping under pressurize irrigation.

	Treatment	Plant height (cm) at harvest	No. of branches /Plant at harvest	No. of pods /Plant	No. of seeds /pod	100-seed weight (g)	Grain yield (t/ ha)
T ₁	Sole sugarcane with surface irrigation	-	-	-	-	-	-
T ₂	Sole sugarcane with drip irrigation	-	-	-	-	-	-
T ₃	Sugarcane + french bean with surface irrigation/ farmers' practice	-	-	-	-	-	-
T ₄	Sugarcane + french bean – green gram with surface irrigation	63.5	3.3	21.5	11.0	27.6	0.71
T ₅	T ₄ + Residue incorporation of green gram	64.2	3.5	21.8	11.5	28.0	0.85
T ₆	Sugarcane with drip irrigation + french bean with micro-sprinkler irrigation	-	-	-	-	-	-
T ₇	Sugarcane with drip irrigation + french bean – green gram with micro-sprinkler irrigation to both the intercrops	67.8	4.1	24.0	12.0	31.2	1.01
T ₈	T ₇ + Residue incorporation of green gram	68.6	4.4	24.5	12.2	31.8	1.14
	SEm ±	-	-	-	-	-	-
	CD (P = 0.05)	-	-	-	-	-	-
	CV (%)	-	-	-	-	-	-
	Mean	66.0	3.8	23.0	11.7	29.7	0.9

be due to continuous accessibility of adequate moisture in the field, consequences the higher nutrient uptake resulting in greater cell division and elongation. The above results conform to the findings of Sathiyaraj and sathiyapriya (2017), and Surendran *et al.*, (2016).

The maximum number of millable canes (1, 22600/ ha) (Fig. 4) was found under (T₂) which was statistically comparable with (T₆) (1, 10100/ ha), (T₇) (1, 10900/ ha) and (T₈) (1, 13800/ ha). During the study, (T₃) produced the minimum number of millable canes (93, 800/ ha). The data indicated that all treatments did not show significant impact on cane diameter (Fig. 5) while the maximum stalk girth (2.36 cm) was found under treatment T₆ and the lowest stalk girth (2.15) was recorded under treatment T₄. The higher single cane weight (855 g) (Fig. 6) was recorded in treatment T₆ and treatment T₃ recorded the lower single cane weight (830 g).

**Fig. 5:** Cane diameter (cm).

The same trend was found concerning the number of millable canes at harvest (Table 1 and Fig. 6). The highest value (1, 22,600/ ha) was obtained with T₂ which was statistically similar to T₆, T₇, and T₈. However, (T₃), recorded a relatively lowest number of millable canes (93,800/ ha), it might be due to competition between growth factors within the row. These outcomes were also found by Resende *et al.*, (2025), and (Raheja *et al.*, 2025). Varied intercrops and irrigation methods did not show any significant influence on cane diameter and single cane weight. It could be attributed to higher plant population and millable canes under the treatment, which in turn competed for growth resources among the tillers resulted in non-significant variation in cane diameter and single cane weight.

Growth parameters, yield attributes, and yield of intercrops

The performance of different intercrops was

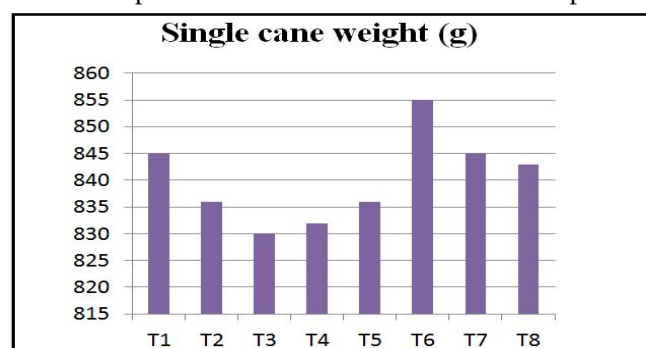
**Fig. 6:** Single cane weight (g).

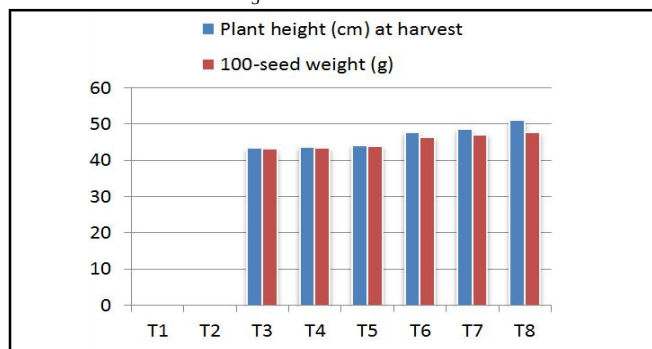
Table 4: Quality parameters of sugarcane ratoon crop and yield of the sugarcane ratoon crop as influenced by high intensity intercropping under pressurize irrigation.

	Treatment	Brix (%)	Pol (%)	Purity (%)	CCS (%)	Cane yield (t/ha)	Sugar yield (t/ha)
T ₁	Sole sugarcane with surface irrigation	18.6	16.24	87.3	11.17	86.4	9.7
T ₂	Sole sugarcane with drip irrigation	19.8	17.45	88.1	12.05	102.1	12.3
T ₃	Sugarcane + french bean with surface irrigation/ farmers' practice	18.6	16.21	87.2	11.14	77.3	8.6
T ₄	Sugarcane + french bean – green gram with surface irrigation	18.5	16.13	87.2	11.08	78.6	8.7
T ₅	T ₄ + Residue incorporation of green gram	18.6	16.10	86.6	11.02	80.1	8.8
T ₆	Sugarcane with drip irrigation + french bean with micro-sprinkler irrigation	19.8	17.43	88.0	12.03	93.1	11.2
T ₇	Sugarcane with drip irrigation + french bean – green gram with micro-sprinkler irrigation to both the intercrops	19.7	17.31	87.9	11.94	93.3	11.1
T ₈	T ₇ + Residue incorporation of green gram	19.3	17.11	87.6	11.84	95.4	11.1
	SEm ±	0.22	0.150	1.01	0.089	4.45	0.58
	CD (P = 0.05)	0.7	0.46	NS	0.27	13.5	1.8
	CV (%)	2.0	1.56	2.0	1.34	8.7	9.9
	Mean	19.1	16.72	87.5	11.51	88.3	10.19

evaluated continuously during 2018-19 and are presented in Table 2 and (Fig. 7 & 8) (French bean) and Table 3 and (Fig No. 9 & 10) (green gram).

French bean

The comparatively higher plant height (51.2 cm) was noted under treatment T₈ and the lower plant height (43.5 cm) was observed with the treatment T₃. The number of branches/ plant was highest with treatment T₈ (4.5) and the minimum value (3.3) was noticed with treatment T₃. The maximum value of number of pods/ plant (8.2) was obtained under treatment T₈ and a lower value (6.2) was produced with treatment T₃. The higher number of seeds/ pod (5.0) was obtained with the treatment T₈ and the lower number of seeds/ pod (3.5) was produced under T₃. The higher 100 - seed weight (47.8 g) with the treatment T₈ which was followed by T₇, T₆, T₅, T₄, and T₃. The findings of grain yield found higher value (1.75 t/ ha) was noted under T₈ and the lower value (1.09 t/ ha) was noticed under T₃.

**Fig. 7:** Plant height (cm) and 100-seed weight (g) of French bean.

Green gram

Different observations of Growth parameters, yield attributes, and yield of a green-gram are presented in Table 3. In general comparatively higher value was noted at harvest with the treatment T₈ which were followed by T₇, T₅, and T₄.

The plant height is observable from data that at harvest, plant height varied from 63.5 to 68.6 cm and comparatively higher value (68.6 cm) was noted under treatment T₈ and minimum plant height (63.5 cm) with treatment T₄. The maximum Number of branches/ plant at harvest (4.4) was noted in treatment T₈ and the lower value (3.3) was noted with T₄. The Number of pods/ plant is found higher value (24.5) with T₈ and the lower value (21.5) was noted with T₄. The findings of these data varied from 11.0 to 12.2. the maximum number of seeds/ pod (12.2) was noticed with treatment T₈ and the

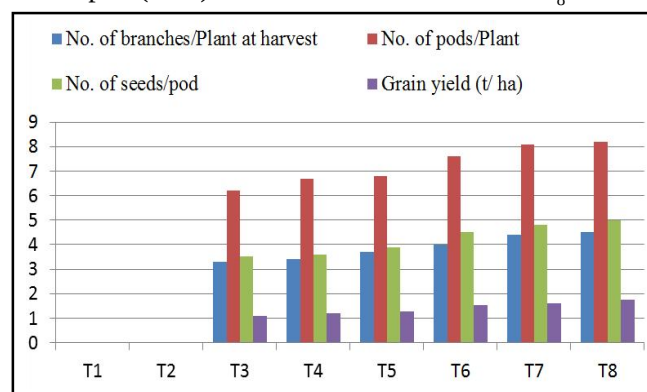
**Fig. 8:** No. of branches/Plant at harvest, No. of pods/ Plant, No. of seeds/pod and Grain yield (t/ ha) of French bean.

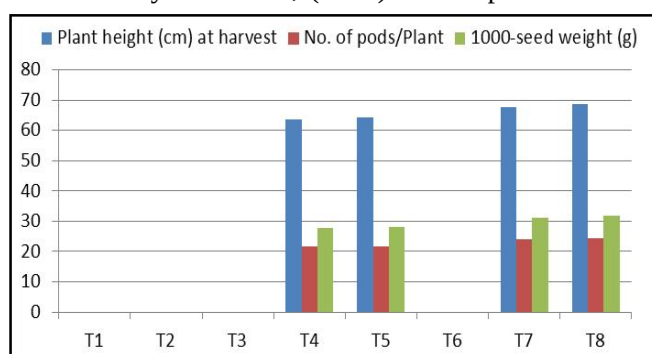
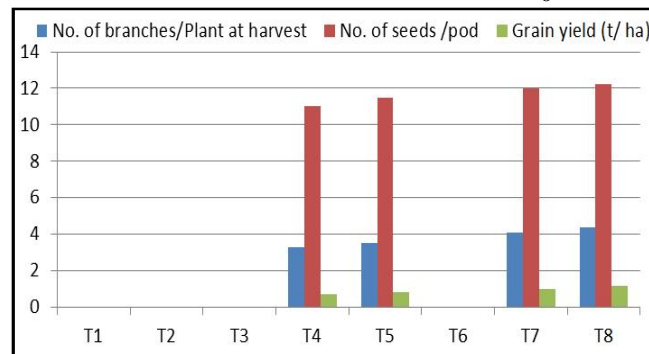
Table 5: Water uses of the system as influenced by high intensity intercropping under pressurize irrigation.

	Treatment	Water requirement (cm)	Water use efficiency(kg/ha ^{cm})	Water productivity (kg/m ³)
T ₁	Sole sugarcane with surface irrigation	121.93	708.60	7.09
T ₂	Sole sugarcane with drip irrigation	73.85	1382.53	13.83
T ₃	Sugarcane + french bean with surface irrigation/ farmers' practice	117.92	834.46	8.34
T ₄	Sugarcane + french bean – green gram with surface irrigation	105.91	1100.00	11.00
T ₅	T ₄ + Residue incorporation of green gram	105.90	1158.64	11.59
T ₆	Sugarcane with drip irrigation + french bean with micro-sprinkler irrigation	101.09	1211.79	12.12
T ₇	Sugarcane with drip irrigation + french bean – green gram with micro-sprinkler irrigation to both the intercrops	126.92	1146.39	11.46
T ₈	T ₇ + Residue incorporation of green gram	126.90	1207.25	12.07
	SEm ±	-	56.205	0.607
	CD (P = 0.05)	-	170.50	1.84
	CV (%)	-	8.90	9.61
	Mean	110.05	1093.71	10.94

minimum number of seeds/ pod (11.0) was noticed with T₄. The results of data varied from 27.6-31.8 g. The treatments T₈ recorded maximum test weight (31.8 g) and the lower test weight (27.6 g) was noted under the treatment T₄. It is concluded that grain yield was varied from 0.71-1.14 t/ ha. The treatment T₈ produced the maximum grain yield (1.14 t/ ha) which were followed by T₇ and T₅. Though minimum grain yield (0.71 t/ ha) among the treatment was observed with treatment T₄.

It was observed from the data showed in the previous chapter in Table 2 (French bean) and Table 3 (green gram), respectively, that the maximum plant height at harvest was recorded with (T₈). A similar result related to plant height was observed by Rao *et al.*, (2016). The increment in number of branches/ plant at harvest directly depends on vegetative growth of the plants. (T₈) noticed higher number of branches/ plant at harvest over other treatments. It may due to the increment in plant height as well as dry matter accumulation. These out-comes was also noted by Rao *et al.*, (2016). The impact of micro-

sprinkler on various yield attributing characters has been clarified in the preceding chapter and related data has been shown in Table 2 (French bean) and Table 3 (green gram), respectively. The analysis of yield components helps to understand the physiological basis and source-sink relationship of crops. However, (T₈) noted the highest number of pods/ plant compared with other treatments. It might be due to the availability of required amount of water and nutrients at right time. The same results were also noticed by Praharaj *et al.*, (2017). The findings of the data noticed that the number of seeds/ pod and test weight were also maximum with (T₈) over other treatments. Since the number of seeds/ pod and test weight is mainly governed by the inherent genetic makeup of the cultivar. These findings were also being found by Hussain *et al.*, (2019). The increment in yield was due to better growth of the plant as evidenced by more number of branches/ plant, number of pods/ plant, and number of seeds/ pod. As yield attributes, higher grain yield of French bean and a green gram was obtained under (T₈) over the

**Fig. 9:** Plant height (cm), No. of pods/Plant and 1000-seed weight (g) of green gram.**Fig. 10:** No. of branches/Plant, No. of seeds / pod and Grain yield (t/ ha) of green gram.

rest of the treatments. It might be due to the constant availability of water at reproductive stage of intercrops and enhanced the yield attributes, which had a direct influence on grain yield. These results are earlier found by Waseem *et al.*, (2017) and Praharaj *et al.*, (2017).

Quality parameters of sugarcane

The quality parameter in respect of brix, pol, purity, and CCS percentage were analyzed at harvest of the ratoon cane and the outcomes are given in Table 4 and (Fig. 11) showed positive response under drip irrigation.

The higher Brix percentage in juice (19.8%) was found in treatment T_2 . However, it remained statistically at par with T_6 (19.8%), T_7 (19.7%) and T_8 (19.3%) and the treatment T_4 recorded significantly lower Brix percentage in juice (18.5%). The maximum pol percentage in juice (17.45%) was found in treatment T_2 as compared to other treatments while the lowest pol percentage in juice (16.10%) was noticed in treatment T_5 . The purity of cane juice varied from 86.6 to 88.1%. It was noted that the treatment T_2 recorded a comparatively higher purity percentage in juice (88.1%) and the minimum purity percentage in juice (86.6%) was recorded in treatment T_5 . The maximum CCS percent (12.05%) was obtained in treatment T_2 , however, it was statistically at par with T_6 (12.03%), T_7 (11.94%), and T_8 (11.84%) and the minimum CCS percent (11.02%) among the treatment was obtained with treatment T_5 .

The brix, pol, purity, and CCS percent are important juice quality parameters and total sugar yield depends on these parameters because all are related to produce final sugar yield (Table 4). Cane quality is greatly influenced by the prevailing environmental factors during the last phase of maturity. Analysis of quality parameters after harvest of ratoon cane showed that irrigation methods differ significantly with all quality parameters except purity percentage in juice where the treatment effect was non-significant (Table 4). Although, from the data presented in Table 4, it can be exhibited that drip-irrigated treatments increased most of the quality parameters. This might be

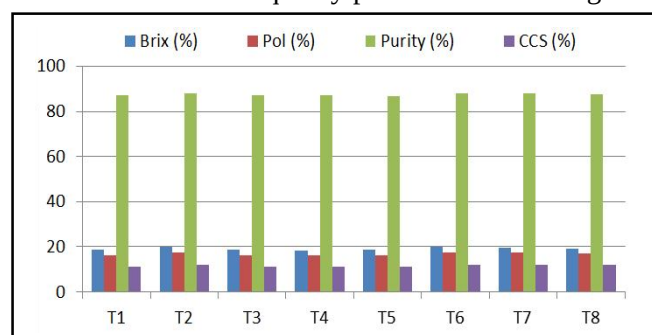


Fig. 11: Brix (%), Pol (%), Purity (%) and CCS (%) of sugarcane ratoon crop.

due to the application of the required amount of water that affects the quality parameters. These results conform by those of Resende *et al.*, (2025), (Raheja *et al.*, 2025), (Singh *et al.*, 2020), and Nagarjuna *et al.*, (2017). The purity percentage in the juice was found comparatively higher in (T_2) (88.1%), and the minimum purity percentage in juice (86.6%) was recorded in (T_5) differences among treatment.

Cane and sugar yield

The findings of cane yield (t/ ha) and sugar yield (t/ ha) data was calculated and showed in Table 5 and graphically depicted with (Fig. 12 & 13) respectively. There was a 15.4% reduction in cane yield to T_1 in comparison to T_2 . The maximum cane yield of 102.1 t/ ha was noted under T_2 which was significantly out yielded than T_1 (86.4 t/ ha), T_3 (77.3 t/ ha), T_4 (78.6 t/ ha), and T_5 (80.1 t/ ha) and statistically on par with T_6 , T_7 , and T_8 . The higher sugar yield was noted under treatment T_2 (12.3 t/ ha) which was comparable with T_6 (11.2 t/ ha), T_7 (11.1 t/ ha), and T_8 (11.1 t/ ha) and the lower sugar yield was noticed in T_3 (8.6 t/ ha).

The cane yield was showed a significant effect on different treatments during investigation (Table 5 and Fig. 12). The maximum cane yield was noticed with (T_2) (102.1 t/ ha) which was, however, comparable with (T_6) (93.1 t/ ha), (T_7) (93.3 t/ ha) and (T_8) (95.4 t/ ha). The higher cane yield in the drip irrigation system was since frequent water resulted in higher water potential thus reducing fluctuation of soil moisture and increase in millable canes which was responsible for higher tonnage. These findings conform by those of Resende *et al.*, (2025), (Raheja *et al.*, 2025), (Singh *et al.*, 2020), Bhuvaneshwari *et al.*, (2019), Gulve *et al.*, (2018) and Prabhakar *et al.*, (2018). The highest sugar yield was noticed under treatment T_2 (12.3 t/ ha), and it was comparable with T_6 (11.2 t/ ha), T_7 (11.1 t/ ha), and T_8 (11.1 t/ ha), while treatment T_3 (8.6 t/ ha) recorded the lowest sugar yield (Table 14). The sugar yield of sole sugarcane with drip irrigation (T_2) was 21.1% higher than

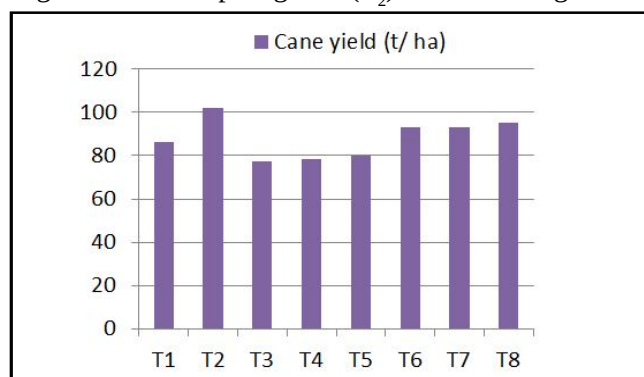


Fig. 12: Cane yield (t/ ha) of ratoon crop.

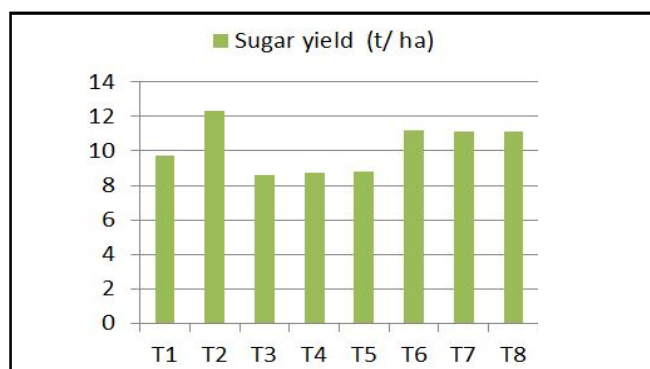


Fig. 13: Sugar yield (t/ ha) of ratoon crop.

sole sugarcane with surface irrigation. This might be due to the wastage of a considerable amount of nutrients through deep percolation Nagaraju *et al.*, (2017) also reported similar findings.

Water use

The mean data of investigation about of on water use by system showed in Table 6 and graphically presented (Fig. 14, 15 & 16). This indicates that in case of limited water availability, drip irrigation in sugarcane and micro-sprinkler for pulses crop taken as intercrops with sugarcane are beneficial in achieving higher net incomes per unit of water use. The drip and micro-sprinklers system resulted in the lowest water applied over surface method of irrigation including effective rainfall.

The maximum water requirement (126.92 cm) was recorded under treatment T_7 as compared to other treatments and minimum water requirement (73.85 cm) was recorded under treatment T_2 during the investigation. The water use efficiency ($\text{kg/ ha}^{-\text{cm}}$) was significantly maximum value (1382.53 $\text{kg/ ha}^{-\text{cm}}$) was noted under T_2 and the minimum value (708.60 $\text{kg/ ha}^{-\text{cm}}$) was noted in T_1 . The highest water productivity (13.83 kg/ m^3) was recorded under T_2 which was statistically on par with T_6 (12.12 kg/ m^3) and T_8 (12.07 kg/ m^3), and the lowest water productivity (7.09 kg/ m^3) was recorded under T_1 .

The results obtained from the experiment (Table 6 and (Fig. 14, 15 & 16)) revealed that though the water requirement was comparatively higher under the surface

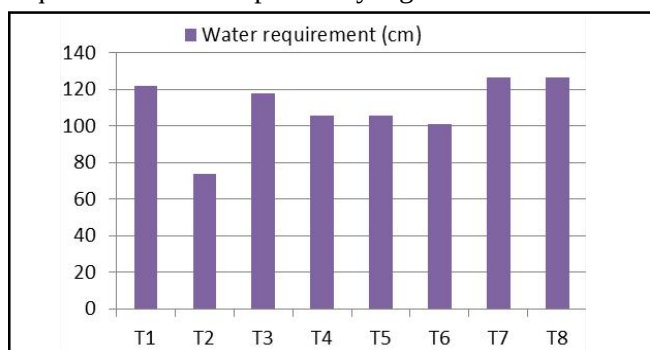


Fig. 14: Water requirement (cm).

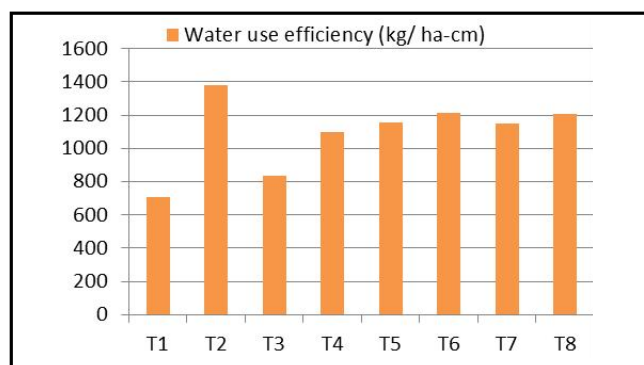


Fig. 15: Water use efficiency (WUE) ($\text{kg/ ha}^{-\text{cm}}$).

irrigation method, however, WUE and water productivity were comparatively higher with drip irrigation method, it was found that drip irrigation was economically better than surface irrigation method. The maximum water requirement (126.92 cm) was recorded under treatment T_7 over the rest of the treatments and the minimum water requirement (73.85 cm) was recorded under treatment T_2 during the study. The drip irrigation method of water management was found effective in sugarcane crop for increasing cane and sugar yield along with water-saving than surface irrigation. Significantly higher water use efficiency was observed with (T_2) (1382.53 $\text{kg/ ha}^{-\text{cm}}$) over other treatments and the lowest water use efficiency was observed with (T_1) (708.60 $\text{kg/ ha}^{-\text{cm}}$). All the treatments received irrigation by surface method recorded lower water use efficiency in comparison to drip irrigation. The increase in WUE with drip method of irrigation was due to effective utilization of available water by canes, which applied at regular intervals throughout the crop period. The results obtained are in a similar line to those reported by Resende *et al.*, (2025), Maheshawari (2018), Patil *et al.*, (2017), and Patil and Poddar (2016). The highest productivity of water (13.83 kg/ m^3) was recorded with (T_2) and which was statistically on par with (T_6) (12.12 kg/ m^3) and (T_8) (12.07 kg/ m^3), and the lowest water productivity (7.09 kg/ m^3) was recorded with (T_1). These findings were also found by Thompson *et al.*, (2016).

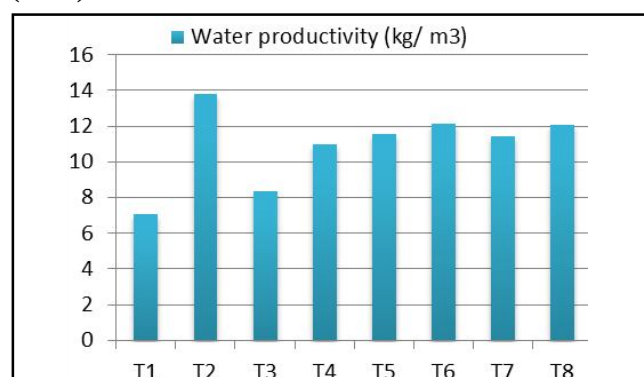


Fig. 16: Water productivity (kg/ m^3)

Conclusion

This investigation carried out with eight treatments, but sole sugarcane with drip irrigation (T_2) had significantly superior to enhanced growth parameters, yield attributes, and yield of sugarcane. However, cane diameter, single cane weight, and purity percentage in the juice were found non-significant. Sugarcane with drip irrigation + French bean – green gram with micro-sprinkler irrigation to both the intercrops + residue incorporation of green gram (T_8) recorded the maximum growth and yield of both the intercrops, and yield of intercrops and also increased productivity and profitability of intercrops. The minimum water requirement was recorded under treatment T_2 during the investigation. The water use efficiency ($\text{kg/ha}^{-\text{cm}}$) was significantly maximum value was noted under T_2 . The highest water productivity was recorded under T_2 which was statistically on par with T_6 and T_8 .

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