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Effect of Method of Irrigation and Intercropping on Yield and Profitability of Sugarcane

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ABSTRACT

An experiment on sugarcane was conducted at Research cum Instructional farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India during *rabi* season of 2016-17 to study the effect of intercropping and method of irrigation on growth, yield and economics of sugarcane. All the growth and yield attributes, cane yield (122.65 t ha^{-1}), intercrops yield, equivalent cane yield (165.50 t ha^{-1}), cost of cultivation (Rs 91772.00 ha^{-1}), net returns (Rs 404756 ha^{-1}), benefit cost ratio (4.4) and land utilization index (1108.88) were recorded significantly higher with drip fertiligation. In case of intercropping, sugarcane + onion (1:3) produced maximum cane yield (114.22 t ha^{-1}), equivalent cane yield (177.92 t ha^{-1}), net returns (Rs 441831 ha^{-1}), benefit cost ratio (4.8) and land utilization index (1210.56).

Keywords Sugarcane, Furrow irrigation, Drip fertiligation, Intercropping, Yield,

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INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) is an important commercial crop of the world and India ranks second among the sugarcane growing countries of the world in terms of both area and production after Brazil. India ranks second in area (20.4%) and production (18.6%) among sugarcane growing countries in World. In India, sugarcane is cultivated in an area of 5.04 million ha with production of 348.04 million tonnes of cane with average productivity of 69 t/ha (Anonymous 2014). Sugarcane being a giant crop producing huge quantity of biomass generally demands higher amounts of nutrient elements. A large number of research experiments have clearly demonstrated that for producing higher cane and sugar yields on a sustainable basis application of adequate amounts of fertilizer nutrients viz., N, P and K is essential. At the same time the cost of chemical fertilizers have increased and there is a need to improve fertilizer use efficiency for more benefits. The water requirement of sugarcane is very high. The micro irrigation methods offer ample opportunities of water saving and increasing water use efficiency. The best answer to this challenge is "Fertigation", where both water and fertilizers are delivered to crop simultaneously through a drip irrigation system. Fertigation ensures that essential nutrients are supplied precisely at the area of most intensive root activity according to the specific requirements of sugarcane crop and type of soil resulting in higher cane yields and sugar recovery. Intercropping of different crop with sugarcane have been reported advantageous in many parts of the country. It increases sugarcane yield with additional income of intercropping.

Table 1. Fertilizer application in intercrops.

Intercrops	Recommended dose of fertilizer (kg ha^{-1}) and method of application	Intercrops	Recommended dose of fertilizer (kg ha^{-1}) and method of application
Cowpea	25:50:50 N- 2 splits (Basal and at 30 DAS) P – Full dose as basal K- 2 splits (Basal and at pod formation stage)	Garlic and onion	100:50:50 N- 3 splits (Basal, at 25 DAS and 40 DAS) P and K – Full dose as basal
Potato	150:50:50` N- 3 splits (Basal, at 30 DAS and 50 DAS) P – 2 splits (Basalat and at 30 DAS) K- 2 splits (Basal and at 30 DAS)	Coriander	80:40:40 N- 3 splits (Basal, at 25 DAS and 50 DAS) P - 3 splits (Basal, at 25 DAS and 50 DAS) K - 3 splits (Basal, at 25 DAS and 50 DAS)
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Okra	80:60:60 N- 3 splits (Basal, at 30 DAS and 50 DAS) P - 3 splits (Basal, at 30 DAS and 50 DAS) K - 3 splits (Basal, at 30 DAS and 50 DAS)	Spinach	50:30:30 N- 2 splits (Basal and at 15 DAS) P - 2 splits (Basal and at 15 DAS) K - 2 splits (Basal and at 15 DAS)

MATERIALS AND METHODS

An experiment on sugarcane was conducted at Research cum Instructional farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India during *rabi* season of 2016-17 to study the effect of method of irrigation and intercropping on growth, yield and economics of sugarcane. Treatments of the experiment consisted of three irrigation methods (Flood furrow irrigation with soil application of 100 % RDF, Drip irrigation with soil application of 100 % RDF and Drip fertigation) in main plots and seven intercrops with sugarcane [Sugarcane + Garlic (1:3), Sugarcane + Onion (1:3), Sugarcane + Potato (1:2), Sugarcane + Cowpea (1:2), Sugarcane + Coriander (1:3) for leaf purpose, Sugarcane + Spinach (1:3) for leaf purpose and Sugarcane + Okra (1:2)] along with one treatment of sole sugarcane in sub plots. The experiment was laid out in strip plot design with three replication. Variety CO-86032 of sugarcane was sown on 13th December 2016 and the sowing of varieties G-282 (Garlic), Kufri chipsona (Potato), Lalita (Cowpea), Deepika (Okra), Nasik red N-53 (Onion), Haritima (Coriander) and All green (Spinach) of intercrops were completed on 23rd December 2016. Fertilizers were applied in intercrops as per Table 1. Sugarcane crop was harvested in mid November 2017 and intercrops were harvested from February to April 2017. The soil of experimental field was midland, Inceptisol (Sandy loam) having low available nitrogen (159.40 kg ha^{-1}), medium phosphorus (8.2 kg ha^{-1}) and potassium (248.24 kg ha^{-1}) with normal pH (6.9). The 100 % recommended dose of fertilizers (RDF) was 250:100:150kg N, P_2O_5 and K_2O ha^{-1} and 10 t FYM ha^{-1} was also applied. Fertilizer application under drip fertigation was as per given fertigation schedule for sugarcane in Table 2.

Table 2. Fertigation schedule for sugarcane.

Sugar cane growth stages	Days	No. of fertigation	Urea (kg/ha)	MAP (kg/ha)	MOP (kg/ha)
Germinations (16-45)	30	7	8.60	2.60	1.79
Tillering (46-90)	45	11	16.42	3.31	2.27
Grand growth (91-180)	90	22	5.47	4.14	3.41
Maturity stage (181-240)	60	15	2.01	1.21	5.83
	Total	55	391.30	163.93	200.00

Above fertigation schedule- Every eourth day.
Magnesium sulphate – Once in a month- 5 kg/100 liter through drip.
First dissolves MOP (White), then urea and then MAP (Mono ammonium phosphate) with double quantity of water.

Table 3. Effect of methods of irrigation and intercropping on growth and yield of sugarcane.

Treatment.	Cane length (cm)	No. of tillers m^{-1} row length	Cane girth (cm)	Length of internodes (cm)	No. of nodes $plant^{-1}$	Millable cane ($1000\ ha^{-1}$)	Cane yield ($t\ ha^{-1}$)
Methods of irrigation							
Flood furrow irrigation with soil application of 100% RDF	341.49	20	7.68	14.57	18	113	81.90
Drip irrigation with soil application of 100% RDF	354.58	22	7.92	14.83	19	128	115.19
Drip fertigation	359.90	24	8.34	15.28	19	141	122.65
SEm ±	2.48	0.15	0.6	0.08	0.08	0.95	0.35
CD (at 5%)	8.26	0.51	0.21	0.28	0.28	3.17	1.18
Intercrops							
Sugarcane + Spinach (1:3)	340.52	20	7.58	14.62	19	112	103.18
Sugarcane + Onion (1:3)	351.27	24	8.25	15.67	18	132	114.22
Sugarcane + Okra (1:2)	341.49	19	8.00	14.51	19	123	100.81
Sugarcane + Potato (1:2)	369.46	24	8.31	14.97	18	135	111.86
Sugarcane + Coriander (1:3) leaf	365.09	22	7.85	14.56	20	126	102.25
Sugarcane + Garlic (1:3)	325.69	22	7.77	14.62	18	121	101.07
Sugarcane + Cowpea (1:2)	355.94	21	7.55	14.44	20	131	106.31
Sole sugarcane	366.45	25	8.51	15.77	18	140	112.96
SEm ±	5.41	0.53	0.13	0.17	0.33	2.08	1.32
CD (at 5%)	16.41	1.61	0.41	0.53	1.01	6.30	3.99

RESULTS AND DISCUSSION

Growth, yield, economics and land utilization index were affected significantly due to different methods of irrigation and intercropping (Tables 3-4).

Growth and yield

Cane length was significantly affected by methods of irrigation and intercropping. Higher cane length was recorded with drip fertigation (359.90 cm) which was at par with drip irrigation along with soil application of 100 % RDF (Recommended dose of fertilizers) (354.58 cm). Lowest cane length was observed under flood furrow irrigation along with soil application of 100 % RDF. In case of intercropping, higher cane length was noted with sugarcane + potato (1:2) (369.46 cm) and it was statistically at par with sugarcane + coriander leaf (1:3), sugarcane + cowpea (1:2) and with sole sugarcane.

Significantly higher number of tillers per meter row length (24), cane girth (8.34 cm) and length of internodes (15.28 cm) were recorded under drip fertigation as compared to drip irrigation and flood furrow irrigation along with soil application of 100 % RDF. In case of intercropping, higher number of tillers per meter row length (25), cane girth (8.51 cm) and length of internodes (15.77 cm) were recorded with sole sugarcane. However, it was at par with intercropping sugarcane + onion (1:3) and sugarcane + potato (1:2).

Similar number of nodes $plan^{-1}$ were recorded with drip fertigation (19) and drip irrigation along with soil application of 100 % RDF (19) which were significantly higher over flood furrow irrigation along with soil application of 100 % RDF. In case of

Table 4. Effect of methods of irrigation and intercropping on economics of sugarcane.

Treatments	Intercrops yield (q ha^{-1})	Equivalent cane yield (t ha^{-1})	Cost of cultivation (Rs ha^{-1})	Net returns (Rs ha^{-1})	Benefit cost ratio	Land utilization index = (Net returns /365)
Methods of irrigation						
Flood furrow irrigation with soil application of 100% RDF	71.9	117.98	79446	274463	3.4	751.96
Drip irrigation with soil application of 100% RDF	78.2	158.03	89446	384641	4.3	1053.83
Drip fertigation	81.7	165.50	91772	404756	4.4	1108.88
SEm ±	0.42	0.47	-	-	-	3.89
CD (at 5%)	1.39	1.58	-	-	-	13.01
Intercropping						
Sugarcane + Spinach (1:3)	138.9	158.72	85784	390412	4.5	1069.44
Sugarcane + Onion (1:3)	136.4	177.92	91858	441831	4.8	1210.56
Sugarcane + Okra (1:2)	44.3	134.06	83542	318635	3.8	873.00
Sugarcane + Potato (1:2)	117.8	151.11	96767	356594	3.7	977.00
Sugarcane + Coriander (1:3) leaf	128.6	153.67	85788	375215	4.4	1028.00
Sugarcane + Garlic (1:3)	32.6	168.34	89844	415224	4.6	1137.56
Sugarcane + Cowpea (1:2)	19.4	120.57	83512	278182	3.3	762.22
Sole sugarcane	0.0	112.96	78007	260866	3.3	714.67
SEm ±	0.74	1.33	-	-	-	10.94
CD (at 5%)	2.25	4.04	-	-	-	33.18

intercropping, similar number of nodes plant^{-1} were noted with sugarcane + coriander leaf (1:3) (20) and with sugarcane + cowpea (1:2) (20) which were statistically at par with sugarcane + spinach (1:3) and sugarcane + okra (1:2).

Significantly higher number of millable cane (141 thousand ha^{-1}), cane yield (122.65 t ha^{-1}), intercrops yield (81.7 q ha^{-1}) and equivalent cane yield (165.50 t ha^{-1}) were recorded with drip fertigation as compared to rest of the treatments. Pawar *et al*. (2013) also reported superiority of drip fertigation over conventional method in terms of sugarcane yield. In case of intercropping, higher number of millable cane (140 thousand ha^{-1}) was noted with sole sugarcane and it was at par with sugarcane + potato (1:2). Higher cane yield (114.22 t ha^{-1}) was recorded with sugarcane + onion (1:3) which was statistically at par with sole sugarcane (112.96 t ha^{-1}) and sugarcane + potato (1:2) (111.86 t ha^{-1}). These results are in conformity of the findings of Zarekar *et al.* (2017) minimum cane yield was recorded with sugarcane + okra (1:2).

Maximum intercrops yield was noted with sugarcane + spinach (1:3) (138.9 q ha^{-1}) and minimum intercrops yield was recorded with sugarcane + cowpea (1:2) (19.4 q ha^{-1}). Maximum equivalent cane yield (177.92 t ha^{-1}) was observed with sugarcane + onion (1:3), whereas, the minimum equivalent cane yield was recorded with sole sugarcane.

Economics and land utilization

Maximum cost of cultivation (Rs 91772.00 ha^{-1}), net returns (Rs 404756 ha^{-1}), benefit cost ratio (4.4) and land utilization index (1108.88) were recorded with drip fertigation as compared to flood furrow and drip irrigation along with soil application of 100 % RDF. The results are in conformity as reported by Pawar *et al.* (2013). In case of intercrops, maximum cost of cultivation was incurred with sugarcane + potato (1:2) (Rs 96767 ha^{-1}) and minimum with sole sugarcane (Rs 78007 ha^{-1}). Maximum net returns (Rs 441831 ha^{-1}), benefit cost ratio (4.8) and land utilization index (1210.56) were recorded with sugarcane + onion (1:3). Singh (2018) also recorded maximum income (38%) under sugarcane + onion intercropping system and the second highest income (26.73%) under sugar-

cane + potato intercropping. Whereas, the minimum net returns, benefit cost ratio and land utilization index were recorded under sole sugarcane.

All the parameters viz., cane length, number of tillers per meter row length, cane girth, length of internodes, number of nodes per plant, number of millable canes ha^{-1}, cane yield, intercrops yield, equivalent cane yield, cost of cultivation, net returns, benefit cost ratio and land utilization index were recorded minimum with flood furrow irrigation with application of 100 % RDF.

CONCLUSION

All the growth and yield attributes, cane yield (122.65 t ha^{-1}), intercrops yield, equivalent cane yield (165.50 t ha^{-1}), cost of cultivation (Rs 91772.00 ha^{-1}), net returns (Rs 404756 ha^{-1}), benefit cost ratio (4.4) and land utilization index (1108.88) were recorded significantly higher with drip fertigation.

In case of intercropping, sugarcane + onion (1:3) produced maximum cane yield (114.22 t ha^{-1}), equivalent cane yield (177.92 t ha^{-1}), net returns (Rs 441831 ha^{-1}), benefit cost ratio (4.8) and land utilization index (1210.56).

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