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Production potential and profitability of autumn sugarcane-based intercropping systems as influenced by intercrops and row spacing

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ABSTRACT

A field experiment was conducted during 2000–2002 at Pantnagar, Uttaranchal, to study the feasibility of various intercrops with autumn sugarcane. Treatments comprising 12 combinations, 6 cropping systems, *viz.* sole sugarcane, sugarcane + lentil/mustard/maize/*rajmash*/rapeseed, as intercrop and 2 row spacings for sugarcane planting, *viz.* 75 cm, and 90 cm were tested in randomized block design. All the intercrops except maize, reduced cane yield attributed to decline in number of millable canes. Mean reduction in cane yield was 8.7% with lentil, 14.8% with mustard, 13.3% with *rajmash* and 8.7% with rapeseed. Sugarcane planted at 90 cm spacing produced 9.5% higher cane yield than that at 75 cm. Sugarcane + maize gave the highest mean cane-equivalent yield (200.6 tonnes/ha) being 52.5, 45.4, 55.7, 50.0 and 48.6% higher than sole sugarcane and its intercropping with lentil, mustard, *rajmash* and rapeseed, respectively. Sugarcane intercropped with maize gave highest net return of Rs 124,874/ha followed by sugarcane alone (Rs 71,145) as against Rs 62,104; 65,067; 67,138 and 69,040 with intercropping of mustard, *rajmash*, rapeseed and lentil respectively. Row spacing for sugarcane of 90 cm gave higher cane equivalent yield and monetary return over 75 cm.

[lentil : *Lens culinaris* Medikus; mustard : *Brassica juncea* (L.) Czernj. & Cosson; maize; *Zea mays* L.; *rajmash: Phaseolus radiatus* L.; rapeseed: *Brassica napus*]

Key words : Sugarcane, Intercropping, Row spacing, Yield, Monetary returns

Sugarcane a major cash crops of India is planted in autumn, spring and late spring seasons in North India. Area under autumn crop is however very low despite the fact it yields 25–30% more than spring cane and 40–50% more than late spring-planted crop. Moreover, farmers do not sacrifice winter (*rabi*) crop at the cost of autumn cane with delayed germination and very slow growth in winter months rendering the resources under-utilized. Intercropping of compatible *rabi* crops can prove a good option to optimize resource use. Selection of crops and space complimentarity however, play a vital role in accruing advantages under intercropping systems. Thus the present investigation was undertaken to study the feasibility of cereals, legumes and oilseeds with autumn sugarcane under different row spacings.

MATERIALS AND METHODS

The field experiment was conducted during 2000–2001 at Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttaranchal. The experimental soil was silty clay loam, rich in organic carbon, medium in available phosphorus and potassium, and neutral in soil reaction. Treatments comprising 12 combinations of 6 cropping systems, *viz.* sole sugarcane, sugarcane + lentil/mustard/maize/*rajmash*/rapeseed, as intercrop and 2 row spacings for sugarcane planting, *viz.* 75 cm and 90 cm, were tested in randomized block design with 3 replications. Autumn cane ('Co-Pant 90223') was planted in first fortnight of October. Two rows each of lentil ('PL 4') and *rajmash* ('PDR 14') and 1 row of maize ('Hybrid 4212'), mustard ('Kranti') and rapeseed ('PT 303') were sown between 2 rows of sugarcane. Lentil was sown on 21 November, whereas other intercrops were sown a day after cane planting. Sugarcane was fertilized with 150, 80 and 60 kg/ha of N, P, and K, whereas intercrops were given NPK based on their population ratio in sole and intercropping situations. Maize was grown for cobs and other intercrops for grain purpose. Lentil, mustard, rapeseed, maize, *rajmash* and sugarcane were harvested on 18 April, 3 March, 17 February, 7 March and 25 November during both the years respectively. Sugarcane was given with full doses of phosphorus and potassium and half of nitrogen

as basal and half nitrogen after harvest of intercrops.

RESULTS AND DISCUSSION

Cropping system

Intercrops had significant effect on yield and yield attributes of sugarcane (Table 1). All the intercrops except maize led to decline in cane yield, though the reduction was significant only with lentil (8.7%), mustard (14.8%) and *rajmash* (13.3%). Shading effect of mustard and its late harvesting might have resulted in such a decline. *Rajmash* though a leguminous crop it did not fix atmospheric nitrogen and might have released some allelochemicals leaving adverse affect on sugarcane. Lentil, maize and rapeseed were harvested early and hence did not have shading effect on sugarcane during its grand growth phase. Gulati *et al.* (1995) also recorded significant decline in cane yield with mustard intercropping. Number of milliable canes also followed the similar trend, being highest in sole stand and declined by 7.5, 12.8, 1.5, 17.3, and 6.8% with lentil, mustard, maize, *rajmash* and rapeseed respectively. The heaviest cane was recorded in crop intercropped with lentil attributed to no shading effect and nitrogen fixation resulted in better opportunity to canes to grow and develop. Reduction in number of millable canes was attributed to poor shoot proliferation under intercropping situation as a result of higher inter- specific competition. Shoot height was, however, higher under intercropping situation due to high plant density.

Commercial cane sugar yield, a function of cane yield and juice sucrose, exhibited a trend similar to cane yield.

Table 1. Effect of cropping systems and row spacing on growth, yield and quality of sugarcane

Treatment	Shoot population ('000/ha) at		Shoot height (cm)		Number of millable canes ('000/ha)	Cane weight (g)	Cane yield (tonnes/ha)	Juice sucrose (%)	Commercial cane sugar (tonnes/ ha)
	HI	MT	HI	MT					
Cropping system									
Sugarcane sole	162	291	75	95	133	1,328	131.5	16.4	13.6
Sugarcane + lentil	138	230	87	101	123	1,527	120.0	16.2	12.1
Sugarcane + mustard	158	236	80	97	116	1,476	112.0	16.4	11.6
Sugarcane + maize	166	307	87	99	131	1,460	131.0	16.3	13.3
Sugarcane + *rajmash*	114	202	77	93	110	1,442	114.0	16.6	11.8
Sugarcane + rapeseed	162	228	77	88	124	1,355	120.0	16.1	12.2
CD (P=0.05)	18	24.8	9.5	8.0	14	78	16.5	0.3	1.5
Row spacing (cm)									
75	164	286	83	97	118	1,427	116.0	16.2	11.8
90	136	212	78	94	127	1,436	127.0	16.5	13.0
CD (P=0.05)	14	18	NS	NS	8	NS	10.0	NS	1.0

HI, Harvest of intercrops; MT, maximum tillering

Table 2. Effect of cropping systems and row spacing on cane equivalent yield (tonnes/ha) and monetary return in sugarcane-based intercropping system

Treatment	Cane-equivalent yield (tonnes/ha)	Cost of cultivation (Rs/ha)	Net return (Rs/ha)	Net return (Rs/ha/day)	Benefit : cost ratio
Cropping system					
Sugarcane sole	131.5	53,780	71,145	167	1.32
Sugarcane + lentil	138.0 (10.7)	62,060	69,040	162	1.11
Sugarcane mustard	128.8 (12.3)	60, 256	62,104	146	1.03
Sugarcane + maize	200.6 (165.3)	65,6961	124,874	294	1.90
Sugarcane + *rajmash*	133.7 (8.5)	61,948	65,067	153	1.05
Sugarcane + rapeseed	135.0 (11.0)	611,120	67,138	158	1.10
CD (P=0.05)	11.2	8,056	24		
Row spacing (cm)					
75	141.2	62,017	72,123	170	1.16
90	148.0	59,600	81,000	190	1.36
CD (P=0.05)	NS	3,562	17		

Values in parentheses are intercrops yield (q/ha)

Highest commercial cane sugar yield (13.6 tonnes/ha) was obtained from sugarcane which reduced by 11.0, 14.7, 2.2, 13.2 and 10.3% with lentil, mustard, maize, *rajmash* and rapeseed respectively. Juice sucrose declined significantly with lentil and rapeseed as intercrops. Increased availability of nitrogen might have increased invertase activity and hence low sucrose per cent. Rana and Saini (1989) also reported an increase in invertase activity with increasing nitrogen supply.

Sugarcane + maize intercropping gave significantly highest cane-equivalent yield, being 52.5, 45.4, 55.7, 50.0 and 48.6% higher than sole sugarcane and its intercropping with lentil, mustard, *rajmash* and rapeseed respectively (Table 2). This might have been due to additional yield from maize without adverse effect on sugarcane and good price of maize cobs in the market. Singh and Chaudhary (1996) also recorded higher cane-equivalent yield with maize intercropping.

Row spacing

Row spacing had significant effect on cane yield (Table 1). Sugarcane planted at 95 cm spacing yielded 9.5% higher than that planted at 75 cm. The higher yield under wider planting was mainly attributed to higher number of millable canes and shoot population recorded at harvest and maximum tillering stages. Lower orders of intra- and inter-specific competition under 90 cm spacing might have provided better opportunity in respect of nutrient and water availability. Juice sucrose remained statistically unaffected due to row spacing; however, marginally higher content was recorded under wide spacing of 90 cm. Commercial cane sugar yield followed the trend similar to cane yield, the major determinant.

Cane-equivalent yield did not exhibit significant variation under different row spacings, though it was 4.8% more under 90 cm. Wider planting gave significantly higher net return (Rs 81,000/ha) owing to higher cane-equivalent and low cost of cultivation. Net return/ha/day was 1.36 under 90 cm and 1.16 under 75 cm spacing.

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