Pakistan J. Sci. Ind. Res., Vol. 30, No. 12, December 1987

YIELD AND QUALITY OF AUTUMN PLANTED SUGARCANE AS AFFECTED BY GEOMETRY OF PLANTING AND INTERCROPPING

Riaz Ahmed, M. Shafi Nazir, Guzanfar Ali and Tariq Mahmood

Department of Agronomy, University of Agriculture, Faisalabad

(Received February 22, 1987; revised November 3, 1987)

Some newly designed patterns of planting sugarcane facilitating intercropping were tested in a replicated field trial, using wheat and berseem as intercrops. The planting patterns comprised 90, 120 and 150 cm apart double, triple and quadruple row strips, respectively with 30 cm space between the rows of each strip. The results revealed that all the three planting systems appeared to be equally good with regards to germination, cane thickness and sucrose contents in cane but differed significantly from one another in respect of cane length, number of harvestable cane/unit area and final cane yield/ha. Sugarcane planted in 3-row strips 120 cm apart gave the higest cane yield of 93.67 tonnes/ha as against 88.49 and 85.95 tonnes/ha for 2-row and 4-row strip planting systems, respectively. Sugarcane intercropped with berseem gave significantly lower cane yield/ha than that intercropped with wheat or non-intercropped sugarcane. The reduction in cane yield/ha as a result of berseem and wheat intercropping amounted to 16.38 and 2.94 percent, respectively. However, at the cost of this reduction, an additional harvest of 68.54 to 71.09 tonnes/ha of berseem green fodder and 2.25 to 2.43 tonnes of wheat grain ± 3.64 tonnes of wheat bhoosa/ha was obtained which compensated more than the loss in cane production.

Key words: Sugarcane, Intercropping, Planting geometry.

INTRODUCTION

Sugarcane is an important sugar crop of Pakistan and is mainly grown in the spring season. Now-a-days some people have started cultivating sugarcane in autumn as it is considered to be a more productive practice compared to conventional spring planting. Since this practice will keep the field under sugarcane for a longer period, it is highly imperative to develop information on the feasibility of intercropping in sugarcane with a view to make good use of soil and irrigation resources besides increasing productivity per unit area and time. The growing interest of planting sugarcane in autumn has made it possible to intercrop wheat or berseem in it. However, present method of planting sugarcane in 60 cm apart rows is not suitable and inconvenient for intercropping because of narrow row spacing. So there is need to develop such a system of planting which may make it convenient to intercrop wheat or berseem in autumn cane without adversely affecting the final cane yield. Recently some new methods of planting sugarcane facilitating intercropping and other agronomic operations have been designed which need to be tested both in term of feasibility and yield performance.

Consequently the present study was taken up to evaluate the feasibility and productive efficiency of the newly suggested geometry of planting sugar-cane in autumn as against the conventional method of planting at constant plant population using wheat and berseem as intercrops.

Review of literature

Nour *et al.* [9] found that a spacing of one metre between the rows and one row of seed material amounting to 1.5 tonnes/ha gave the maximum sugar production. Fasihi *et al* [3] studied the effect of sub-soiling and row spacing on the yield and quality of sugarcane variety BL-4. The crop was planted on flat at row distance of 60, 90 and 120 cm and in trenches at 120 cm row distance using the seed rate of 75,000 double budded setts per hectare. The results showed that planting at 60 cm was better than 90 cm and 120 cm spacings in respect of germination, tillering and number of cane stalks per hectare. Kanwar and Sharma [5] in a comparison of 5 inter-row spacings (60, 90, 120, 150 and 180 cm) observed higher tiller population in closer spacings, while thicker cane and more sucrose contents in wider spacings. Ramos [11] stated that 90 cm spacing gave significantly higher cane yield than the standard 150 cm. Gowhane and Patil [4] reported that intercropping sugarcane crop with hybrid maize reduced the cane yield by 15 tonnes/ha, while juice quality was slightly improved. Narwal and Behl [7]

observed that the cane yield was the highest (627.6 Q/ha) when the sugarcane was planted at 60 cm apart rows and intercropped with moong, while the lowest of 448.2 Q/ha was obtained from the cane planted in rows 90 cm apart and intercropped with Okra. Rathi and Singh [12] reported that highest cane yields were obtained with sugarcane + potato followed by onion. However, juice quality was not affected at all. Shanmugasandarum and Venugopal [14] conducted experiment in different regions of India and concluded that for high and low yielding cane varieties a row spacing of 105 and 60 cm, respectively was the optimum while the optimum seed rate varied between 25,000 3 budded setts to 1,25,000 2-budded setts/ha depending on air temperature and soil moisture during the early growth period. Nour *et al* [10] reported that when the sugarcane CV. G.T. 54-9 was planted in September and inter planted with onion two months later, the cane yield was reduced slightly, but the net income increased by about £ 212 per feddan (1.038), while sucrose and purity percentage remained unaffected. Sethi and Parashar [13] reported that each intercrop (moong, cow peas and soybean) reduced the cane yield over sugarcane alone. However, sugarcane + cow-peas proved highly profitable. Arfins [1] found that cane yield was increased 12% by onion, intercropping lowered 4% by groundnut, 16% by sesamum and sweet potato and 4% by cotton, while mung bean had no effect. However, non of the intercrops affected the sucrose contents in cane. Dhouble and Khuspe [2] intercropped sugarcane with groundnut, onion, clusterbean, maize and observed that sugarcane + onion gave the highest net profit/ha, while sugarcane + clusterbeans was the second highest. Leclezio *et al* [6] reported that intercropping sugarcane with *P. vulgaris* reduced the tiller development, leaf area and dry matter production. Nazir *et al* [8] suggested that sugarcane should be planted in double or triple row strips 90 or 120 cm apart, respectively as it facilitates interculture and intercropping without too much intercrop competition.

MATERIALS AND METHODS

The study was conducted at the Agronomic Research Area, University of Agriculture, Faisalabad on a sandy clay loam soil. The experimental treatments comprised planting geometry of sugar cane *viz.* 2-row strips 90 cm apart, 3-row strips 120 cm apart and 4-row strips 150 cm apart with 30 cm space between the rows of each strip, and three intercropping systems were used i.e. no intercropping, intercropping berseem in between the strips and intercropping wheat in between the strips of sugarcane. The experiment was laid out in split plot design using four replications and randomizing the planting geometry and the intercropping systems in the main and subplots, respectively. Each plot measured 7.20 x 4.80 m. A recommended sugarcane variety BL-4 was used as a medium of the trial. The crop was planted on October 27, 1980 and the seed rate used was 1,04,166 two budded setts/ha in all the treatments. Wheat as an intercrop was planted in 30 cm apart lines in between the strips on October 29, using a seed rate of 60 Kg/ha while berseem was intercropped on November 7 by broad cost, using a usual seed rate of 20 kg/ha. A basal dose of 100 kg P_2O_5/ha was applied at the time of planting sugarcane while 100 kg N/ha as urea was top dressed after taking the last cutting of berseem and harvesting wheat. The cane crop was harvested manually on November 25, 1981 and the data on number of millable canes was recorded from a unit area of 7.20 x 4.80 m in all the treatments. The individual observations on cane length, cane girth and weight per cane based on twenty canes taken at random from each plot. Five out of these twenty canes, were taken to the laboratory for sucrose determination. Sucrose percentage was determined by Horne's Dry Lead Acetate method for sugar analysis. The data were analysed statistically by using analysis of variance technique and Duncan's New Multiple Range Test at 5% probability was used to test the significance of the data (Steel and Torrie [15].

RESULTS AND DISCUSSION

The data pertaining to different yield parameters and sucrose contents in cane Table 1, revealed that there was significant difference among various intercropping treatments with regard to number of millable canes per unit area. Sugar cane alone produced significantly more number of millable canes per unit area than that intercropped with berseem but was at par with that intercropped with wheat In other words, intercropping of wheat in between the strips of sugarcane had little effect on the tillering potential of sugarcane (3.38%) while berseem intercropping reduced the tillering capacity by 13.37% compared to non-intercropped sugarcane. As regards planting geometry, all the three planting systems appeared to be statistically at par with one another in respect of tillering irrespective of their variable space adjustment. However, relatively lesser number of millable cane in plots planted in the pattern of 4-row strips 150 cm apart was attributed to comparatively poor tillering of plants growing in the central two rows of the strip, partly due to hard competition because of over lapping of the plants roots in a limited area and partly as a result of mutual over shading of the crop plants.

Table. 1. Yield parameters, cane yield and sucrose contents in cane as affected by geometry of planting and intercropping of wheat and berseem.

	No. of millable canes/unit area (7.20 x 4.80 m)	Cane length (m)	Cane girth (cm)	Weight/cane (kg)	Cane yield tonnes/ha	Sucrose contents in cane (%)
A. *Planting patterns*						
P_1 Planting in 2-row strips 90 cm apart.	378^{NS}	1.87 a[1]	2.21^{NS}	0.77^{NS}	84.23 ab[1]	14.49^{NS}
P_2 Planting in 3-row strips 120 cm apart	395	1.98 b	2.23	0.77	88.05 a	14.75
P_3 Planting in 4-row strips 150 cm apart.	375	1.84 a	2.20	0.76	78.47 b	14.42
B. *Intercropping*						
T_1 No intercropping	405 a	1.92^{NS}	2.25^{NS}	0.76^{NS}	89.33 a$^{(1)}$	14.56^{NS}
T_2 Berseem intercropping	351 b	1.89	2.19	0.77	74.71 b	14.34
T_3 Wheat intercropping	391 a	1.88	2.20	0.77	86.71 a	14.75

NS = Non Significant.
(1) Means followed by same letter do not differ significantly at five percent.

The data on cane length indicated significant difference among the three planting patterns under study. Planting in 3-row strips 120 cm apart produced significantly longer cane than that of 2-row and 4-row strip planting systems which were at par with each other. However, the differences among intercropping treatments were non-significant. Similarly cane girth varied little as a result of planting geometry and intercropping treatments and it ranged between 2.20 to 2.23 cm. The reason for nonsignificant differences in cane thickness was attributed to variable cane stand of the intercropped and non--intercropped treatments. Relatively lower cane stand in the 4-row strip planting and in the intercropped treatments enabled them to produce individual cane comparable to rest of the treatments as a result of relatively more nutritional area per cane. These results are contradictory to those of Kanwar and Sharma [5] who observed thicker cane and more sucrose contents at wider space.

It is evident from Table 1 that weight per cane was not affected appreciably by the different planting and intercropping treatments and it varied from 0.76 to 0.77 kg per cane. The results further indicated that although intercropping of berseem and wheat in 2, 3 and 4-row strip planting systems reduced tillering over sugarcane alone but the growth and development of individual plants was made up to a considerable extent probably due to compromising effect of cane stand per unit area and the size of nutritional area per cane at later stage. Almost similar results were reported by Kanwar and Sharma [5].

The date pertaining to cane yield/ha indicated that cane yield was influenced significantly by the different planting and inter cropping treatments under study. Sugar cane planted in 3-row strips 120 cm apart gave significantly higher cane yield than 4-row strip planting but was at par with 2-row strip planting which in turn did not differ from 4-row strip planting to a considerable extent.

As regard inter-cropping treatments, significant differences were observed among them. Sugarcane intercropped with berseem gave significantly lower cane yield than that intercropped with wheat or sugar cane alone. The reduction in cane yield was, however, more pronounced in case of berseem intercropping (16.3%) compared to wheat intercropping (2.94%). The yield difference between the wheat intercropped and non-intercropped cane was, however,

Table 2. Economic aspects.

		Yields tonnes/ha			Income/ha			Total income	Additional cost incurred on seed, sowing & harvesting of berseem and wheat	Net income	Average
		Cane	Berseem	Wheat	Cane	Berseem	Wheat + Straw				
A.	*Planting geometry*										
P_1	2-row strip planting alone	88.49	–	–	19910.00	–	–	19910.00	–	19910.00	–
	2-row strip planting + berseem.	78.33	71.09	–	17624.00	8886.00	–	26510.00	1640.00	24870.00	22591.00
	2-row strip planting + wheat	85.89	–	2.29	19325.00	–	4007.00 +772.00	24105.00	1113.00	22992.00	
P_2	3-row strip planting alone	93.57	–	–	21053.00	–	–	21053.00	–	21053.00	
	3-row strip planting + berseem	81.67	69.50	–	18375.00	8687.00	–	27062.00	1640.00	25422.00	23362.00
	3-row strip planting + wheat	88.89	–	2.26	20000.00	–	3955.00 +763.00	24717.00	1106.00	23611.00	
P_3	4-row strip planting alone	85.95	–	–	19339.00	–	–	19339.00	–	19339.00	
	4-row strip planting + berseem	67.04	68.54	–	15084.00	8567.00	–	23651.00	1640.00	22011.00	21495.00
	4-row strip planting + wheat	85.34	–	2.43	19202.00	–	4252.00 +820.00	24274.00	1144.00	23134.00	
B.	*Intercropping*										Increase over no inter-cropping
T_1	No intercropping	89.33	–	–	20099.00	–	–	20099.00	–	20099.00	
T_2	Berseem intercropping	74.71	69.71	–	16810.00	8714.00	–	25524.00	1640.00	23884.00	+3785.00
T_3	Wheat intercropping	86.71	–	2.33	19510.00	–	4077.00 +786.00	24373.00	1122.00	23251.00	+3152.00

Cane Price = Rs. 225.00/tonnes
Berseem green fodder = Rs. 125.00/tonne
Wheat grain = Rs. 1750.00/tonne
Wheat straw = Rs. 225.00/tonne

Berseem
Berseem seed 20kg/ha @ Rs. 20/kg = 400.00
Sowing charges/ha 2 men @ Rs. 20.00/man = 40.00
Harvesting charges 20/men/cuttin @ Rs. 20.00/man 3 cutting = 1200.00
Total = Rs. 1640.00

Wheat
Wheat seed 60 kg/ha @ Rs. 1.75/kg = 105.00
Wheat sowing charges
i) 2 men @ Rs. 20.00/man = Rs. 40.00
ii) One pair of bullocks @ Rs. 30.00 = 30.00
Wheat harvesting charges = 250 kg/ha @ Rs. 1.75 kg = 437.00
Wheat threshing @ 5kg 510.00 40 kg grain = Rs. 291.25 kg

non-significant. The berseem as an intercrop reduced the yield of associated cane crop substantially by adversely affecting its tillering capacity as a result of hard competetion between two associated crops for essential growth factors, while wheat as an intercrop did not appear to be a hard competitive and showed very little side effects on tillering and yield/ha of the associated cane crop. However, at the cost of these reductions additional harvests of 68.54 to 71.09 tonnes/ha berseem fodder and 2.25 to 2.43 tonnes of wheat grain + 3.64 tons wheat bhoosa/ha were obtained which compensated much more than the reduction in cane yield of the respective treatments. In the light of these results it is suggested that sugar cane should preferably be planted in 3-row or 2-row strips 120 cm and 90 cm apart, respectively with 30 cm space between the rows and that wheat or berseem as intercrop may be grown in between the strips for increasing production per unit area and time. Besides, sufficient space between the strips of cane facili-

tates not only convenient, interplanting and handling of the intercrops but also permits easy and free working of the inter tillage devices especially bullocks drawn implements, and sound earthing up without damaging the crop roots, which helps preventing lodging and saving irrigation water. These findings are partially in accordance with the results reported by Fasihi *et al* [3], Ramos [11], Tang (1977), Narwal and Behl [7], Sethi and Parashar [13] Arfine [1] and Nazir *et al* [8].

A perusal of Table 1 indicated sucrose contents in cane were not affected to a significant extent by both the planting and intercropping treatments under study. The sucrose contents in cane varied from 14.34 to 14.75 percent. These results are supported by the findings of Nour *et al* [9] and Arfins [1].

As regards economic aspects, (Table 2) sugarcane planted in the patterns of 3-row strips 120 cm apart gave the highest income of Rs. 23362.00 as against Rs. 22591.00 and Rs. 21495.00 for 2-row strip and 4-row strip planting systems, respectively. Sugar cane intercropped with berseem invariably gave higher net income per hectare than that intercropped with wheat and sugarcane alone. Considering the intercropping treatments separately, the highest income of Rs. 23884.00/ha was obtained from berseem intercropping as against Rs. 23251.00 and Rs. 20099.00/ha in case of wheat intercropping and no intercropping treatments, respectively. The results further suggested that intercropping berseem or wheat in autumn planted cane is a profitable practice provided strip planting geometry is adopted as, it not only helps minimizing the inter-crop competition but also facilitates interplanting and handling of the intercrops. However, out of the 2 intercrops studied, berseem appeared to be better than wheat. This combination besides giving the highest income per unit area, leaves the soil in good physical and more productive condition by adding biologically fixed nitrogen and organic matter. Almost similar results were reported by Sethi and Parashar [13], Arfins [1], Dhouble and Khuspe [2] and Nazir *et al* [8].

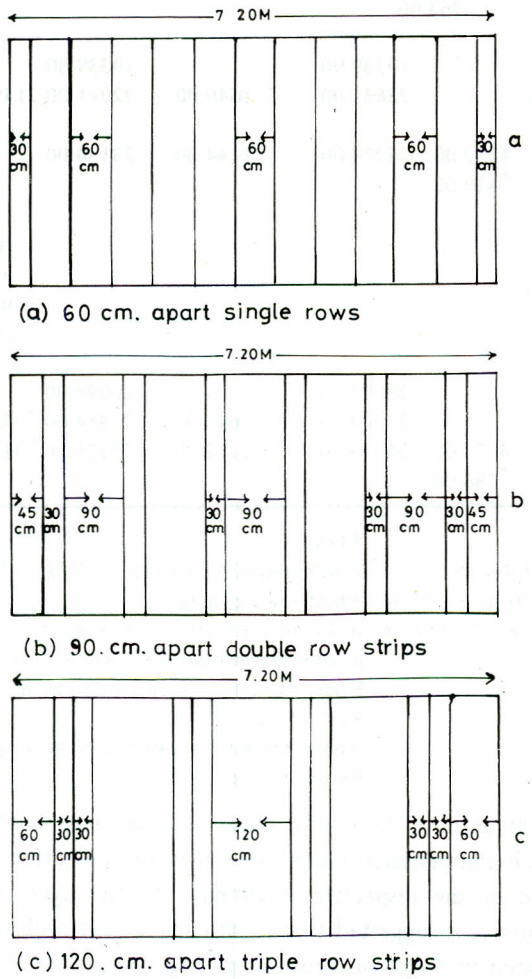

Fig 1. Plantation scheme

NOTE:- In all the three planting system two budded double sets are placed end to end in each row (Furrow).

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