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Effect of Different Planting Methods of Soybean in an intercropping with Sugarcane at Wonji-Shoa Sugar Estate

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ABSTRACT

An experiment was conducted at Wonjii-Shoa Sugar Estate plantation in 2012/13 cropping season to determine the effect of planting methods (planting on ridge, planting one side of the ridge, planting on alternate furrows and planting on two sides of the ridge) of soybean in an intercropping with sugarcane. The experiment was conducted on heavy soil in a randomized complete block design using two soybean varieties (NSO15 and Ethiogoze) and sugarcane variety B52-298. In general, the soybean and sugarcane intercropping result indicated that one side of ridge planting of soybean variety NSO15 during intercrop gave a higher net return of 5.25% (3389.79 birr/ha) compared to the sole cropping of sugarcane. Therefore, one side of ridge planting is found to be best planting method among the others.

Keywords: sugarcane, intercropping, NSO15, Ethiogoz, ridge, soybean.

INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) is an important industrial crop of the world providing around 65 % of sugar (Hunsingi, 1993). Currently, the Ethiopian Government has aimed to enhance sugar production to meet the current and future demand of the country and export surplus sugar abroad by the end of 2014. Exporting by itself requires competency in price, which makes cost minimization and maximizing profit are inevitable issues. Thus, it is imperative to search alternative options of minimizing cost and generating profit in the sugar production system of the country to be competent in the World market. Among these, intercropping of sugarcane with legumes is the important one.

An intercropping system is where two or more crops share the same piece of land for part, or for all, of their growing season. Inter-cropping in sugarcane refer to growing alternative crops between crops of sugarcane (Irvine, 2004). Intercropping helps in maintaining the soil

fertility and making efficient use of nutrients and ensures economic utilization of land, labour and capital resources (Nazir *et al*., 2002). In the sugar industry effective utilization of available resource is one of the means to minimize cost of production and maximize profit. Thus, in major sugar producing countries like India, Brazil, Australia, Mauritius and South Africa intercropping is considered as one of the management options, especially for small farmers with limited land and inputs (Bolonhezi *et al*., 2010; Parsons, 2003).

The growth rate of sugarcane during its early growth stages is slow, with the leaf canopy providing sufficient uncovered area for growing of other crops. Inter-cropping in sugarcane with short duration crops is agronomically advantageous and could provide additional revenue (Ayyer, 1963). Further, alterations in planting methods that do not compromise cane yields will provide additional opportunity to exploit the potential of the crop by growing intercrops. To ensure optimum productivity in an intercropping system, one must ensure that the peak periods of growth of the two crops do not coincide, so that one quick-maturing crop completes its life cycle before the main period of growth of the other crop starts (Saxena, 1972). With this regard sugarcane offers a unique potential for intercropping. When intercropping is practiced with sugarcane inter-row crop must therefore mature and be harvested within 85-90 days before the cane canopies.

Therefore, crops selected in intercropping with sugarcane should be short duration, less shading and less bushy type, similar to sugarcane in input requirement, having no allelopathic effect, easily manageable by growers, none attractive to disease and pest and readily marketable (Sundara, 2000). In intercropping increment, reduction or no change in cane yield is obtained depending on interspecies competition between the cane and the intercrops mainly for nutrients and water (Verma *et al*., 1981; Kandasami *et al*., 1997). According to Govinden and Arnason (1990), cane intercropping systems can only overcome the problem of reduced cane yields by ensuring adequate irrigation of both crops. Moreover, experience from South Africa indicate that intercrop in alternate cane interrows will reduce costs and competition effect on cane yield, by maintaining a useful profit from the food crop (Parsons, 2003). Intercrops of soybeans reduced cane yields when planted in every row, but, when planted in alternate rows allowed almost full recovery of cane yield before harvesting (Sih Marjayanti and Arsana, 1993; Parsons, 2003).

Soybean (*Glycine max* L. Merril) is a very important recognized oil seed and protein crop in the world. It is a good source of protein, unsaturated fatty acids, minerals like Ca and P including vitamins A, B and D that meet different nutritional needs (Rahman, 1982).The |seed contains about 40-45% protein, 18-20% edible oil and 20-26% carbohydrate (Gowda and Kaul, 1982).The multipurpose use of soybean is gradually increasing day by day in our country. According to (Sundara, 2000), soybean is one of the important intercrop suitable and compatible with sugarcane. This is mainly due to the fact that soybean has adapted well to the climatic conditions of the sugarcane producing areas and has the greatest potential to fix nitrogen i.e up to 300kg N/ha (Shokoo and Tagwira, 2005). Since nitrogen fertilizer is a substantial cost component of sugarcane cropping system, the use of soybean as intercropping plays a considerable role in optimising the benefit to be obtained from the sugar sector.

The USA, Brazil, China, Argentina, India, Italy, Paraguay, Indonesia and Canada are important soybean producing countries. In tropical Africa, important countries for soybean production are Zimbabwe, Nigeria, Zambia, Zaire, Rwanda, Uganda and Ethiopia. In Ethiopia, soybean is grown over wider agro-ecologies especially in low to mid altitude areas (1300 to 1700 m a s l) that have moderate annual rainfall (500-1500mm) (Fekadu *et al*, 2009)
In commercial cane fields of Ethiopian sugar estates one of the difficulties of intercropping is lack of scientific information on the intercropping. Among these, lack of proper planting methods is the important one. According to Khandagave (2010), change in planting methods that do not compromise cane yields will provide additional opportunity to exploit the potential of the crop by growing intercrops. With this respect to realize the possible benefits obtained from soybean-sugarcane in Ethiopian sugar industries it is vital to search the right method of

planting soybean when intercropped with sugarcane. Therefore, a study was initiated with the objectives to determine optimum planting method for soybean intercropped with sugarcane and evaluate the economical advantages of soybean sugarcane intercropping.

MATEREALS AND METHODS

Description of Study Areas

Wonji/Shoa is found in the Rift Valley of Ethiopia at an altitude and longitude of 8º31'N and 39º12'E, respectively, with an elevation of 1550 masl. The area has a mean maximum and minimum temperature of 26.9^{0}C and 15.3^{0}C, respectively with annual rainfall of 800mm.

Methods

The experiment was conducted at Wonjii-Shoa Sugar Estate during 2012/13 cropping season on plant cane crop in a randomized complete block design (RCBD) on A_1 soil cycle (heavy). The irrigation system used was surface (furrow) type of irrigation. The treatments consisted of four planting methods (planting on ridge, planting one side of the ridge, planting on alternate furrows and planting on two sides of the ridge). The sugarcane variety used for the study was B52-298 and the soybean varieties were NSO15 and Ethiogoz. Plot size was 6 rows of 5 meter length at 1.45 cm interval between furrows. Soybean seeds were planted at 5 cm spacing at a depth of 2.5 - 4 cm. Planting of sugarcane was made on 21/12/13, while soybean planting was made 1 day after sugarcane planting. Soybean variety NSO15 was harvested 90 days after planting, and Ethiogoz was harvested 145 days after planting.

Data collected

In the course of the experiment, data on sprouting was collected at 30 and 45 days after planting at Finchaa and Wonjii-Shoa, respectively. Tiller and stalk population count was made at 120 and 300 days after planting, respectively. Juice quality parameters (pol%, Brix% and Purity), cane and estimated sugar yield were also determined at harvest. For soybean, germination (%), thousand seed weight (gm), number of seed per pod, number of pod per plant and grain yield were taken at harvest.

Finally, the data collected were analysed using Fisher's analysis of variance technique with SAS software (SAS Institute, 2002). Comparisons among treatment means with significant differences for the measured and counted parameters were based on the Duncan Multiple Range Test (DMRT).

Partial budgeting, which is a method of organizing experiments, was analyzed for this new cropping system as per the methodology of budget of CIMMYT (1998). The partial budgeting was analyzed based on the following assumptions:

- Crop yields were reduced to 85% to avoid overestimation of yield in researcher managed trials (CIMMYT,1988); total profits were calculated based on the prices of sugar & soybean seed: 12.00 & 8.00 birr per kg;
- The cost of production were set at 682.60 & 300.00 birr per quintal for sugar and soybean, respectively;
- Selling prices at both estates were set at 1200.00 & 800.00 birr per quintal for sugar and soybean, respectively.

RESULTS AND DISCUSSION

Effect of Intercropping Soybean with Sugarcane on Early Growth and Yield of Sugarcane

The analysis of variance showed that there was no significant ($p<0.1$) difference among the treatments in sprouting percentage, average single cane weight and sucrose content (Table 1).

However, there was a highly significant difference ($p<0.01$) in number of millable canes, cane and sugar yield, and a significant ($p<0.05$) difference among treatments in number of tillers.

Table 1: Effect of different methods of planting of soybean during intercropping with sugarcane at Wonji-Shoa on yield and yield components of sugarcane conducted in 2012-2013 G.C.

Treatments	Sprouting (%)	Tillers (000/ha)	Stalk Weight (Kg)	Millable canes (000 ha^{-1})	Cane Yield (t ha^{-1})	Sucrose (%)	ESY (t ha^{-1})
NSO15, Ridge + SC	78	169.5ab	1.06	106.3a	112.7a	11.9	13.4a
Ethiogoz, Ridge + SC	73	177.6a	1.16	101.1a	117.6a	12.7	14.6a
NSO15, one side +SC	78	166.7ab	1.13	109.3a	122.8a	11.4	14.0a
Ethiogoz,one side+SC	73	164.9ab	1.15	105.7a	121.7a	10.5	12.7a
NSO15, alternate+SC	77	174.0a	1.03	102.7a	106.4a	11.6	12.2a
Ethiogoz,alternate+SC	78	166.7ab	1.12	100.6a	112.5a	11.1	12.5a
NSO15,two side+SC	79	137.2bc	0.96	84.0b	80.4b	11.2	9.0b
Ethiogoz,two side+SC	72	124.7c	0.94	81.8b	77.1b	11.7	9.1b
Sugarcane Solo	79	163.2ab	1.06	104.5a	110.2a	12.6	13.9a
SE(±)	4.5	10.6	0.07	3.75	7.70	0.57	0.72
CV	10.1	11.5	11.6	6.5	12.5	8.5	10.1

Means followed by the same letter in a column are not significantly different from each other.

Furthermore, tiller population of the cane was significantly inferior on two sides of ridge planting of Ethiogoz soybean variety as compared to others. This indicates that the soybean variety Ethiogoz had influenced early growth of the cane due to its vigorous growth habit resulted from competition for the limited resources. Similarly, the two side of ridge planting of NSO15 also resulted in lower sugar yield, which implied that the variety had influenced the cane the same to the former. The incidence of severe competition at early growth stage of the cane was also reflected on ultimate estimated sugar yield (Table 1). In line with this, a few researchers reported that interspecific competition in intercropping can affect growth, development and yield of each component crop due to differences in species and microclimate, and mutual shading (Rana *et al.*, 2001; Rashid and Hamayatullah, 2003).

Of the planting methods used in the intercropping, one side of the ridge and alternate planting of soybean varieties had showed a significantly higher cane and estimated sugar yields as compared to two sides of ridge plantings (Table 1). Though, there was no significant variation between one side and alternate planting methods of both soybean varieties, it had clear numerical variation on average cane yield and estimated sugar yield.

Effect of Intercropping Soybean with Sugarcane on Early Growth and Yield of Soybean

Soybean thousand seed weight, Number of pod per plant and yield were significantly ($p<0.01$) affected by method of planting; however, germination and number of seed per pod were not affected by any of the treatments (Table 2). In terms of thousand seed weight, two side of ridge planting of NSO15 and Ethiogoz resulted in a significantly ($p<0.01$) lower weight than all and were in statistical parity each other. However, in number of pods per plant, planting of Ethiogoz variety on two sides of ridge was found to be inferior to all the treatments including two side of ridge planting of NSO15 with sugarcane (Table 2). This was due to the fact that Ethiogoz is late maturing variety and characterized by vigorous growth as compared NSO15.

Furthermore, the soybean planted on two sides of the ridge of both varieties showed superior yield (Table 2). However, two sided planting method had severely affected cane and estimated sugar yield (Table 1). On the other hand, one side of the ridge planting of soybean in the intercrop gave a significantly superior soybean yield as compared to alternate planting of NSO15 (Table 2). In contrary to this, a study conducted in South Africa indicated that intercrop in alternate cane interrows will reduce costs and competition effect on cane yield, by maintaining a useful profit from the food crop (Parsons, 2003).

Table 2: Effect of different methods of planting of soybean during intercropping with sugarcane at Wonjii-Shoa on germination and yield of soybean conducted in 2012-2013 G.C

Treatments	Germination (%)	1000 seed weight (gm)	Number of seed per pod	Number of pod per plant	Soybean Yield (Q/ha)
Ethiogoz, one side+SC	66.12	168.7ab	3.67	25.0ab	8.4c
NSO15, alternate+ Solo	69.90	164.7ab	4.00	25.7a	6.9cd
Ethiogoz,alternate+SC	66.13	171.7ab	4.33	25.3ab	4.8ef
NSO15, one side+ Solo	71.67	178.7a	4.00	25.0ab	7.2cd
Ethiogoz,two side+Solo	70.00	167.7ab	3.67	23.7ab	13.4b
NSO15, two side+SC	70.00	145.3bc	3.67	20.7ab	13.6b
NSO15,two side+Solo	67.24	163.0ab	4.00	25.3ab	15.7a
Ethiogoz, alternate+Solo	69.38	176.0a	3.67	24.7ab	5.8de
NSO15,alternate+SC	69.90	173.3ab	4.00	24.0ab	3.7f
Ethiogoz, one side+Solo	68.79	165.3ab	3.67	26.7a	8.43c
Ethiogoz,,two side+SC	67.90	129.0c	4.00	19.3b	17.1a
NSO15,one side+SC	65.54	165.3ab	3.67	24.7ab	5.9de
SE(±)	3.23	8.22	0.36	1.79	0.63
CV	8.17	8.68	16.3	12.8	11.8

Means followed by the same letter in a column are not significantly different from each other;

Economic Analysis

The partial budget analysis indicated that among the treatments considered in this study, one side of ridge planting of soybean variety NSO15 during intercrop gave a higher economic advantage of 5.25% (3,389.79 birr/ha) as compared to the sole cropping of sugarcane (Annex Table 1).

Though, Ethiogoz at two sides of ridge planting gave a higher economic return as compared NSO15 which was inferior in economic terms at one side of ridge planting; however, from practical perspective, due to the impedance of moulding (earthing-up), makes it unsuitable for intercropping with sugarcane. Furthermore, it is a late maturing variety (matures after 120 days).

CONCLUSION

From the current result it can be concluded that on one side of ridge planting of soybean variety NSO15 during intercropping performed better than the rest with minimal sugarcane yield loss. However, the variety Ethiogoz was found to be unsuitable for intercropping due to it is late maturing and impedes plantation cane moulding (earthing-up) operation. The partial budget analysis indicated that among the treatments considered in this study indicated that one side of ridge planting of soybean variety NSO15 during intercrop gave a higher economic advantage of 5.25% (3389.79 birr/ha) compared to the sole cropping of sugarcane. Therefore, one side of ridge planting is found by far suitable planting method in sugarcane soybean intercropping system with reasonable soybean yield.

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