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Effect of planting density of soybean grown in association with Eucalyptus tree on its yield and yield contributing characters under the cropland Agroforestry system

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Abstract

A field experiment was conducted at the Agroforestry Farm of Bangladesh Agricultural University, Mymensingh, during the period from December 2003 to April 2004 to find out the effect of planting density of soybean in association with Eucalyptus tree on its yield and yield contributing characters under the cropland agroforestry system. The experiment was carried out in a factorial Randomized Complete Block Design (RCBD) with four replications. The density of soybean was 60 plants/m^2, 50 plants/m^2 and 40 plants/m^2. Two factors i.e. tree (Eucalyptus) and planting density of soybean was involved in the experiment. In general Eucalyptus tree influenced plant height, no of seed pod^{-1}, seed yield and total dry matter yield of soybean significantly; while no of pod $plant^{-1}$, length of pod, weight of 1000 seed and harvest index were insignificant. Among the three plant densities of soybean, 50 plants/m^2 gave best results in all the yield and yield contributing characters except no of pod $plant^{-1}$ and harvest index compared to that of 40 plants/m^2 and 60 plants/m^2. Considering Eucalyptus-Soybean association 50 plants/m^2 plant densities of soybean grown as undestroyed crop in association with Eucalyptus is best for higher yield of soybean.

Keywords: Soybean yield, Eucalyptus, Cropland agroforestry

Introduction

Soybean [*Glycine max* (L.) Merr.] is one of the most important leguminous crop used by worldwide human being, livestock, and fish culture as food or feed, respectively. Soybean contains higher amounts of both oil and protein than any other legume crops. It contains about 43.2% protein, 19.5% fat, 20.9% carbohydrate and a good amount of calcium, phosphorus, iron and vitamins (Gopalan *et al.* 1971). Soybean is an excellent source of major nutrients including vitamin A, B, C and D, rich in unsaturated fatty acid and minerals like Ca and P that can meet up different nutritional need (Rahman, 1982). Soybean provides around 60% of the world supply of vegetable protein and 30% of the oil (Fehr, 1989). It is used for preparing many food dishes, confectioneries, baby foods and soybean milk. Its milk is comparable to cow's milk and it contains higher quality of specific nutrients (Smith, 1975). In industry, soybean is used in the manufacture of edible lard, margarine, vegetable ghee, milk, pastries. Soybean can be used as vegetable. Soybean helps to improve the soil fertility and productivity by fixing atmospheric nitrogen through *Rhizobium* bacteria that live in root nodules. Soybean can also be used as a green manure crop. For better production of soybean, we need proper technology. Planting density is one of the main factor that has an important role on growth and yield of soybean. For optimum growth of plant and better yield, optimization of planting density is important in soybean cultivation.

Bangladesh is one of the most densely populated country of the world. The demand for food, shelter, fuel and fodder is rising at a geometric rate due to rapid population growth and increasing per capita consumption. As a result, the gap between actual demand and supply is widening day to day. It is necessary to bridge this gap. On the other hand, it is said that a country needs 25% of its area under forest cover while Bangladesh has barely 6-7% of the area under tree cover. Under this alarming condition, it is necessary to find out a suitable alternative to overcome the situation. Since there is neither scope for expending forest area nor sole crop areas, the country has to develop agroforestry production system integrating trees and crops. This can solve the problem of shortage of food, fuel wood, timber, fodder and conserve soil moisture contents and also ameliorate the harsh climatic condition. With this views, the rapidly growing Eucalyptus trees are now largely cultivated in cropland agroforestry system of our country for fuel wood and timber. In this system, since the growth and development of any of the components do influence the other (Torquebiau, 1994), the effect of tree-soybean association on the yield of the latter is necessary to determine. Keeping this view in mind, this piece of research was undertaken to determine the influence of tree species on the yield and yield contributing characters of soybean.

Materials and Methods

The experiment was carried out at the experimental farm, Department of Agroforestry, Bangladesh Agricultural University, Mymensingh (Old Brahamaputra Floodplain soil, AEZ-9) during the period from 15 December 2003 to 24 April 2004 to evaluate the response of PB-1 (sohag) variety of soybean to different planting density and its performance as intercrop with Eucalyptus tree. In this study the soybean [*Glycine max* (L.) Merr.] crop was used as plant material. The experiment was laid out in a Factorial RCBD design with four replications. Two factors i.e. tree (Eucalyptus) and planting density of soybean was involved in the experiment. Four (4) plots each of 1.5m × 1m were laid around the tree base (1.5m distance from the tree base). All plots were divided into three (3) sub plots each of 0.5m × 1m. Each treatment was replicated 4 times. Manures and fertilizer dose were Rhizobium inoculants (for seeds) @ 25 g/kg, Cowdung @ 4000 kg/ha, TSP @ 120 kg/ha, MP @ 60 kg/ha and gypsum @ 25 kg/ha, respectively. All the management practices were done in proper time starting from land preparation to crop harvest.

Factor A: Tree (T)

T_0 = Open field - out side of the tree canopy (control)
T_1 = Eucalyptus tree (*Eucalyptus brasiana*)

Factor B: Planting density (D)

D_1 = 40 plants (Soybean)/m^2
D_2 = 50 plants (Soybean)/m^2
D_3 = 60 plants (Soybean)/m^2

The crop was harvested after 114 days (24 April 2004) from the date of sowing at full maturity of the crop. In each unit plot 10 plants were selected at random for collection of data. Recorded data were analyzed statistically using " Analysis of Variance" technique and mean differences were adjudged with Duncan's Multiple Range Test (DMRT) [Gomez and Gomez, 1984].

Results and Discussion

Plant height (cm), number of seed pod^{-1}, seed yield (t ha^{-1}) and total dry matter yield (TDM) were significant but number of pod plant^{-1}, length of pod (cm), weight of 1000 seed (g), and harvest index (%) were unaffected due to Eucalyptus tree. Compared to open field (T_0) soybean grown in all orientation under eucalyptus tree-soybean association was significantly shorter (Table 1).

Table 1. Effect of tree on the yield and yield contributing characters of soybean

Tree	Plant height (cm)	Number of pod plant^{-1}	Length of pod (cm)	Number of seed pod^{-1}	Weight of 1000 seed (g)	Seed yield (t ha^{-1})	Total Dry Matter (TDM) yield (t ha^{-1})	Harvest index (%)
T_1	48.537b	30.437	4.286	2.823b	120.248	2.38b	3.13b	44.25
T_0	50.951a	30.859	4.469	2.922a	121.103	2.47a	3.22a	43.96
CV (%)	3.57	3.93	9.16	2.08	1.85	2.34	1.68	2.16
Level of significance	*	NS	NS	**	NS	**	**	NS

In a column, figures bearing letter(s) in common do not differ significantly.
T_1= Eucalyptus tree, T_0 = Control plot
* = Significant at 5% level of probability, ** = Significant at 1% level of probability

Planting density significantly influenced plant height (cm), number of pod plant^{-1}, length of pod (cm), number of seed pod^{-1}, weight of 1000 seed (gm), seed yield (t ha^{-1}), total dry matter yield (t ha^{-1}), harvest index (%). The tallest plant (51.21 cm) of soybean was found from D_2 (50 plants/m^2) and the shortest (48.065 cm) from D_3 (60 plants/m^2). Plant height increased with the increasing planting density up to D_2 and decreased at D_3. The highest pod plant^{-1} (36.963) of soybean was observed from D_1 (40 plants/m^2) and the lowest (25.353) from D_3. Number of pod plant^{-1} of soybean decreased with the increasing of plant density. Similar findings were reported by Ram *et al* (1999). The highest length of pod (4.783 cm) was obtained from D_2 (50 plants/m^2) and lowest from D_3 (60 plants/m^2). Increased length of pod with increasing planting density and thereafter decreased, it may be due to the competition of light and nature. The highest number of seed pod^{-1} (3.005) of soybean was observed from D_2 (50 plants/m^2) and lowest (2.732) from D_3 (60 plants/m^2). Number of seed pod^{-1} was lower at the highest plant density which was reported by Kang *et al* (1998). The highest weight of 1000-seed (121.817 g) of soybean was obtained from D_2 (50 plants/m^2) and the lowest (119.705 g) from D_1 (40 plants/m^2). The highest seed yield (2.49 t ha^{-1}) was achieved from D_2 (50 plants/m^2) and the lowest from D_3 (60 plants/m^2). The highest total dry matter yield (3.56 t ha^{-1}) was achieved from D_2 (50 plants/m^2) and lowest (2.66 t ha^{-1}) from D_1 (40 plants/m^2). The highest harvest index (47.99%) of soybean was obtained from D_2 (50 plants/m^2) and the lowest (42.05%) from D_3 (60 plants/m^2) (Table 2).

Yield and yield components did not vary significantly due to the interaction of tree and planting density of soybean. Harvest index was the highest (48.16 %) in the eucalyptus tree with 40 plants/m^2 planting density. The lowest harvest index (41.64 %) was in control plot with 60 plants/m^2 planting density (Table 3).

From the present study, it can be concluded that production of soybean in tree-crop agroforestry system is influenced by planting density of the crop under tree in the crop field. In tree-crop agroforestry system the effect on crop yield could be positive or negative depending on climate and soil conditions. In the present study, although crop yield was influenced, it was not significantly affected when grown under Eucalyptus tree, indicate that soybean can be cultivated in association with this tree. The tree in the long run will generate cash for the farmer.

Table 2. Effect of planting density of soybean on the yield and yield contributing characters of soybean

Density	Plant height (cm)	Number of pod plant^{-1}	Length of pod (cm)	Number of seed pod^{-1}	Weight of 1000 seed (g)	Seed yield (t ha^{-1})	Total Dry Matter (TDM) yield (t ha^{-1})	Harvest index (%)
D_1	49.952ab	36.963a	4.26b	2.882b	119.705b	2.41b	2.66c	47.99a
D_2	51.215a	29.627b	4.783a	3.005a	121.817a	2.49a	3.56a	42.26b
D_3	48.065b	25.353c	4.088b	2.732c	120.505ab	2.38b	3.32b	42.05b
CV (%)	3.57	3.93	9.16	2.08	1.85	2.34	1.68	2.16
Level of significance	*	**	*	**	**	**	**	**

In a column, figures bearing letter(s) in common do not differ significantly.
D_1= 40 plants/m^2 planting density, D_2= 50 plants/m^2 planting density, D_3= 60 plants/m^2 planting density
* = Significant at 5% level of probability, ** = Significant at 1% level of probability

Table 3. Effect of tree and planting density of soybean on the yield and yield contributing characters of Soybean

Tree x Density	Plant height (cm)	Number of pod plant^{-1}	Length of pod (cm)	Number of seed pod^{-1}	Weight of 1000 seed (g)	Seed yield (t ha^{-1})	Total Dry Matter (TDM) yield (t ha^{-1})	Harvest index (%)
T_1D_1	48.05	36.90	4.180	2.81	119.047	2.37	2.62	48.16
T_1D_2	50.14	29.35	4.643	2.98	121.467	2.43	3.54	42.11
T_1D_3	47.42	25.06	4.033	2.68	120.230	2.33	3.24	42.46
T_0D_1	51.85	37.03	4.340	2.95	120.363	2.44	2.69	47.83
T_0D_2	52.29	29.90	4.923	3.03	122.167	2.55	3.58	42.40
T_0D_3	48.71	25.64	4.143	2.78	120.780	2.43	3.40	41.64
CV (%)	3.57	3.93	9.16	2.08	1.85	2.34	1.68	2.16
Level of significance	ns	ns	ns	ns	ns	ns	ns	ns

In a column, figures bearing letter(s) in common do not differ significantly.
T_1= Eucalyptus tree, T_0 = Control plot
D_1= 40 plants/m^2 planting density, D_2= 50 plants/m^2 planting density, D_3= 60 plants/m^2 planting density
* = Significant at 5% level of probability, ** = Significant at 1% level of probability

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