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Growth and Yield of Maize (*Zea mays*) as Influenced by Intercropping of French Bean and Soybean

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ABSTRACT

Background: The intercropping of maize with legumes is beneficial in multifaceted aspects. Advantages of maize-legume intercropping is pronounced in the form of higher yield and greater utilization of available resources, benefits in weeds, pests and disease management, fixation of biological nitrogen by legumes and transfer of nitrogen to associated maize and control of erosion by covering a large extent of ground area. The current investigation aimed to study the effect of maize-French bean and maize-soybean intercropping on growth and yield of maize under rainfed condition of Namsai district of Arunachal Pradesh.

Methods: The field experiment was conducted during 2021 in randomized block design consisting of 3 treatments *i.e.* T_1- sole maize, T_2- maize + French bean and T_3- maize + soybean with four replications. Observations on growth and yield parameters and yield of maize were recorded on harvesting of the crop. The results were analysed using standard statistical procedures of ANOVA.

Result: In maize + French bean and maize + soybean intercropping, the growth and yield parameters as well as yield of maize was higher in maize + soybean intercropping as compared to maize + French bean system. The grain yield of maize under maize + soybean intercropping was 5541.67 kg ha^{-1}. From this study, it can be concluded that the intercropping of maize with soybean would be profitable due to higher yield of maize (2 rows of maize and 2 rows of soybean) under farmer's field condition of Namsai district of Arunachal Pradesh.

Key words: French bean, Intercropping, Legume, Maize, Soybean.

INTRODUCTION

Intercropping is an ancient multiple-cropping system that is popular among smallholder farmers in developing countries today, due to its higher land and nutrient use efficiency, better economic returns and lower pest and disease incidence as compared to sole crops (Huang *et al*., 2019). Intercropping of cereals with legumes has been very popular in the rainfed areas due to its advantages for soil conservation and stability relative to sole cropping and fulfilling diversified needs of small farmers (Dhima *et al.,* 2007). Generally, cereals are nutrient-exhaustive crops and absorb nutrients from upper soil layers (Ali *et al.,* 2012). Legume, being able to fix atmospheric N in soil, improves the soil fertility and reduces the completion of limited soil nutrients within the soil (Meena *et al*., 2015). Further, legumes help in absorbing nutrients from deeper soil layers due to their robust tap root system (Jat *et al*., 2012).

In various cropping systems as well as in intercropping, maize can be fit due to its wider adaptability in different seasons and agro-climatic conditions. Maize is characterised by aggressivity in cereal legume mixtures and improved the quantity of cropping system while legumes are thought to improve the quality of its associated crops (Kour *et al*., 2015). The intercropping of maize with legumes like soybean (*Glycine max* L.), French bean (*Phaseolus vulgaris*), groundnut (*Arachis hypogaea* L.), *etc.* provide a great scope for minimizing the adverse impact of moisture stress. Besides, these crops with their varied morphology can exploit the edaphic and climatic conditions more efficiently as compared to their cultivation as sole crops (Ram and Meena, 2014). Maize-legume intercropping has a great role for subsistence agriculture and provides a diversified food crops in both developed and developing countries particularly in areas having limited irrigation facilities (Tsubo *et al*., 2005).

Hence, in the premise of the above background the present investigation was undertaken to evaluate the effect of maize + French bean and maize + soybean intercropping system on growth and yield of maize for higher sustained productivity and to standardize a sustainable maize-based cropping system among French bean and Soybean under rainfed condition of Namsai district of Arunachal Pradesh.

MATERIALS AND METHODS

The experiment was conducted during *rabi* season 2020-21 at the Agriculture Research Farm, Arunachal University

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of Studies, Namsai Arunachal Pradesh, located in between latitude 27°30′ to 27°55′N and longitude 95°52′ to 96°20′E with an elevation of 156 m a.s.l. The average annual temperature is 22.8°C. Maximum and minimum winter temperatures are 25°C and 10°C, respectively. Precipitation here averages 2728 mm with maximum rainfall 750-800 mm is recorded during July-August with a relative humidity of 80%. The soil of the experimental field comes under the soil order of *Inceptisols.* It is sandy loam in texture. The three treatments were selected with four replications and each consist of a Sole Maize as Control (T_1), Maize + French bean intercropping (T_2) and Maize + Soybean intercropping (T_3) having a plot size of 12.20 m × 7 m. The replicated treatments were laid out under randomized block design (RBD). The varieties sown were Ganga 5 for maize, Arun and Moti for French bean and soybean, respectively. The crops were sown on 4th March, 2021. Row spacing of 60 cm × 25 cm was followed for sowing of sole maize. Whereas 40 cm × 10 cm and 40 cm × 6 cm spacing were followed for intercropping of maize with French bean and soybean, respectively. The seed rate of maize was 22.5 kg ha^{-1} for each treatment. The seed rate of French bean and soybean were 40 kg ha^{-1} and 65 kg ha^{-1}, respectively. FYM were applied during land preparation. Before sowing the seeds of maize, French bean and soybean were treated with carboxin @ 2 g/kg seeds. In the sole crop, fertiliser dose was given as per respective crop's recommendation. In intercropping it was that of main crop *viz*. maize. In maize, recommended dose of N: P_2O_5: K_2O was 60:40:40 kg ha^{-1}. The entire quantity of P_2O_5 and K_2O and half of N were applied in furrows before sowing. The remaining quantity of N were top dressed at 30 days after emergence of seedlings. Harvesting was done at 150-160 days after sowing for maize, 90-100 days for French bean and 85-100 days for soybean. In case of maize, the cobs were harvested when the husk cover turns pale yellow. French beans were harvested when 75-80% of the pods turn brownish in colour. Soybean were harvested when leaves start falling and pods look dry, but before getting dried completely. The maize was shelled by hand and the yield was expressed at 14% moisture content. French bean and soybean were harvested manually.

In this study, the growth parameters concerned plant height, number of leaves per plant and leaf area per plant, while the yield parameters relate to length of cob, cobs number per plant, cobs diameter, thousand grains weight and grain yield. Plant height (cm) was measured from the base of the plant to upper the topmost leaves. Leaf area was estimated non-destructively from leaf length (cm), from the collar to the tip of fully expanded leaves and leaf width (cm) at the widest point. It was calculated as the product of leaf length and widest middle portion of the leaf and multiplied by the correction factor (0.75) (Elings, 2000). The plants of two central rows were used for data collection. All the growth and yield parameters were recorded at harvest. Grain yield of maize was recorded by threshing the crop after 10-15 days of air-drying the cobs. The grain yield was adjusted at 14% grain moisture content. Thousand grains weight (g) was taken from the three-grain lot of each treatment and weighed by using electronic digital balance.

Data collected on various growth and yield parameters were subjected to analysis of variance (ANOVA) techniques using statistical analysis system software The treatments means was separated using LSD test at 0.05 probabilities.

RESULTS AND DISCUSSION

Effect of cropping system on growth parameters of maize

Plant height was significantly higher in sole maize followed by maize + soybean inter-cropping (Table 1). It might be due to inter specific competition for growth resources *viz*., light, moisture and nutrients arising due to increased population pressure per unit land area or demand exceeding supply or due to both. Silwana and Lucas (2002) also reported that maize monocrop was taller than intercropping with beans. Number of leaves was significantly affected by intercropping combinations (Table 1). The significantly higher number of leaves was recorded in maize + soybean intercropping and the lowest in sole crop of maize. Intercropping has resulted in a greater number of leaves and hence better crop canopy in intercropping and efficient utilization of the solar radiation available during the growing season (Ginwal *et al*., 2019). This result is in accordance with Hamd Allah *et al*. (2014) who reported the higher number of leaves/plants in intercropping combination of forage maize and cowpea crop than their pure stand. Significant differences in leaf area were observed among the three cropping systems. Maize intercropped with soybean had a significantly higher leaf area compared to maize with French bean intercropping and sole maize. This implies that maize leaf area was affected by the intercropping systems. The higher leaf area is due to the beneficial effects of legumes intercrop over the companion crops. The highest leaf area in maize + soybean intercropping was due to better growth of maize plants due to poor competition from

Table 1: Effect of cropping system on growth parameters of maize in maize + French bean and maize + soybean intercropping.

Treatments	Plant height (cm)	Number of leaves per plant	Leaf area (cm^2 plant^{-1})
Sole maize	177.3	13.50	4021
Maize+French bean	173	14.49	4530
Maize+Soybean	175.3	15.75	5505
SE (m)±	1.25	0.65	435.38
CD (P=0.05)	4.91	1.95	1709.51

Table 2: Effect of cropping system on yield parameters and yield of maize in maize + French bean and maize + soybean intercropping.

Treatments	Length of cob (cm)	Number of cobs per plant	Cob diameter (cm)	1000-grain weight	Grain yield (kg ha^{-1})
Sole maize	15.3	1.31	16.44	227.6	2000.0
Maize+French bean	15.7	1.33	16.65	228.6	2333.0
Maize+Soybean	16.2	1.60	17.19	231.6	5541.67
SE (m)±	0.26	0.10	0.31	5.10	230.37
CD (P=0.05)	1.22	0.41	1.22	20.04	904.54

intercropped soybean (Telkar *et al.*, 2017). Similar results were also reported in intercropping of soybean with maize by Undies *et al*. (2012) and Mandal *et al*. (2014).

Effect of cropping system on yield parameters and yield of maize

The yield components of maize *viz*., cobs length, number of cobs per plant, cob diameter and 1000 grain weight were higher under maize + soybean intercropping (Table 2). This might be due to the complementary effect of soybean which favoured the source-sink relation in maize and produced better yield components resulted in higher grain yield of maize (Chalka and Nepalia, 2006). The yield components of maize in maize + French bean showed more or less equal value as that of sole maize.

Different cropping system influenced the grain yield of maize significantly (Table 2). Among the cropping system, maize + soybean intercropping recorded a higher grain yield of 5541.67 kg ha^{-1} followed by maize + French intercropping. The lowest grain yield of maize was recorded in sole maize. This might be due to higher growth and yield attributes along with better utilization of the available resources (Mandal *et al.*, 2014). Row arrangement, in contrast to arrangement of component crops within rows, may also influence the productivity of an intercropping system (Oseni and Aliyu, 2010).

CONCLUSION

From the experimental results, it can be concluded that maize + soybean intercropping recorded the higher growth and yield attributes as well as grain yield of maize under maize based intercropping. Therefore, the study suggests that the intercropping of maize with soybean would be profitable under farmer's field of Namsai region of Arunachal Pradesh.

Conflict of interest: None.

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