Effect of Integrated Nutrient Management on growth and yield attributes of Maize (*Zea mays* L.) Intercropping System with green gram under Island Ecosystem, A&N Islands

Abstract

An experiment was conducted during Rabi season of dry months (January to April) of 2016 and 2017 at Field crops Experimental Research Farm Bloomsdale, Chouldhari, ICAR- CIARI, Port Blair, Andaman and Nicobar Islands to study the **Effect of Integrated Nutrient Management on growth and yield attributes of Maize (*Zea mays* L.) Intercropping System with green gram under Island Ecosystem.** The experiment was laid out in randomized block design (RBD) with three replications each consisting of two intercropping 1:1 and 2:2 ratios and eight nutrient sources. The main plots treatments include maize, green gram inter cropping ratio, with 8 nutrient applications. The results indicated that the intercropping of (Maize + Green gram (2:2) + 25% RDN through Urea + 75% N through Poultry Manure + 25% Gliricidia+ Azotobacter) series was found to be the most effective under experimental conditions, gave best result in term of growth yield and character which is statistically at par with N_8(25% RDN through Urea + 50 % through PM + 25% Gliricidia + Azot), N_7(25% RDN through Urea + 50% N through VC + 25% Gliricidia + Azot.) and N_6(25% RDN through Urea +50% N through FYM + 25% Gliricidia + Azot.), gave the maximum net returns and maximum benefit: cost ratio.

Key words: Maize-green gram intercropping, growth and yield.

Introduction

Maize (*Zea mays* L.) is an important cereal crop and ranks third in production after rice and wheat in India. It is a plant belonging to the family of grasses (Poaceae). In respect of production also USA stands first followed by China. In India, area production and productivity of maize is 9.43 mha, 24.35 mt and 2557kg/ha respectively (Anonymous 2015). "Nutrient is the most important constraint for realizing higher productivity of maize. Maize being an exhaustive crop has very high nutrients demand and its productivity mainly depend upon nutrients managements system. The recent energy crisis, high fertilizer cost and low purchasing power of the farming community have made it necessary to rethink alternatives. They enhance crop yield per unit of applied nutrients by providing a better physical, chemical and microbial environment" (Madakemohekar *et al*., 2013). He also reported that continues application of chemical fertilizer can change the soil pH, upset beneficial microbial ecosystems, increase pest and even contribute to the release of greenhouse gases.

Therefore, maximizing the usage of organic waste and combining it with chemical fertilizers and bio fertilizers in the form of integrated manure appears to be the best alternative. Gundlur *et al*., (2015) state that "application of inorganic fertilizers with different sources of organic manures in different proportions has significant role to boost crop productivity, improve nutrient uptake by plants and maintain soil nutrient status in maize based cropping systems". However, the package of practices not only differs for various cropping systems in different regions of the country but also require some adjustment to meet the specific needs of the individual farmer so as to increase his productivity and profit. The sustainability of the maize production will greatly depends on balanced fertilization of organic and inorganic fertilizers for optimum plant growth and nutrient supply for realizing yield potential. Plant nutrients can be supplied from different sources viz., organic manures, crop residues, bio-fertilizers and chemical fertilizers. For better utilization of resources and to produce crops with less expenditure, integrated nutrient management is the best approach. In this approach, all the possible sources of nutrients are applied based on economic consideration and the balance required for the crop is supplemented with chemical fertilizers. "Integrated nutrient management including application of organic and inorganic fertilizers, and bio fertilizers are warranted for sustainable food production and maintaining soil health" **(Patil *et al*. 1992). De *et al*. (1986)** indicated that "utilization of nitrogen was more in maize + green gram intercropping system than sole crop of maize". **Mishra *et al*. (1995)** observed "that in maize, grain yield and net returns were the highest with combination of NPK + Azotobacter"**. Nanda *et al***. (1995) reported that "green fodder yield and benefit: cost ratio were the highest with combination of 75 kg N / ha and seed inoculation with Azosprillium".

"The nutrient requirement of these crops particularly in intercropping system will be different than that for their sole crops. The maintenance and/or augmentation of productivity of this system call for balanced use of nutrients. The survey of available research information has shown that there is no information available on nutrition aspects of intercropping system for Andaman and Nicobar Islands. Therefore, it was deemed necessary to conduct the field studies on nutritional aspects of maize + mung bean intercropping system. Intercropping of maize + green gram will have significant effect on soil fertility and productivity" **(Dahmardeh *et al.*, 2010).** The integrated nutrient management comprising of different sources of nutrients and management practices complementary to the intercropping systems play a vital role in maintaining the soil fertility and long term productivity for sustainable production.

Materials and Methods

A field experiment was conducted at the Student's Field Crops Experimental Farm, ICAR- Central Island Agricultural Research Institute, Port Blair, Andaman and Nicobar Islands, India during January to April in 2016 & 2017. The experiment laid out in randomized block design (RBD with three replications each consisting two intercropping 1:1 and 2:2 ratios and eight nutrient sources. The main plots treatments include maize, green gram, with 8 nutrient applications The treatments details are as T_1 Maize + Green gram (1:1) Recommended dose of fertilizer (100%), T_2 Maize + Green gram (1:1) 100% RDM through Organic manure (33% FYM +33% VC +33% PM), T_3 Maize + Green gram (1:1) + 50% RDN through Urea + 50% N through Farm Yard Manure, T_4 Maize + Green gram (1:1) + 50% RDN through Urea + 50% N through Vermi Compost, T_5 Maize + Green gram (1:1) + 50% RDN through Urea + 50% N through Poultry Manure, T_6 Maize + Green gram (1:1) + 25% RDN through Urea + 50% N through Farm Yard Manure + 25% Gliricidia+ Azotobactor, T_7 Maize + Green gram (1:1) + 25% RDN through Urea +

50% N through Vermi Compost +25% Gliricidia+ Azotobactor, T_8 Maize + Green gram (1:1) + 25% RDN through Urea + 50% N through Poultry Manure+ 25% Gliricidia+ Azotobactor also same combination was used (2:2) plot . The soil at the experimental site was an Entisol with sandy clay loam texture having a bulk density (1.42 Mg m^3). The soils are slightly acidic (pH 6.0), non saline (EC 0.02 dS m^{-1}), and contained 3.7 g kg^{-1} of organic carbon, 163 kg ha^{-1} of available N, 14.8 kg ha^{-1} P and 256 kg ha^{-1} ammonium acetate K. The field was ploughed and given pre-sowing irritation. After the preparatory tillage, field was Total number of plots 54, different plots of 4.20 m x 2.5 m size. The pre-treated seed of maize (var. Vivek 27) was intercropped with green gram (var. CARI Mung1) during dry period under rainfed condition with small amount of supplemental irrigation during critical crop growth stages were sown by dibbling method in between the rows by using maize seed at the rate of 20kg/ha. RDF- Recommended dose of fertilizers (120:80:60 NPK for maize) RDN- Recommended dose of N, FYM- Farm yard manure, VC- vermin compost, PM- poultry manure as basal and remaining dose of N was applied as topdressing in two split at knee high stage and at Pre-teaselling stage. The amount of vermin- compost, FYM, Azotobacter and PSB was applied at per treatment wise. The field was kept free from weeds by manual hoeing. Plant protection measures and irrigations whenever required were provided in same manner for all the treatments. Yield attributes parameters were recorded just before harvesting of crop. The crop was harvested on 10 May 2017 when about 80 per cent of the cobs turned yellowish and grains became hard and then tied in the labelled bundles. The sun dried weight of bundles was recorded. The cobs were removed from the plants, dried and threshed with hand operated maize sheller. Thus grain yield of each plot was recorded.

Result and Discussion

Growth characters

The result under maize-green gram intercropping due to cropping systems showed that growth parameters of plant such as plant height, stem diameter, number of leaves/plant, Leaf area index/plant, dry weight (g), Crop growth rate and relative growth rate of maize crop were non significant.

Table 1: Effect of cropping system and Integrated nutrient management on growth attributes parameters in maize (*Zea mays* L.) as influenced by intercropping with green gram (*Vigna radiata* L. Hepper) at different days interval.

Factors	Dose	Plant height (cm)	Stem Diameter	No of Leaves	Leaf area index/plant	Dry Weight	CGR ($g/m^2/day$)	RGR (g/g/day)
Method of intercropping								
S_1	Maize + Green gram (1:1)	140.3	1.63	9.54	3.05	67.27	197.74	0.254
S_2	Maize + Green gram (2:2)	140.19	1.63	9.48	2.98	65.31	191.34	0.256
F-test		NS	NS	NS	S	S	NS	NS
S. Ed. (±)		0.723	0.121	0.132	0.149	0.471	4.583	0.008
C. D. (P = 0.05)		1.477	0.061	0.261	0.295	0.961	9.359	0.017
Nutrient management practices								
N_1	100% RDF (Recommended Dose of Fertilizers)	145.41	2.01	10.65	3.42	97.73	293.24	0.302
N_2	100% RDN through Organic manure (33% FYM +33% VC +33% PM)	132.81	1.27	8.27	3.22	34.2	91.72	0.203
N_3	50% RDN through Urea + 50% N through Farm Yard Manure	136.03	1.32	8.62	2.83	38.11	108.2	0.212
N_4	50% RDN through Urea + 50% N through Vermicompost	138.31	1.51	8.87	2.8	45.98	120.53	0.237
N_5	50% RDN through Urea + 50% N through Poultry Manure	139.1	1.61	9.2	3.02	60.24	176.16	0.25
N_6	25% RDN through Urea +50% N through FYM + 25% Gliricidia + Azot.	140.07	1.67	9.59	2.37	64.34	180.37	0.259
N_7	25% RDN through Urea + 50% N through VC + 25% Gliricidia + Azot.	142.24	1.76	10.36	3.08	92.69	290.67	0.275
N_8	25% RDN through Urea + 50 % through PM + 25% Gliricidia + Azot	144.85	1.88	10.56	3.38	97.04	295.45	0.305
F-test		S	S	S	NS	S	S	S
S. Ed. (±)		0.892	0.048	0.076	0.277	0.235	2.292	0.004
C. D. (P = 0.05)		1.766	0.095	0.15	0.548	0.481	4.679	0.008

Table 2: Effect of cropping system and Integrated nutrient management on yield attributes and yield parameters in maize (*Zea mays* L.) as influenced by intercropping with green gram (*Vigna radiata* L.Hepper) at different days interval.

Factors	Dose	Number of cob/plant	Cob Diameter (cm)	Length of Cob (cm)	Weight of Cob (g) with husk	Weight of cob (g) without husk	Number of Row Per Cob	No of Grain per row	100 Seed Weight (gm)	Total yield (q/ha)	Stover yield/Biological yield (q/ha)
Method of intercropping											
S_1	Maize + Green gram (1:1)	1.00	14.06	15.26	130.25	110.39	13.48	25.77	33.72	48.32	159.97
S_2	Maize + Green gram (2:2)	1.01	14.05	15.08	129.66	109.8	13.44	24.71	33.67	45.58	150.66
F-test		NS	NS	NS	NS	NS	NS	NS	NS	S	S
S. Ed. (±)		0.064	0.163	0.41	1.061	2.811	0.145	0.482	0.301	0.62	0.748
C. D. (P = 0.05)		0.131	0.326	0.82	2.122	5.741	0.295	0.985	0.615	1.265	1.527
Nutrient management practices											
N_1	100% RDF (Recommended Dose of Fertilizers)	1.30	15.06	16.30	149.02	135.82	14.27	29.78	39.00	60.49	166.69
N_2	100% RDN through Organic manure (33% FYM +33% VC +33% PM)	0.32	13.17	13.65	109.22	71.38	12.7	21.51	28.75	31.15	156.83
N_3	50% RDN through Urea + 50% N through Farm Yard Manure	0.48	13.51	13.93	112.32	85.32	13.01	22.69	29.91	34.06	156.49
N_4	50% RDN through Urea + 50% N through Vermi compost	0.78	13.77	14.75	133.76	101.25	13.13	24.19	31.63	40.67	151.38
N_5	50% RDN through Urea + 50% N through Poultry Manure	1.01	13.92	15	123.28	111.28	13.23	24.75	33.21	44.22	139.08
N_6	25% RDN through Urea +50% N through FYM + 25% Gliricidia + Azot.	1.22	14.1	15.35	147.27	116.62	13.62	25.32	34.21	48.42	152.88
N_7	25% RDN through Urea + 50% N through VC + 25% Gliricidia + Azot.	1.37	14.38	15.78	146.25	125.08	13.75	26.43	35.5	56.36	159.59
N_8	25% RDN through Urea + 50 % through PM + 25% Gliricidia + Azot	1.56	14.57	16.63	148.78	134.02	13.95	27.25	37.36	60.22	163.49
F-test		S	S	S	S	S	S	S	S	S	S
S. Ed. (±)		0.032	0.089	0.212	0.798	1.406	0.072	0.241	0.151	0.31	0.374
C. D. (P = 0.05)		0.066	0.178	0.424	1.596	2.871	0.148	0.492	0.308	0.633	0.764

The result under maize-green gram of the present study indicated that growth parameters of plant such as plant height, stem diameter, number of leaves/plant, Leaf area index/plant, dry weight (g), Crop growth rate and relative growth rate of maize crop were significantly influenced by different integrated nutrients management treatments in table 1. Among the integrated nutrient management treatments, during the successive stages in pooled analysis the maximum (145.41,2.01,10.65,3.42 and 97.73) were recorded in application of N_1 [100% RDF (Recommended Dose of Fertilizers)], followed by N_8[25% RDN through Urea + 50 % through PM + 25% Gliricidia + Azot] was [144.85,1.88,10.56,3.38 and97.04], however the maximum crop growth rate and relative growth rate was recorded in N_8[25% RDN through Urea + 50 % through PM + 25% Gliricidia + Azot].

The reason for higher values of growth parameter can be discussed in the light of fact that crop under these treatments had comparatively make easily extractable and more nutrient available in the field for plants and thereby more availability of nutrients than other treatments which resulted in better crop growth like plant population, Plant height, number of leaves, stem girth, leaf area, leaf area index, dry weight, crop growth rate, relative growth rate, were all measured throughout the inquiry and pooled analysis of the maize crop at all growth phases. When compared to solitary maize, the data in Tables 1 showed an increase in plant height, number of leaves, and stem diameter due to intercropping with green gram. Maize plant height, number of leaves, and stem diameter increased in association with green gram during the successive stages. This could be attributed to the maize and component crop association's synergistic effect (Singh and Bajpai, 1991). This could possibly be due to green gram and cluster bean's ability to fix atmospheric nitrogen in the soil, making it available to plant roots (Chen *et al*., 2004). In addition, legumes can provide nutritive value to the soil by directly fixing nitrogen (N) to non-legumes through mycorrizal links, root exudates, or decay of roots and nodules; or indirectly during the spring season, when the legume fixes atmospheric nitrogen (N2), reducing competition for soil NO3 with non-legumes (Hellou *et al*., 2006). All of these modifications are predicted to have an additive influence on the crop's availability of both applied and native nutrients. It is reflected in the findings of this study. At all stages, these growth indicators showed an improvement. These findings are in agreement with the findings recorded by Jat *et al*. (2014), Shahbazi and Sarajuoghi (2012) and Mobasser *et al.* (2014).

Yield attributes

Yield attributes, which determine yield, is the resultant of the vegetative development of the plant. All the attributes of yield viz. Number of cob/plant, Cob Diameter (cm), Length of Cob (cm), Weight of Cob (g) with husk, Weight of cob (g) without husk, Number of Row Per Cob, No of Grain per row, 100 Seed Weight (gm).The result under maize-green gram intercropping due to cropping systems showed that non significant except Total yield (q/ha) and Stover yield/Biological yield (q/ha).

The result under maize-green gram of the present study indicated that all the yield attributes of Number of cob/plant, Cob Diameter (cm), Length of Cob (cm), Weight of Cob (g) with husk, Weight of cob (g) without husk, Number of Row Per Cob, No of Grain per row, 100 Seed Weight (gm). The result under maize-green gram intercropping due to cropping systems showed that non significant except Total yield (q/ha) and Stover yield/Biological yield (q/ha) were significantly influenced by different integrated nutrients management treatments in table 2. Among the integrated nutrient management treatments, during the successive stages in pooled analysis the maximum yield attributes (15.06, 149.02, 135.82, 14.27, 29.78, 39.00, 60.49 and 166.69) were recorded in application of N_1 [100% RDF (Recommended Dose of Fertilizers)], followed by N_8 [25% RDN through Urea + 50 % through PM + 25% Gliricidia + Azot] was [144.85, 1.88, 10.56, 3.38 and 97.04], however the maximum Number of cob/plant and Length of Cob (cm) was recorded in N_8 [25% RDN through Urea + 50 % through PM + 25% Gliricidia + Azot], respectively.

Intercrops' beneficial effects promote vigour and growth, which boost maize's ability to produce dry matter. This made it possible for maize's yield qualities to develop more effectively. The considerably higher in the pooled analysis. Furthermore, the treatments of Maize + Green Gram (1:1) Recommended Dose of Fertilizer (100%) showed significantly higher Stover Yield/Biological (q/ha) than sole Maize, which could be attributed to improved growth parameters like plant height, number of leaves, stem girth, leaf area, and ultimately dry weight per plant. The fact that maize intercrops with component crops leads to an increase in cob girth may be due to both maize’s superior ability to compete with legumes in terms of more efficient resource use as well as the intercrop's access to sufficient soil moisture due to less evapo transpiration than a sole crop (Odhiambo and Ariga, 2001). Another aspect contributing to the improvement in yield characteristics was probably increases in N intake by linked maize as a result of elevated nitrogen fixation by companion crops (Haymes and Lee, 1999). Odhiambo and Ariga (2001), Latati *et al*. and others (2013).

CONCLUSIONS

Intercropping systems were shown to be advantageous in terms of atmospheric N2 fixation because inter specific competition combined with complementarily boosts crop stand ability to utilise natural resources efficiently. Under test settings, it was discovered that intercropping maize with green gram in a 1:1 additive series was the most productive for improving growth, yield, economics, efficiency of land use, and N2 fixation. The growth, yield, quality, soil nutrient availability, nutrient absorption, and economics of maize and green gram were all improved by the complimentary application of several types of organic manure. Because inter specific competition and complementarities improve crop stands' capacity to effectively exploit natural resources, intercropping systems have been proven to be favourable in terms of atmospheric N2 fixation. Intercropping maize with green gram in a 1:1 additive series was shown to be the most effective under test conditions for enhancing growth, yield, economics, land-use efficiency, and N2 fixation. The complementary application of several forms of organic manure enhanced the growth, yield, quality, soil nutrient availability, nutrient absorption, and economics of maize and green gram.

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