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Role of Different Fertilization on Growth, Yield and Quality Evaluation in Maize (*Zea mays* L.) and Cowpea (*Vigna unguiculata* L.) Intercropping

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment had conducted during *Zaid* season 2022-2023. The experiment was conducted in split plot design and replicated thrice. The treatment in main plot consisted of three intercropping and in sub plots five different organic manures and different levels of fertilizers. Soil of the experiment field was clayey in texture had soil slightly alkaline, medium organic carbon (0.71%), low in available nitrogen (246.64 kg ha^{-1}), medium in available phosphorous (21.6 kg ha^{-1}) and high in available potassium (282 kg ha^{-1}). A keen observation of data revealed that application of organic manures and different levels of fertilizers with intercropping both significantly influenced the growth parameters, yield parameters and yield, economic attributes like gross return, net return and B:C ratio was significantly maximum at IC_2 maize + cowpea (2:1) with different organic manures and levels of fertilizers application F_5 (50% RDF + 5 t FYM ha^{-1} + 2 t VC ha^{-1} + 2 t PM ha^{-1}).

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Keywords: Zea mays L.; Vigna unguiculata L.; intercropping; organic manures.

1. INTRODUCTION

Maize (*Zea mays* L.) is one of the most important cereal crops in the world. It belongs to family Gramineae and originated from the Central America and Mexico. It belongs to C_4 plant. Maize is highly valued cereals in the world that is why it is called "Queen of cereals". Having haploid number of 10 chromosomes (2n=20). In India, the average area is 9.76 million hectare with production of 26.14 million tones and having productivity 2629.28 kg ha^{-1} [1]. Maize crop absorbs large quantity of nutrients from soil for complete their life cycle. Mahmood *et al.* [2] adopted the different management practices to increase the maize yield and their production. Use of organic manures to increase the soil structure, soil texture and water holding capacity in the soil is improved. The application of UREA and DAP is help to increase the yield of maize.

Cowpea (*Vigna unguiculata* L.) known as "lobia" is used as a pulse crop, a fodder crop and green manure crop. It is a legume crop. It is also known as black eye pea [3]. It is rich in protein that's why it is also known as vegetable meat. It is used for both men as well as animal feed. Cowpea is mainly grown in Africa. About 90% of the total world acreage is in Africa. In India the area under cowpea is 3.9 million hectares with annual production of 2.21 million tones with a national productivity of 638 kg ha^{-1}.

Intercropping of legumes and cereals is an old practice in tropical agriculture that dates back to ancient civilization. Cereal and Legume intercropping is more productive and profitable cropping system in comparison with solitary cropping [4]. The main objective of intercropping has been to maximize use of resources such as space, light and nutrient [5]. The importance of intercropping in farming practices has long been recognized in India [6].

2. MATERIALS AND METHODS

The present investigation was carried out during *Zaid* season of the year 2022-2023 at Agronomy Research Farm Dhablan (Patiala). The experimental site is situated at about 30°19' North Latitude and 76°24' East Longitude at an altitude of about 250 m above the mean sea level.It is located in south eastern direction in Punjab state and North West India. The experiment site falls in Indo-Gangetic plains. During growing season (February to June), the weekly maximum and minimum temperature ranged from 24.7 ^{O}C – 44.4 ^{O}C and 10.4 ^{O}C – 27.7 ^{O}C, respectively. The average relative humidity ranged 90.2% to 43.0%. The total rainfall received during the crop period was 17.3 mm. The soil of experiment site was clayeyhaving 0.71% organic carbon, 246.64 kg ha^{-1}, 21.6 kg ha^{-1} and 282 kg $ha^{-1}$of available N, P_2O_5andK_2O respectively. The experiment was laid out in a SPD (split plot design) and replicated thrice. The main plot having three intercropping and the sub plot having five organic manures and different levels of fertilizers. The intercropping IC1 (5:1), IC_2 (2:1) and IC_3(3:1). Thefertilizer levels F_1: 100% RDF, F_2: 75% RDF +10 t FYM ha^{-1}, F_3: 50% RDF +5 t FYM ha^{-1} + 2 t VC ha^{-1}, F_4: 50% RDF +5 t FYM ha^{-1} + 2 t PM ha^{-1}, F_5: 50% RDF +5 t FYM ha^{-1} + 2 t VC ha^{-1} + 2 t PM ha^{-1}. The maize Variety CV-1899@ 20 kg $ha^{-1}$and cowpeavariety CV- S263 @ 18 kg ha^{-1} were sown in lines, row to row spacing is 45 cm and plant to plant spacing is 25 cm. The data recorded at 30, 60, 90 DAS and at harvest for all the parameters. Harvesting is done after cobs had turned brownish and grain hardened. The harvesting of cowpea was done manually with the help of sickle when pods were matured (when nearly 75% pods had turned brown). Shelling of cobs was done and grains were kept in bags treatment. Threshing was done by beating the bundle with sticks. Seeds were separated by winnowing and kept treatment wise in bags [7,8].

3. RESULTS AND DISCUSSION

3.1 Different Growth Parameter

The most decisive factors of growth is plant height (cm), number of leaves $plant^{-1}$, dry weight (g), leaf area index (LAI) have been shown in Table1. The highest value for plant height (172.22 cm), number of leaves $plant^{-1}$ (15.55), dry weight (63.29 g), leaf area index (6.14) was recorded with intercropping IC_2 maize + cowpea (2:1),respectively. Significantly maximum values for plant height (174.81 cm), number of leaves $plant^{-1}$ (17.53), dry weight (65.03 g), leaf area index (6.44) wasrecorded with different organic manures and fertilizer levels F_5 (50% RDF + 5 t FYM ha^{-1} + 2 t VC ha^{-1} + 2 t PM ha^{-1}). The probable reason for highest values might due to combined application of organic manures and RDF levels of fertilizers. On the other hand

cowpea is a legume crop having nodules which resulted in higher fixation of atmospheric nitrogen.The legume crop increase the root length and root volume of maize, which helps to absorb more water and nutrients. The similar results were also reported by Murlidhar [9].

The dry weight plant^{-1} was increased due to manures and intercropping with legume improves the physical, chemical as well as biological properties of the soil, which helps in providing suitable environment for growth of plant. The similar results were founded by Asangla and Gohain [10].

Intercropping can increase the leaf area index and crop growth rate of both crops. A higher leaf area index means that there are more leaves available for photosynthesis, which can lead to higher yields. These findings are in close vicinity of those of Alhaji [11] and Choudhary *et al.* [12].

The intercropping IC1 (5:1), IC_2 (2:1), IC_3 (3:1). The fertilizer levels F_1: 100% RDF, F_2: 75% RDF +10 t FYM ha^{-1}, F_3: 50% RDF +5 t FYM ha^{-1} + 2 t VC ha^{-1}, F_4: 50% RDF +5 t FYM ha^{-1} + 2 t PM ha^{-1}, F_5: 50% RDF +5 t FYM ha^{-1} + 2 t VC ha^{-1} + 2 t PM ha^{-1}.

Table 1. Effect of different fertilization on growth parameters of maize with cowpea intercropping

Treatments	Growth parameters			
	Plant height (cm)	Number of leaves plant^{-1}	Dry weight (g)	Leaf Area Index (LAI)
Main plot Intercropping				
IC_1: Maize + Cowpea (5:1)	168.72	14.51	61.55	5.96
IC_2: Maize + Cowpea (2:1)	172.22	15.55	63.29	6.14
IC_3: Maize + Cowpea (3:1)	169.87	14.98	63.23	6.06
SEm(±)	0.21	0.27	0.18	0.01
CD 5%	0.82	1.05	0.71	0.04
Sub plot (Fertilizers)				
F_1: 100% RDF	167.79	12.55	60.35	5.67
F_2: 75% RDF +10 t FYM ha^{-1}	168.37	13.88	60.79	5.87
F_3: 50% RDF +5 t FYM ha^{-1}+ 2t VC ha^{-1}	169.76	15.24	63.17	6.05
F_4: 50% RDF +5t FYM ha^{-1} +2 t PM ha^{-1}	170.61	15.86	64.14	6.24
F_5: 50% RDF +5 t FYM ha^{-1} +2 t VC ha^{-1}+2 t PM ha^{-1}	174.81	17.53	65.03	6.44
SEm(±)	1.04	0.47	0.51	0.01
CD 5%	3.00	1.37	1.47	0.02

Table 2. Effect of different fertilization on yield parameters of maize with cowpea intercropping

Treatments	Yield parameters	
	Seed yield (q ha^{-1})	Stover yield (q ha^{-1})
Main plot Intercropping		
IC_1: Maize + Cowpea (5:1)	42.94	60.39
IC_2: Maize + Cowpea (2:1)	45.27	66.63
IC_3: Maize + Cowpea (3:1)	45.02	63.39
SEm(±)	0.07	0.10
CD 5%	0.29	0.40
Sub plot (Fertilizers)		
F_1: 100% RDF	43.48	61.24
F_2: 75% RDF +10 t FYM ha^{-1}	44.22	62.40
F_3: 50% RDF +5 t FYM ha^{-1}+ 2t VC ha^{-1}	44.53	62.98
F_4: 50% RDF +5t FYM ha^{-1} +2 t PM ha^{-1}	44.74	63.47
F_5: 50% RDF +5 t FYM ha^{-1} +2 t VC ha^{-1}+2 t PM ha^{-1}	45.09	67.27
SEm(±)	0.11	0.51
CD 5%	0.32	1.48

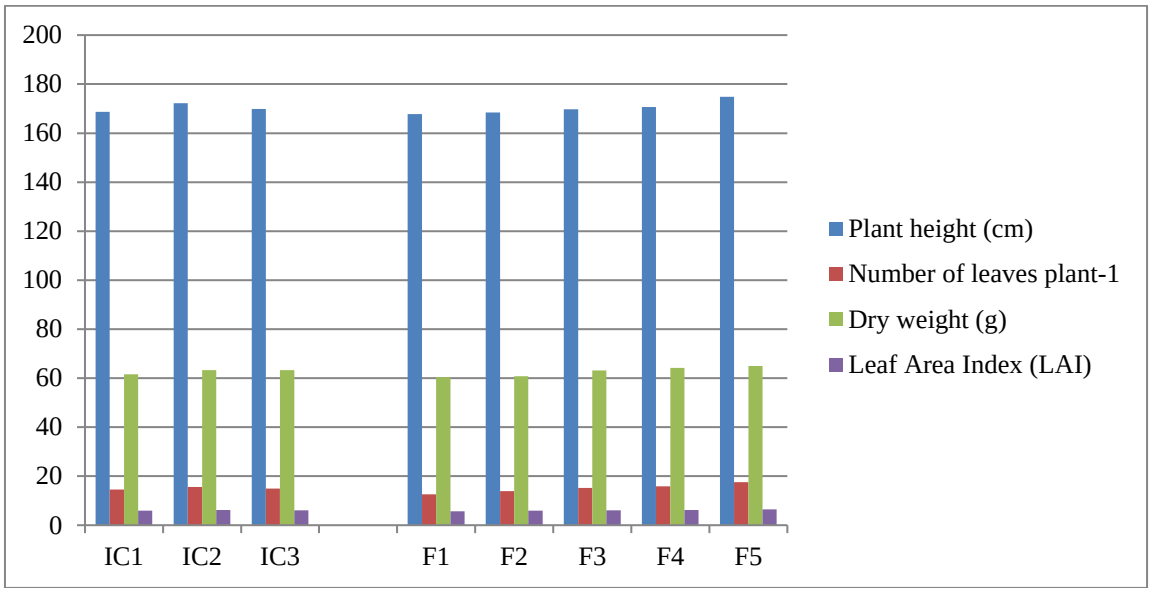

Fig. 1. Effect of different fertilization on growth parameters of maize with cowpea intercropping

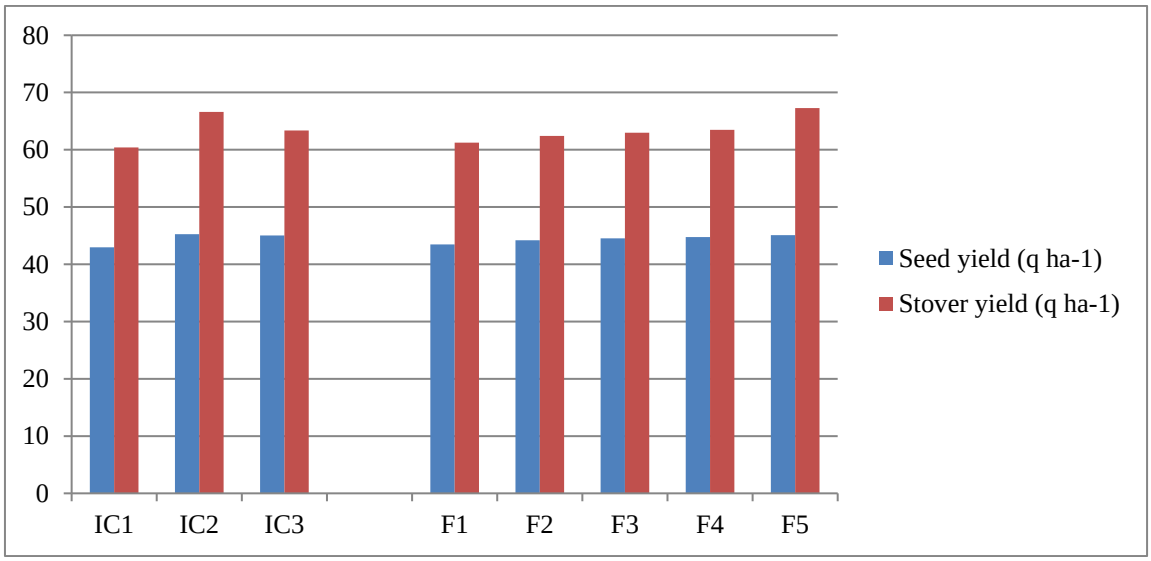

Fig. 2. Effect of different fertilization on yield parameters of maize with cowpea intercropping

3.2 Yield Parameters

The data on seed yield and stover yield was increased with the organic manure and different levels of fertilizers with intercropping. The maximum seed yield (45.27 q ha^{-1}) and stover yield (66.63 q ha^{-1}) were recorded with IC_2 maize + cowpea (2:1) and also seed yield (45.09 q ha^{-1}) and stover yield (67.27 q ha^{-1}) with F_5 (50% RDF + 5 t FYM ha^{-1} + 2 t VC ha^{-1} + 2 t PM ha^{-1}). The reason behind this proper vegetative and reproductive growth is better with combined application of fertilizers and manures with intercropping. These also stimulated the various physiological process and metabolic activities which gave better growth and yield of crop [13-15].

4. CONCLUSION

On the basis of obtained results from the field experiment, it can be concluded that maximum growth parameters was achieved when the crops intercrop with IC_2 maize + cowpea (2:1) and also with F_5 (50% RDF + 5 t FYM ha^{-1} + 2 t VC ha^{-1} + 2 t PM ha^{-1}).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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