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## Effect of nutrient management and intercropping with cowpea on growth and yield of maize (*Zea mays* L.)

Debasmita Patra and Joy Dawson

### Abstract

A field experiment was conducted during *Kharif* 2021 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.36%), available N (171.48 kg/ha), available P (15.2 kg/ha) and available K (232.5 kg/ha). The experiment was laid out in Randomized Block Design with nine treatments each replicated thrice on the basis of one year experimentation. The treatments which are T<sub>1</sub>: Sole Maize + 25% RDN + 75% FYM + Biofertilizers, T<sub>2</sub>: Sole Maize + 50% RDN + 50% FYM + Biofertilizers, T<sub>3</sub>: Sole Maize + 75% RDN + 25% FYM + Biofertilizers, T<sub>4</sub>: Sole Cowpea + 25% RDN + 75% FYM + Biofertilizers, T<sub>5</sub>: Sole Cowpea +50% RDN + 50% FYM + Biofertilizers, T<sub>6</sub>: Sole Cowpea + 75% RDN + 25% FYM + Biofertilizers, T<sub>7</sub>: Maize + Cowpea (1:2) + 25% RDN + 75% FYM + Biofertilizers, T<sub>8</sub>: Maize + Cowpea (1:2) + 50% RDN + 50% FYM + Biofertilizers, T<sub>9</sub>: Maize + Cowpea (1:2) +75% RDN + 25% FYM + Biofertilizers used. The results showed that Sole Maize + 75% RDN + 25% FYM + Biofertilizers was recorded significantly higher Plant height (173.89 cm), Plant dry weight (148.68 g/plant), crop growth rate (41.38 g/m<sup>2</sup>/day), Cobs/Plant (2.67), cob length (23.60 cm), Cob weight (89.39 g), Grains/cob (371.37), seed index (26.05 g), Seed yield (6391.63 kg/ha) and Straw yield (9247 kg/ha) in Maize crop.

**Keywords:** Biofertilizer, FYM, intercropping, maize, nitrogen

### Introduction

Maize (*Zea mays* L.) is a cereal crop and it is called as “queen of cereals” and “non-tillering plant”. Maize is one of the three major world food crops, is recognized as the “golden food” because of its high grain yield and nutrition value, and plays a very important role in the daily calorie intake of humans. Maize is the third most important crop in India after rice and wheat. In the world, India’s ranks 5th in acreage and 8th in production of maize (USDA 2018). Maize or corn serves as a basic raw material to thousands of industrial products that may include oil, starch, alcoholic beverages, pharmaceutical, food sweeteners, cosmetic, gum, textile, package and paper industries. Corn is good for digestion due to its fiber content and corn may prevent diabetes and hypertension. The nutritional value of maize is high as it contains 72% starch, 10% protein, 8.5% fibre, 4.8% oil, 3.0% sugar and 1.7% ash (Hokmalipour *et al.*, 2010) [5]. The starch in maize can be hydrolysed and enzymatically treated to produce syrups, particularly high fructose corn syrup, and a sweetener; and also fermented and distilled to produce grain alcohol. Grain alcohol from maize is traditionally the source of Bourbon whiskey (Mohammadi *et al.*, 2012) [9]. The major maize producing countries are USA, China, Brazil, Argentina, Mexico, South Africa, Yugoslavia and India. In India, Maize is emerging as third most important cereal crop after rice and wheat that occupies an area of 9.60 million ha with the production of 27.15 million tonnes, having average productivity of about 2.8 tonnes/ha.

Intercropping is one of the ways to increase the productivity/unit area of land under the supply of limited resources. This system not only provides certain insurance against biotic and abiotic stress but also helps in the maximization of productivity and profit by efficient utilization of natural resources. Cereal-legume intercropping plays an important role in subsistence food production in both undeveloped and developing countries, especially in situations of limited water resources. Yields of intercropping are often higher than in sole cropping systems (Dahmardeh *et al.*, 2009) [4].

Biofertilizers stimulates the activity of microorganisms that makes the plant to get the macro and micro-nutrients through enhanced biological processes, increase nutrient solubility, alter soil salinity, sodicity and pH. (Alabadian *et al.*, 2009) [1], though, they contain relatively low

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concentrations of nutrients and handling them is labour intensive, there has been largely increase in their use over inorganic fertilizers as nutrient source (Kannan *et al.*, 2005)<sup>[7]</sup>. The long term manurial studies conducted at many places have revealed the superiority of integrated nutrient supply system in sustaining crop productivity at comparison to chemical fertilizer alone.

## Materials and Methods

The present examination was carried out during *Kharif* 2021 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj, UP, which is located at 25.28°N latitude, 81.54°E longitude and 98 m altitude above the mean sea level. The experiment laid out in Randomized Block Design which consisting of nine treatments with T<sub>1</sub>: Sole Maize + 25% RDN + 75% FYM + Biofertilizers, T<sub>2</sub>: Sole Maize + 50% RDN + 50% FYM + Biofertilizers, T<sub>3</sub>: Sole Maize + 75% RDN + 25% FYM + Biofertilizers, T<sub>4</sub>: Sole Cowpea + 25% RDN + 75% FYM + Biofertilizers, T<sub>5</sub>: Sole Cowpea + 50% RDN + 50% FYM + Biofertilizers, T<sub>6</sub>: Sole Cowpea + 75% RDN + 25% FYM + Biofertilizers, T<sub>7</sub>: Maize + Cowpea (1:2) + 25% RDN + 75% FYM + Biofertilizers, T<sub>8</sub>: Maize + Cowpea (1:2) + 50% RDN + 50% FYM + Biofertilizers, T<sub>9</sub>: Maize + Cowpea (1:2) + 75% RDN + 25% FYM + Biofertilizers used. The experimental site was uniform in topography and sandy loam in texture, nearly neutral in soil reaction (P<sup>H</sup> 7.1), low in Organic carbon (0.38%), medium available N (225 kg ha<sup>-1</sup>), higher available P (19.50 kg ha<sup>-1</sup>) and medium available K (213.7 kg ha<sup>-1</sup>). In the period from germination to harvest several plant growth parameters were recorded at frequent intervals along with it after harvest several yield parameters were recorded those parameters are growth parameters, plant height, plant dry weight are recorded. The yield parameters like Cobs/plant, Cob length (cm), Cob weight, No. of grains/cob, seed yield, stover yield and Seed index were recorded and statistically analyzed using analysis of variance (ANOVA) as applicable to Randomized Block Design (Gomez K.A. and Gomez A.A. 1984).

## Results and Discussion

### Growth attributes

#### Plant height

Plant height was recorded maximum of 173.89 cm in T<sub>3</sub> (Sole Maize + 75% RDN + 25% FYM + Biofertilizers). However, plant height 170.12 cm with T<sub>2</sub> (Sole Maize + 50% RDN + 50% FYM + Biofertilizers), 168.53 cm with T<sub>1</sub> (Sole Maize + 25% RDN + 75% FYM + Biofertilizers) and 167.51 cm with T<sub>9</sub> (Maize + Cowpea (1:2) + 75% RDN + 25% FYM + Biofertilizers) were statistically at par with T<sub>3</sub> compared to other treatments.

Sole cropping of maize recorded highest plant height due to the absence of intercropping competition during initial stages, which resulted in the higher plant height and also the supply of nitrogen through chemical means and biological means boosted the plant height. The results were found to be similar with AnilKumar *et al.* (2007)<sup>[2]</sup>.

The significant increase in the height may be due to inoculation of bacterial preparation accelerate plant growth provide biologically fixed nitrogen to the inoculated plant, and also supply of nitrogen through inorganic and organic means promoted the increase in plant height. Similar results were observed by Thavaprakash *et al.* (2008)<sup>[11]</sup>.

#### Plant dry weight (g/plant)

Dry weight was recorded maximum of 148.68 g in T<sub>3</sub> (Sole Maize + 75% RDN + 25% FYM + Biofertilizers). However, dry weight 145.53 g with T<sub>2</sub> (Sole Maize + 50% RDN + 50% FYM + Biofertilizers) and 143.42 g with T<sub>1</sub> (Sole Maize + 25% RDN + 75% FYM + Biofertilizers) were statistically at par with T<sub>3</sub> compared to other treatments.

The probable reason for higher dry matter production might the application of FYM stimulated the plant growth due the higher microbial activity and soil reaction and large portion of nitrogen in FYM in organic fractions and application of RDF through inorganic means resulted in higher concentration of nutrients in plant results in higher dry matter accumulation. The results were found in accordance with Rawat *et al.* (2018)<sup>[10]</sup>.

### Yield attributes and Yield

#### Cobs/plant

T<sub>3</sub> (Sole Maize + 75% RDN + 25% FYM + Biofertilizers) recorded maximum cobs/plant (2.67). However, cobs/plant 2.46 with T<sub>2</sub> (Sole Maize + 50% RDN + 50% FYM + Biofertilizers) and 2.35 with T<sub>1</sub> (Sole Maize + 25% RDN + 75% FYM + Biofertilizers) were statistically at par with T<sub>3</sub> compared to other treatments.

#### Cob length (cm)

T<sub>3</sub> (Sole Maize + 75% RDN + 25% FYM + Biofertilizers) recorded maximum cob length (23.60 cm). However, cob length 21.70 cm with T<sub>2</sub> (Sole Maize + 50% RDN + 50% FYM + Biofertilizers) and 20.57 cm with T<sub>1</sub> (Sole Maize + 25% RDN + 75% FYM + Biofertilizers) were statistically at par with T<sub>3</sub> compared to other treatments.

#### Cob weight (g)

T<sub>3</sub> (Sole Maize + 75% RDN + 25% FYM + Biofertilizers) recorded maximum cob weight (89.39 g). However, cob weight 88.41 g with T<sub>2</sub> (Sole Maize + 50% RDN + 50% FYM + Biofertilizers), 87.22 g with T<sub>1</sub> (Sole Maize + 25% RDN + 75% FYM + Biofertilizers) and 86.38 g with T<sub>9</sub> (Maize + Cowpea (1:2) + 75% RDN + 25% FYM + Biofertilizers) were statistically at par with T<sub>3</sub> compared to other treatments.

#### Grains/cob (No.)

T<sub>3</sub> (Sole Maize + 75% RDN + 25% FYM + Biofertilizers) recorded maximum grains/cob (371.37). However, grains/cob 362.37 with T<sub>2</sub> (Sole Maize + 50% RDN + 50% FYM + Biofertilizers), 357.20 with T<sub>1</sub> (Sole Maize + 25% RDN + 75% FYM + Biofertilizers) and 351.10 with T<sub>9</sub> (Maize + Cowpea (1:2) + 75% RDN + 25% FYM + Biofertilizers) were statistically at par with T<sub>3</sub> compared to other treatments.

Sole stand of maize recorded better yield attributes *viz.* cobs/plant, cob length, cob weight and grains/cob as compared to intercropping systems might be due to plant population at maturity stage along with less mortality percentage and lesser competition for nutrients, light and space. The findings were similar with Iderawumi (2014)<sup>[6]</sup>.

#### Seed index (g)

T<sub>3</sub> (Sole Maize + 75% RDN + 25% FYM + Biofertilizers) recorded maximum seed index (26.05 g). However, seed index 25.64 g with T<sub>2</sub> (Sole Maize + 50% RDN + 50% FYM + Biofertilizers) and 25.43 g with T<sub>1</sub> (Sole Maize + 25% RDN

+ 75% FYM + Biofertilizers) were statistically at par with T<sub>3</sub> compared to other treatments.

### Seed yield (kg/ha)

T<sub>3</sub> (Sole Maize + 75% RDN + 25% FYM + Biofertilizers) recorded maximum seed yield (6391.63 kg/ha). However, seed yield 6276.9 kg/ha with T<sub>2</sub> (Sole Maize + 50% RDN + 50% FYM + Biofertilizers), 6186.13 kg/ha with T<sub>1</sub> (Sole Maize + 25% RDN + 75% FYM + Biofertilizers) and 5964.90 kg/ha with T<sub>9</sub> (Maize + cowpea (1:2) + 75% RDN + 25% FYM + Biofertilizers) were statistically at par with T<sub>3</sub> compared to other treatments.

### Straw yield (kg/ha)

T<sub>3</sub> (Sole Maize + 75% RDN + 25% FYM + Biofertilizers) recorded maximum seed yield (9247.40 kg/ha). However, seed yield 9144.57 kg/ha with T<sub>2</sub> (Sole Maize + 50% RDN + 50% FYM + Biofertilizers), 8982.37 kg/ha with T<sub>1</sub> (Sole Maize + 25% RDN + 75% FYM + Biofertilizers), 8865.43 kg/ha with T<sub>9</sub> (Maize + Cowpea (1:2) + 75% RDN + 25% FYM + Biofertilizers) and 8791.10 kg/ha with T<sub>8</sub> (Maize + Cowpea (1:2) + 50% RDN + 50% FYM + Biofertilizers) were statistically at par with T<sub>3</sub> compared to other treatments.

The higher grain yield and straw yield were recorded in sole cropping of maize because the higher plant population at maturity and also the lesser competition between the crops for natural resources. Similar findings were observed by Biswas *et al.* (2017).

This positive effect might be due to the fact that nitrogen is well known for its role in development and growth of plant

and in various vitally important metabolic processes in the plant, the positive results of RDF and FYM application helped in increase of plant growth which led to higher seed and stover yield. The similar findings were found by Kundu (2004) [8].

**Table 1:** Effect of intercropping system and nutrient management on growth attributes of Maize

Treatments	Plant height (cm)	Dry weight (g/plant)
Sole Maize + 25% RDN + 75% FYM + Biofertilizers	168.53	143.42
Sole Maize + 50% RDN + 50% FYM + Biofertilizers	170.12	145.53
Sole Maize + 75% RDN + 25% FYM + Biofertilizers	173.89	148.68
Sole Cowpea + 25% RDN + 75% FYM + Biofertilizers	-	-
Sole Cowpea + 50% RDN + 50% FYM + Biofertilizers	-	-
Sole Cowpea + 75% RDN + 25% FYM + Biofertilizers	-	-
Maize + Cowpea (1:2) + 25% RDN + 75% FYM + Biofertilizers	157.74	137.34
Maize + Cowpea (1:2) + 50% RDN + 50% FYM + Biofertilizers	161.51	139.74
Maize + Cowpea (1:2) + 75% RDN + 25% FYM + Biofertilizers	167.51	141.52
F-test	S	S
S. EM (±)	3.60	2.61
C. D. (P = 0.05)	10.80	7.83

**Table 2:** Effect of intercropping system and nutrient management on yield attributes of Maize

Treatments	Cobs/plant	Cob length (cm)	Cob weight (g)	Grains/cob (No.)	Seed index (g)	Seed yield (kg/ha)	Straw yield (kg/ha)
Sole Maize + 25% RDN + 75% FYM + Biofertilizers	2.35	20.57	87.22	357.20	25.43	6186.13	8982.37
Sole Maize + 50% RDN + 50% FYM + Biofertilizers	2.46	21.70	88.41	362.37	25.64	6276.93	9144.57
Sole Maize + 75% RDN + 25% FYM + Biofertilizers	2.67	23.60	89.39	371.37	26.05	6391.63	9247.40
Sole Cowpea + 25% RDN + 75% FYM + Biofertilizers	-	-	-	-	-	-	-
Sole Cowpea + 50% RDN + 50% FYM + Biofertilizers	-	-	-	-	-	-	-
Sole Cowpea + 75% RDN + 25% FYM + Biofertilizers	-	-	-	-	-	-	-
Maize + Cowpea (1:2) + 25% RDN + 75% FYM + Biofertilizers	1.89	17.70	84.02	325.40	24.87	5682.47	8810.17
Maize + Cowpea (1:2) + 50% RDN + 50% FYM + Biofertilizers	2.02	18.87	85.01	340.10	25.01	5746.23	8791.10
Maize + Cowpea (1:2) + 75% RDN + 25% FYM + Biofertilizers	2.14	19.70	86.38	351.10	25.17	5964.90	8865.43
F test	S	S	S	S	S	S	S
S. EM (±)	0.12	1.19	1.42	8.26	0.20	194.11	159.05
CD (P = 0.05)	0.37	3.56	4.26	24.75	0.59	581.93	476.84

### Conclusion

It is concluded that Sole crops recorded highest grain yield compared to intercropping. Since, the findings based on the research done in one season.

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