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Maize Yield Response to Organic Fertilizers and Biofertilizers in a Sub-Tropical Zone of Eastern Himalayan Region of Arunachal Pradesh, India

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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 was conducted at the Department of Agriculture at Himalayan University, Jullang, Arunachal Pradesh, to assess the impact of composts and biofertilizers on plant growth. The available soil nutrient status were medium in N, High in P and medium in K in study soil.The treatments considered of T_1- Control 100 % RDF, T_2 - Vermicompost 0.5 Kg/ha + *Phosphorus solubilizing bacteria* 0.5Kg/ha, T_3 – Poultry manure 0.5 Kg/ha + *Azotobacter* 0.5Kg/ha, T_4 – Compost 0.5Kg/ha + *Phosphorus solubilizing bacteria* 0.5Kg/ha + Azotobacter 0.5Kg/ha, T_5 –

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compost 0.5Kg/ha + *Phosphorus solubilizing bacteria* 0.5 Kg/ha , T_6 – Poultry manure 0.5Kg/ha+ *Azotobacter* 0.5Kg/ha, T_7 – Vermicompost 0.5Kg/ha + *Phosphorus solubilizing bacteria* 0.5Kg/ha + *Azotobacter* 0.5Kg/ha.The highest cob plant^{-1} recorded highest in treatment receiving Vermicompost 0.5 Kg/ha + *Phosphorus solubilizing bacteria* 0.5 Kg/ha + *Azotobacter* 0.5 Kg/ha(T_7) i.e 1.93. highest cob length recorded 13.80 cm receiving treatment Vermicompost 0.5Kg/ha+ *Phosphorus Solubilizing Bacteria* 0.5Kg/ha + *Azotobacter* 0.5Kg/ha (T_7).The highest number of cob grain^{-1} is 394.47 receiving Vermicompost 0.5Kg/ha + *Phosphorus solubilizing bacteria* 0.5Kg/ha + *Azotobacter* 0.5Kg/ha (T_7) and 12.03 g of test weight were obtained with treatment (T_7) receiving Vermicompost 0.5Kg/ha + *Phosphorus solubilizing bacteria* 0.5Kg/ha + *Azotobacte* 0.5Kg/ha .

Keywords: Maize; vermicompost; PSB; azotobacter; compost and das.

1. INTRODUCTION

“Maize is one of the most important cereal crops of the world in terms of its global production. It ranks second to wheat and equal to rice. Globally, 67 percent of maize is used for livestock feed, 25 percent for human consumption and industrial purposes, while 5 percent is used for seed purposes to sow next crop” [1]. During its vegetative growth the maize plant consumes large quantities of water which it utilizes very rationally to form its organic mass. During intensive growth a full grown maize plant evaporates about 2-4 kilograms of water daily [2]. “As corn plant grows, its demand for water increases with increasing leaf area which reaches a maximum near the tasseling stage. The period of time shortly before pollination through grain fill, when the kernels begin to dent, is a critical period during which adequate moisture is important to corn yield” [3].

“Maize consumption in India can broadly be divided into three categories *viz*. Feed, food and industrial non-food products (mainly starch). The most important use and demand driver of maize is poultry and cattle feed which accounts 63 % of total maize consumption and nearly 8 per cent of maize is consumed by humans. The major consumption states in India are Karnataka, Andhra Pradesh, Punjab, Gujarat, Haryana, Telangana, Tamil Nadu, Bihar, West Bengal” [4].

2. MATERIALS AND METHODS

The experiment was conducted during the *rabi* season from November to December of 2022 at the Himalayan University, Itanagar. The farm is located in Jullang, University campus. The Crop Research Farm is situated at 27.14^0 N latitude and 93.62^0 E longitudes and at an altitude of 320 m above mean sea level. The site comes under the Eastern Himalayan region and the agro climatic zone is under sub-tropical zone of Arunachal Pradesh [5]. The soil of the experimental field constituting a part of central Gangetic alluvium is neutral and deep. Pre-sowing soil samples were taken from a depth of 15 cm with the help of an auger. The composite samples were used for the chemical and mechanical analysis. The soil was sandy loam in texture with high acidic content and also rich in organic matter. The mechanical, chemical and physio-chemical properties of the soil of experimental field.

3. RESULTS AND DISCUSSION

The number of cobs plant^{-1}, recorded at harvest is presented in Tables . The data shows that there was significant effect of different treatments on the number of cobs plant^{-1}.Maximum number of cobs plant^{-1} was found to be statistically significant in treatment T_7 (Vermicompost 0.5Kg/ha + *Phosphorus Solubilizing Bacteria* 0.5Kg/ha + *Azotobacter* 0.5Kg/ha) *i,e.,* 1.93 and T_2 (Vermicompost 0.5Kg/ha + *Phosphorus Solubilizing Bacteria* 0.5Kg/ha) *i,e.,* 1.73 was found to be statistically at par with T_7 (Vermicompost 0.5Kg/ha + *Phosphorus Solubilizing Bacteria* 0.5Kg/ha + *Azotobacter* 0.5Kg/ha). Lowest number of cobs plant $^{-1}$ was observed in treatment T_1 (Control) *i.e.,* 1.20.

The probable reason for recording higher number of cobs plant^{-1} under treatment T_7 (Vermicompost 0.5Kg/ha + *Phosphorus Solubilizing Bacteria* 0.5Kg/ha + *Azotobacter* 0.5Kg/ha) is due to the use of Vermicompost which increased the total N uptake in the above ground biomass of maize and the maximum number of cobs plant^{-1} and biological yield was seen in the combination of *Azotobacter* and *Phosphorus solubilizing bacteria* [6].

At harvest, the significant and highest cob length was recorded in treatments T_7 (Vermicompost 0.5Kg/ha + *Phosphorus Solubilizing Bacteria*

0.5Kg/ha + *Azotobacter* 0.5Kg/ha) *i,e.,* 13.80 cm and T_2 (Vermicompost 0.5Kg/ha + *Phosphorus Solubilizing Bacteria* 0.5Kg/ha) *i,e.,* 12.20 cm was found to be statistically at par with T_7 (Vermicompost 0.5Kg/ha + *Phosphorus Solubilizing Bacteria* 0.5Kg/ha + *Azotobacter* 0.5Kg/ha). Lowest cob length (cm) was observed in treatment T_1 (Control) *i.e.,* 11.47 cm. The probable reason for recording higher cob length (cm) under treatment T_7 (Vermicompost 0.5Kg/ha + *Phosphorus Solubilizing Bacteria* 0.5Kg/ha + *Azotobacter* 0.5Kg/ha) is due to the vermicompost was sustainable model for increasing water storage, producing greater economic benefit and maintaining SOC balance for maize production Khalil *et al*. 2005 and use of *Azotobacter* and *Phosphorus solubilizing bacteria* biofertilizer increases the yield parameters, diameter of cob, volume of cob and number of rows per cob [7].

Chart 1. Initial soil properties of field experiment

Soil properties	Status
Sand (%)	53.47 %
Silt (%)	37.65 %
Clay (%)	8.88 %
Organic carbon	5.2%
pH	5.10
EC	0.6 dS/m
Available Nitrogen	290 Kg/ha
Available Phosphorus	35.50 Kg/ha
Available Potassium	157.9 Kg/ha

Table 1. Effect of organic fertilizers and biofertilizers on number of cobs plant^{-1} of *rabi* maize

	Treatments	Number of cobs plant $^{-1}$
T_1	Control	1.20
T_2	Vermicompost 0.5Kg/ha + *Phosphorus Solubilizing Bacteria* 0.5Kg/ha	1.73
T_3	Poultry manure0.5Kg/ha + *Azotobacter*0.5Kg/ha	1.47
T_4	Compost 0.5Kg/ha + *Phosphorus Solubilizing Bacteria* 0.5Kg/ha + *Azotobacter* 0.5Kg/ha	1.73
T_5	Compost 0.5Kg/ha + *Phosphorus Solubilizing Bacteria* 0.5Kg/ha	1.60
T_6	Poultry manure 0.5Kg/ha + *Phosphorus Solubilizing Bacteria*0.5Kg/ha	1.60
T_7	Vermicompost 0.5Kg/ha + *Phosphorus Solubilizing Bacteria* 0.5Kg/ha + *Azotobacter* 0.5Kg/ha	1.93
F test		S
SEd (±)		0.06
CD (P= 0.05)		0.12

Table 2. Effect of organic fertilizers and biofertilizers on cobs length (cm) of *rabi* maize

Treatments	Cobs length (cm)
T_1	11.47
T_2	12.95
T_3	11.93
T_4	12.75
T_5	12.40
T_6	12.20
T_7	13.80
F test	S
SEd (±)	0.21
CD (P= 0.05)	0.47

Table 3. Effect of organic fertilizers and biofertilizers on grains/cob of *rabi* maize

Treatments	Grains/cob
T_1	339.73
T_2	390.87
T_3	360.67
T_4	381.40
T_5	383.93
T_6	379.93
T_7	394.47
F test	S
SEd (±)	4.54
CD (P= 0.05)	9.88

Table 4. Effect of organic fertilizers and biofertilizers on test weight (g) of *rabi* maize

Treatments	Test weight (g)
T_1	7.87
T_2	10.79
T_3	9.81
T_4	10.57
T_5	10.42
T_6	10.24
T_7	12.03
F test	S
SEd (±)	0.24
CD (P= 0.05)	0.53

Table 5 Effect of organic fertilizers and biofertilizers on grain yield of *rabi* maize

Treatments	Grain yield (t ha^{-1})
T_1	3.73
T_2	4.73
T_3	4.07
T_4	4.47
T_5	4.40
T_6	4.30
T_7	5.03
F test	S
SEd (±)	0.14
CD (P= 0.05)	0.31

The significant and highest grains cob^{-1} was recorded and observed in treatment T_7 (Vermicompost 0.5Kg/ha + *Phosphorus Solubilizing Bacteria* 0.5Kg/ha + *Azotobacter* 0.5Kg/ha) *i,e.,* 394.47 and T_2 (Vermicompost 0.5Kg/ha + *Phosphorus Solubilizing Bacteria* 0.5Kg/ha) *i,e.,* 390.87 was found to be statistically at par with T_7 (Vermicompost 0.5Kg/ha + *Phosphorus Solubilizing Bacteria* 0.5Kg/ha + *Azotobacter* 0.5Kg/ha). Lowest grain cob^{-1} was observed in treatment T_1 (Control) *i.e.,* 339.73.

The probable reason for recording higher grains cob^{-1} under treatment T_7 (Vermicompost 0.5Kg/ha + *Phosphorus Solubilizing Bacteria* 0.5Kg/ha + *Azotobacter* 0.5Kg/ha) was because of the balanced nutrient through *Azotobacter* and *Phosphorus solubilizing bacteria* improved the growth parameter and root density like number of the grains per cob, diameter of cobs, test weight [7].

The significant and highest test weight (g) was recorded in treatment T_7 (Vermicompost 0.5Kg/ha + *Phosphorus Solubilizing Bacteria* 0.5Kg/ha + *Azotobacter* 0.5Kg/ha) *i,e.,* 12.03 g and T_2 (Vermicompost 0.5Kg/ha + *Phosphorus Solubilizing Bacteria* 0.5Kg/ha) *i,e.,* 10.79 g was found to be statistically at par with T_7

(Vermicompost 0.5Kg/ha + *Phosphorus Solubilizing Bacteria* 0.5Kg/ha + *Azotobacter* 0.5Kg/ha). Lowest test weight (g) was observed in treatment T_1 (Control) *i.e.,* 7.87 g.

The probable reason for recording higher test weight (g) under treatment T_7 (Vermicompost with PSB) was because of Vermicompost significantly affected extracellular enzyme production and N fertilizer application significantly affected the composition of the soil microbial community and use of *Phosphorus solubilizing bacteria* was recorded highest in test weight, grain yield and cob weight [8] and uptake of nitrogen by the crop is significantly increases in pod tests with the seeds were inoculated with *Azotobacter* spp.

The significant and highest grain yield was recorded in treatment T_7 (Vermicompost 0.5Kg/ha + *Phosphorus Solubilizing Bacteria* 0.5Kg/ha + *Azotobacter* 0.5Kg/ha) *i,e.,* 5.03 t ha^{-1} and T_2 (Vermicompost 0.5Kg/ha + *Phosphorus Solubilizing Bacteria* 0.5Kg/ha) *i,e.,* 4.73 t ha^{-1}, T_4(Compost 0.5Kg/ha + *Phosphorus Solubilizing Bacteria* 0.5Kg/ha + *Azotobacter* 0.5Kg/ha) *i,e.,* 4.47 t ha^{-1}, T_5 (Compost 0.5Kg/ha + *Phosphorous solubilizing Bacteria*0.5Kg/ha) *i,e.,* 4.40 t ha^{-1}, T_6 (Poultry manure 0.5Kg/ha + *Phosphorous solubilizing Bacteria* 0.5Kg/ha) *i,e.,* 4.30 t ha^{-1}, T_3 (Poultry manure 0.5Kg/ha + *Azotobacter* 0.5Kg/ha) *i,e.,* 4.07 t ha^{-1}. Lowest grain yield (t ha^{-1}) was observed in treatment T_1 (control) *i.e.,* 3.73 t ha^{-1} .

"The probable reason for recording higher grain yield (t ha^{-1}) under treatment T_7 (Vermicompost 0.5Kg/ha + *Phosphorus Solubilizing Bacteria* 0.5Kg/ha + *Azotobacter* 0.5Kg/ha) is due to phosphorous application because phosphorous was directly related to the vegetative and reproductive phases of the crop and attributes complex phenomenon of phosphorous utilization in plant metabolism. It also helped in the efficient absorption and utilisation of the other required plant nutrients which ultimately increased the grain yield and it was found that the *Azotobacter* improves the protein yield of the maize, and it increased the uptake of N significantly improves the grain and stover yield" [9].

4. CONCLUSION

Considering the salient findings in perspective, the study revealed that application of Vermicompost 0.5Kg/ha with *Phosphorus Solubilizing Bacteria* 0.5Kg/ha and *Azotobacter* 0.5Kg/ha (T_7) was found to be best combination for maximizing the yield parameters (number of cobs $plant^{-1}$, cobs length, cobs grain, test weight and grain yield) of maize. Treatments with Vermicompost 0.5Kg/ha and *Phosphorus Solubilizing Bacteria* 0.5Kg/ha was also observed best in yield parameters.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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