RESEARCH ARTICLE

EFFECT OF BIOFERTILIZERS ON YIELD AND YIELD COMPONENTS OF MAIZE (ZEA MAYS L.) VARIETIES ECO-92 AND AFRICAN TALL

1*Shinde Madhumati Y., 2Khade S K., 3Patil V.A.

1P.G. Department of Botany, Dattajirao Kadam Arts, Science and Commerce College, Ichalkaranji, Dist. Kolhapur-416115, Maharashtra, Affiliated to Shivaji University, Kolhapur, India
2Padmabhushan Dr Vasantraodada Patil (PDVP) Mahavidyalaya, Tasgaon, Maharashtra, Affiliated to Shivaji University, Kolhapur, India
3P.G. Department of Botany, Dattajirao Kadam Arts, Science and Commerce College, Ichalkaranji. Dist. Kolhapur-416115, Maharashtra, Affiliated to Shivaji University, Kolhapur, India

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ABSTRACT

An attempt has been made of study the effect of different biofertilizers such as Azotobacter and Phosphate Solubilizing Bacteria (PSB) on yield and yield components of Maize (Zea mays L.) varieties viz. Eco-92 and African tall. The experiments were carried out in a randomized complete block design with three replications. The yield parameters like weight of cob, diameter of cob, length of cob, number of rows per cob, weight of grains, number of grains per cob, weight of 100 grains, grain yield Kg/ha. Result showed that, maize yield and yield components were significantly different at (p≤0.05) higher in application of biofertilizers treatments. However, treatment with combined application of Azotobacter+PSB biofertilizer (A+P) biofertilizers had the highest weight of cob and grain yield Kg/ha as compared to control. Overall, Azotobacter and PSB biofertilizers improved the quality and quantity of yield.

INTRODUCTION

Maize (Zea mays L.) being an important staple food crop after Rice and Wheat throughout the world (FAO, 2002), Maize originated from Mexico. Every part of the maize plant has economic value and cob can all be used to produce a large variety of food and non-food production (IITA 2006). Apart from the soil the fertility and productivity issues, use of chemical fertilizers are also becoming more and more difficult for the farmers due to their high costs. Large amount of chemical fertilizers and pesticides are being used for its higher yield production, but the problem is, they influence human and environmental health. To get rid off from the problems, we required to alter ways of increasing yield production by applying biofertilizers (Shevananda, 2008). Nitrogen and phosphorus are essential nutrients for plant growth and development in Maize. N$_2$-fixing and P-solubilizing bacteria are important for plant nutrition by increasing N and P uptake by the plants and playing a significant role as that like biofertilizer, so Azotobacter and Phosphate solubilising bacteria are used in this study.

Though nitrogen and phosphorous are essential nutrient for plant growth and development in corn, biofertilizers are able to fix atmospheric nitrogen in the available form of plants (Chen, J.2006). For highest grain yield in agriculture in addition to both, the nitrogen and phosphate fertilizer are very important (Shaban.2013 a.b). Biofertilizers include mainly the nitrogen fixing, phosphate solubilizing and growth promoting microorganisms (Goel et al., 1999). Among biofertilizers benefitting the crop production are Azotobacter, Azospirillum, Blue green algae, Azolla (Hegade et al., 1999) Application of biofertilizer provides effective implementation of biological mechanisms of plant nutrition, growth promotion and protection (Bashan and Levanony, 1990; Doebereiner, 1995). In maize the present positive effect of biofertilizers on growth, yield and yield component was revealed because of the increasing demand for food and livestock feed. The similar results are concurred in case of barley (Azimi et al.2013). Azotobacter species besides playing a role in nitrogen fixation, it has the capacity to synthesized and secrete considerable amounts of biological active substances like vitamins, gibberellins and auxins (Suhag, 2016).
Nitrogen is the most critical element of plant growth and plays a key role in many metabolic and physiological functions (Balasubramaniyan and Palaniappan, 2001). Biological fertilizers are obviously an important part of a sustainable agricultural system, they The present study was undertaken to assess the effect of liquid biofertilizer different levels (doses) on growth and yield of two maize cultivars and to determine the optimum level suitable for improving maize production. According to Beyranvand et al 2013 them nitrogen and phosphate biofertilizers increase in the yield components like plant height, cob weight, and cob length, number of grain per cob and grain yield.

**MATERIALS AND METHODS**

To evaluate effect of biofertilizers (Azotobacter and Phosphate Solubilizing Bacteria) on yield and yield components two maize (Zea mays L.) varieties Eco-92 and African tall are selected.

**Experimental site:** The field experiment were conducted at the Experimental farm Belanki (Santoshwadi Lat. 16°50’42”N, Long.74°51’54”E), Dist.Sangli.

**Land Preparation, experimental design:** The land was ploughed twice with bullock drawn mould board plough followed by harrowing using cultivator and the entire plot was leveled with leveler. A rectangular plot having uniform fertility and even topography was selected for conducting the experiment and individual plots were made manually as per experimental plan. Pre-sowing irrigation was given 10 days before the land preparation. The land was prepared to good tilth and leveled uniform before sowing. The two maize cultivars were considered as main plots and the three levels of biofertilizers as sub-plots.

**Treatments:** Azotobacter biofertilizer considered as ‘A’.PSB biofertilizer considered as ‘P’ and collective application was considered as ‘A+P’ arranged respectively as in the form. Characters using a split plot based on a randomized complete block design with three replications.

**Fertilizer applications:** The treatment of bio-fertilizer levels were corresponding to (TA1), (TA2), (TA3), (TP1), (TP2), (TP3) and (TA+P1), (TA+P2), (TA+P3) respectively.

**Seed and Sowing:** Before sowing of crop, furrows were opened at 60 cm interval with the help of hand hoe. Two seeds were dibbled at 30 cm spacing on 22nd May 2015. Advised nutrients and microbial inoculants were applied separately at the base of row and covered with soil.

**Thinning:** A week after emergence, seedlings were thinned to control two plants per hill. Final thinning was appeared two weeks after the emergence to maintain only one healthy seedling per hill.

**Weeding:** Hand weeding was done at 30 days after sowing and one time planting by chipkunte was carried at 20 days after sowing to keep all the plots systematic weed release throughout the crop growth period. Earthing up of soil was also made at 30 days after sowing to have good support and aeration to the plant roots.

**Irrigation:** Protective irrigation was supplied to the crop. Proper care was taken to keep away from movement of fertilizers from one plot to another during irrigation. All plots were irrigated immediately after sowing for uniform germination. Further irrigation was given at 5 days interval during crop growth. Irrigation was stopped one week earlier to harvest of the crop.

**Harvesting and threshing:** The crop was harvested when the cobs became green stage and plants showed physiological maturity. First, the cobs were removed from the standing crop and stover was harvested later. The harvested cobs were kept in separate gunny bags for each plot and dried in sun before shelling. After shelling the grains were dried in the sun to bring the moisture content 15% and then the final weights were recorded. Five plants were randomly selected in each net plot area for recording yield attributing parameters. The crop in the net plot was harvested and threshed separately. The stover was also bundled separately for each plot and dried thoroughly in the sun before taking the final weight. Grain and straw were sun dried and weight was recorded as per treatment and converted to yield in kg per hectare.

**Measurements and data gathering:** All plant growth observations were recorded treatment wise in the net plot area at monthly interval, starting from 30 days after sowing to till harvest. Five plants were tagged at random in each plot and observations were recorded. The crop in the net plot was harvested and threshed separately .10 plants were randomly selected to each plot area for recording yield attributing parameters .At harvest, the following characters were measured included: Plant height (cm), cob diameter (cm), Cob length (cm), Number of rows cob per plant, Number of rows cob, Number grains per cob, 100-grain weight (g) and Grain yield (kg ha⁻¹).

**Statistical analysis:** The collected data was statistically analyzed separately according to the analysis of variance (ANOVA) by and Duncan’s Multiple Range Test (DMRT) used to determine the level of significance at p ≤0.05 with SPSS excel software.

**RESULTS**

**Cob length and Diameter:** The Analysis of variance showed that, the effect of Azotobacter, PSB and interaction between them on cob length and diameters were significant. The comparison of the mean values of the cob length and diameter for interaction between different biofertilizers showed that combine treatment of Azotobacter and PSB (TA+TP1), (TA+TP2), (TA+TP3) had the highest length and diameter as compared to control in variety Eco 92 and African tall(Table 1 and 2).

**Number of row per cob:** The effect of biofertilizer Azotobacter and phosphate solubilizing bacteria on number of row per cob were significant. The comparison of the mean values of African tall and in Eco 92 number of rows per cob for (TA3), (TA+TP2), (TA+TP3) treatment showed that, the highest number of row per cob (16.3),(16.0) and control treatment had lowest number of row per cob (11.33),(16.33) and the differences were significant. The combined biofertilizer treatment had the highest number of row per cob as compared to control (Table 1 and 2).
Table 1. Effect of Biofertilizers on yield and yield components of Maize (Zea mays L.) Variety African tall

<table>
<thead>
<tr>
<th>Sr. no</th>
<th>Treatments</th>
<th>No. of cob/Plant</th>
<th>Diameter of cob</th>
<th>Length of cob</th>
<th>Horizontal cob lines /cob</th>
<th>Vertical cob lines /cob</th>
<th>No. of grain /cob</th>
<th>Cob weight</th>
<th>Weight of grains /ear</th>
<th>100 grain weight</th>
<th>Grain yield kg/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Control</td>
<td>2</td>
<td>5.50e</td>
<td>14.67e</td>
<td>32.00e</td>
<td>11.33e</td>
<td>520e</td>
<td>179.10e</td>
<td>107.69e</td>
<td>28.68e</td>
<td>11486e</td>
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<tr>
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<td>(TA₁)</td>
<td>2</td>
<td>4.37b</td>
<td>16.00c</td>
<td>38.67c</td>
<td>15.33b</td>
<td>521 b</td>
<td>271.32b</td>
<td>167.59b</td>
<td>44.43b</td>
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<tr>
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<td>2</td>
<td>4.53b</td>
<td>16.27b</td>
<td>38.67c</td>
<td>15.33b</td>
<td>529b</td>
<td>270.18b</td>
<td>166.62b</td>
<td>45.02b</td>
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</tr>
<tr>
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<td>39.33b</td>
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<td>541a</td>
<td>278.87b</td>
<td>182.27b</td>
<td>42.31c</td>
<td>19373a</td>
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<td>4.10d</td>
<td>16.00c</td>
<td>35.53d</td>
<td>13.33d</td>
<td>438c</td>
<td>223.24d</td>
<td>128.15d</td>
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<td>14.00c</td>
<td>394d</td>
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<td>4.97a</td>
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<td>39.67b</td>
<td>15.67b</td>
<td>550a</td>
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<td>190.82a</td>
<td>48.39a</td>
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<td>4.97c</td>
<td>17.33a</td>
<td>36.07b</td>
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<td>192.50a</td>
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<td>40.33a</td>
<td>16.00c</td>
<td>557a</td>
<td>303.89a</td>
<td>192.30a</td>
<td>48.46a</td>
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</table>

Table 2. Effect of Biofertilizers on yield and yield components of Maize (Zea mays L.) Variety Eco-92

<table>
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<tr>
<th>Sr. no</th>
<th>Treatments</th>
<th>No. of cob/Plant</th>
<th>Diameter of cob</th>
<th>Length of cob</th>
<th>Horizontal cob lines/cob</th>
<th>Vertical cob lines/cob</th>
<th>No. of grain/ear</th>
<th>Cob weight</th>
<th>Weight of grains/ear</th>
<th>100 grain weight</th>
<th>Grain yield kg/ha</th>
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</thead>
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<td>Control</td>
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<td>3.93e</td>
<td>15.13e</td>
<td>35.67e</td>
<td>13.33e</td>
<td>489e</td>
<td>218.49e</td>
<td>137.20e</td>
<td>19.09e</td>
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<td>2</td>
<td>4.37d</td>
<td>16.17b</td>
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<td>16.33b</td>
<td>615b</td>
<td>282.58b</td>
<td>169.44c</td>
<td>33.44c</td>
<td>18073c</td>
</tr>
<tr>
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<td>(TA₂)</td>
<td>2</td>
<td>4.73c</td>
<td>16.17b</td>
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<td>16.00c</td>
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<td>16.00c</td>
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<td>16.33b</td>
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<td>193.86a</td>
<td>33.91c</td>
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<tr>
<td>4</td>
<td>(TP₁)</td>
<td>2</td>
<td>4.37d</td>
<td>16.00c</td>
<td>36.67c</td>
<td>14.67d</td>
<td>559d</td>
<td>245.18d</td>
<td>164.38c</td>
<td>30.26d</td>
<td>17524a</td>
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<tr>
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<td>(TP₂)</td>
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<td>4.37d</td>
<td>15.66d</td>
<td>36.00d</td>
<td>16.00c</td>
<td>536d</td>
<td>248.95d</td>
<td>156.46d</td>
<td>30.13d</td>
<td>16689c</td>
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<td>6</td>
<td>(TP₃)</td>
<td>2</td>
<td>4.40d</td>
<td>16.03c</td>
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<td>16.00c</td>
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<td>7</td>
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<td>308.86a</td>
<td>191.40a</td>
<td>39.99a</td>
<td>20415a</td>
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</table>
**Cob weight:** Results showed that, the effect of Azotobacter and Phosphate Solubilizing Bacteria biofertilizers and interaction between them on cob weight was significant (Table 1 and 2). The comparison of the values of the cob weight for interaction between Azotobacter and PSB biofertilizers showed that, (TA+TP1), (TA+TP2), (TA+TP3) treatment had the highest (308.8gm)cob weight and control had lowest cob weight( 218.4gm)The differences were significant (Table 1 and 2).

**Weight of 100 grains:** The effect of Azotobacter and Phosphate Solubilizing Bacteria biofertilizers and interaction between them on cob weight were significant. The comparison of the mean values showed that, (TA+TP1), (TA+TP2), (TA+TP3) treatments had the highest (African tall =48.46gm), (Eco 92 =39.99gm) 100 grain weight and control (African tall=28.68gm)( Eco 92 =19.09gm) had lowest 100 grain weight and differences were significant.

**Grain yield:** The effect of Azotobacter, Phosphate Solubilizing Bacteria biofertilizers and interaction between them on grain yield were significant. The comparison of the values of the grain yield for interaction between Azotobacter and PSB biofertilizers showed that, highest grain yield as compared to control.

**DISCUSSION**

According to the data of table 1 and 2, the effect of Azotobacter and phosphate solubilising bacteria (PSB) biofertilizers were evaluated positively, there were an increase in plant height, ear weight, and number of grain per ear, grain yield and biomass yield. Statistical analysis was performed on the effect of nitrogen and phosphate biofertilizer treatments on plant growth, corn yield in variety African tall and Eco-92. The means were compared according to Duncan multiple range test (DMRT).Maize grain and biomass yield increasing was reported with the biofertilizer application which account important benefit to the maize producers and maize production. It may be concluded that photosynthetic capacity of plants treated with phosphors-solubilizing microorganism’s increases due to increased supply of phosphors nutrition. Seed weight also increases due to better transfer of photosynthetic substances. Use of these biofertilizers as environment friendly helps to reduce the much expensive chemical fertilizers. Phosphorus and nitrogen biofertilizers could help to increase the availability of accumulated phosphate (by solubilization) efficiency of biological nitrogen fixation and increase the availability of Fe, Zn etc., through production of plant growth promoting substances. The research of various other studies has demonstrated that mixed treatments increase plant vegetative growth, resulting in increased yield in crops and legumes under farm conditions. The result showed that treatments of biofertilizers in the form of N-fixing Azotobacter and phosphate solubilising bacteria (PSB) enhanced increase yield with positive effects on measured plant height ,number of cob, diameter of cob, cob weight, grain yield. Given the significant enhancement in growth and yield of maize taking place mainly N-fixing Azotobacter and phosphate solubilising bacteria (PSB) under environmental condition, the mechanism for this beneficial effect could be due to more balanced nutrition and improved absorption of nitrogen and other nutrients by the corn. Interaction between N and P showed that the comparison of the values of the grain yield for interaction between Azotobacter and PSB biofertilizers showed that, highest grain yield as compared to control and differences were significant. In the final results of this study revealed that, the application of nitrogen and phosphate solubilising bacteria (PSB) biofertilizers increased yield and yield components of maize under environmental condition.

**Conclusion**

It is concluded that, the treatment of biofertilizer increase the yield and yield components more effectively than the control. The use of biofertilizer influenced the Maize variety Eco-92 and African tall positively. Biofertilizer as a source in agricultural production, decreases environmental pollution and leads to economic savings for farmers.

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