



Biofertilizers effects on the germination and photosynthetic pigments of maize (*Zea mays L.*)

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Abstract

A field experiment will examine how biofertilizers affect the germination of maize (*Zea mays L.*). Was completed in the month of Kharif 2022 at the Annamalai University's botanical garden field station in Tamil Nadu, India. The study made use of the CO-2 variety of maize. The plot experiment used a randomized complete block design with five treatments and three replications. In order to maintain production, modern agriculture must employ chemicals, yet they are not eco-friendly. Less than one crore microorganisms have been found in one gram of soil in numerous agricultural areas of our country, demon. This results in contaminated soil, which weakens the environment and escalates production costs. According to this study, the combined effect of biofertilizers improved the biochemical and germination rate in *Zea mays L.*

Keywords: biofertilizers, eco-friendly, chemical fertilizers, environment, agricultural

Introduction

India, the country with the second-largest population, relies heavily on agriculture to make a living. Because soil contains microflora like bacteria, actinomycetes, fungi, and algae, it is a living organism on which agriculture is largely dependent. In agricultural land in tropical and subtropical regions, one gramme of soil often contains ten crores of microorganisms. Only 5-7% of the ten billion bacteria are hazardous; the others are incredibly helpful in agriculture and good to nature (Chowdhury and Mukherjee, 2006) [6]. Maize is known as the "King of Cereals" because it has the largest output potential of any cereal crop. It is a very demanding crop, so the fertilizer management system has a significant impact on productivity. Given India's exploitative agriculture methods, inherent soil fertility can no longer be sustained over the long term. Some studies claim that a continuous and intensive farming technique gradually reduces the soil's ability to provide nutrients. The developing shortages of secondary and micronutrients as well as unfavorable changes in the physical and chemical qualities of soil are likely to blame for the failure of the appropriate levels of N, P, and K to maintain yield levels. Farmers are finding it difficult and harder to use chemical fertilizers due to their high cost and limited availability throughout the growing season, in addition to issues with soil fertility and crop output. In order to maintain soil fertility and productivity, more and more people are becoming aware of the benefits of using organic materials, such as biofertilizers, which are sources of macro, micro, and secondary nutrients. Sandalled soil's ability to retain water is enhanced by organic matter, as is clayey soil's ability to drain. By giving nutrients to soil microorganisms, organic manure improves soil microbe activity, which in turn aids in the conversion of inaccessible plant nutrients into forms that may be used to promote plant growth. The biofertilizers have been found to make a good contribution to soil fertility, increasing agricultural output without endangering the environment, water quality, or soil. In order

to mobilise nitrogen and solubilize phosphorus for plant growth, nitrogen-fixing and phosphorus-solubilizing bacteria are crucial. In modern agriculture, use of chemical fertilizers is essential for sustainable yield but these are not ecofriendly. The chemical fertilizers pose a health hazard and microbial population problem in soil besides being quite expensive and making the cost of production high (Chandrasekar *et al.*, 2005) [5]. Indiscriminate use of chemical fertilizers has developed disturbances in the soil reaction, development of nutrient imbalances in plants, increased susceptibility to pests and diseases, reduction in legume root nodulation and plant mycorrhizal associations, decrease in soil life and environmental hazards such as water pollution and soil humus reduction. One of the major effects of such activities is gradual decrease in the number of useful microorganisms in agricultural soil.

The issue is so severe that less than one crore microorganisms have been discovered in one gramme of soil in various agricultural areas of our nation (Chowdhury and Mukherjee, 2006) [6]. Because of these factors, the yield of agricultural produce fluctuates significantly and the land is also damaged through environmental instability. In such a scenario, biofertilizers are crucial. According to authors, biofertilizers capture air nitrogen and provide it right to the plant (Ganachitra, 2000) [8].

Materials and Methods

Plant Materials

Biofertilizers used in the experiments were Azotobacter, Azospirillum, Phosphate Solubilizing Bacteria (PSB). Maize *Zea mays L.* Var. CO-2 was taken for investigation.

Sample collection and soil nutrient analysis

Collection of seeds

The seeds of Maize (*Zea mays L.*) Var. CO-2 was obtained from Tamil Nadu Agricultural University, Coimbatore.

Collection of biofertilizers

The biofertilizers selected for the study were (Azotobacter, Azospirillum, Phosphate Solublizing Bacteria (PSB) collected from Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, and India.

Soil analysis

Soil samples were collected from the experimental field and analyzed in soil testing laboratory for nitrogen, phosphorus and potassium (Black, 1957) [3].

The pH of the soil was determined using pH meter (Systronic model 321) and the mean values were calculated.

Experimentation

Eight experimental plots were planted with the treated seeds. One of the plots served as a control, unfertilized. The remaining seven pots were used as test plots, and 50 g of seeds were injected with biofertilizers there (Mono, dual and combined types). Regular irrigation was carried out without resulting in any physical harm. The third leaf stage, which is the experimental stage, is when the experiment began. Three times the experiment was run. The various vaccinations included the following: T0-Control, T1-Azospirillum, T2-Azotobacter, T3-Phosphate Solublizing Bacteria (PSB), T4-Azotobacter+Azospirillum+Phosphate Solublizing Bacteria (PSB).

Germination percentage

The number of seeds germinated, were counted to find out the germination percentage. It was calculated the formula

$$\text{Germination Rate} = \frac{\text{Number of seeds germinated}}{\text{Number of seeds sown}} \times 100$$

The germination rate is expressed in Percentage (%).

Biochemical studies

Extraction and estimation of Chlorophyll and Carotenoid were done by Arnon, 1949 method.

Results

Data on the seed germination % of (Zea mays L.) Var. CO-2 is shown in Table 1. The control group's 70% seed germination rate was the lowest. For T1-Azotobacter, T2-Azospirillum, and T3-Phosphate Solublizing Bacteria mono-inoculations of biofertilizer treatments, the minimum percentage of seed germination was 95%. (PSB). In compound inoculations, T4-Azotobacter+Azospirillum+Phosphate Solublizing Bacteria (PSB) showed the greatest germination percentage (100%) The combined biofertilizers treatment had the highest percentage of seed germination when compared to all other treatments and the control.

Table 1: Response of biofertilizers on the percentage of seed germination in *Zea mays L.* Var. CO-2

Biofertilizer	Germination % of seed
T0-Control	70
T1-Azos	85
T2-Azoto	94
T3- PSB,	92
T4-Azot+Azos+ PSB.	100

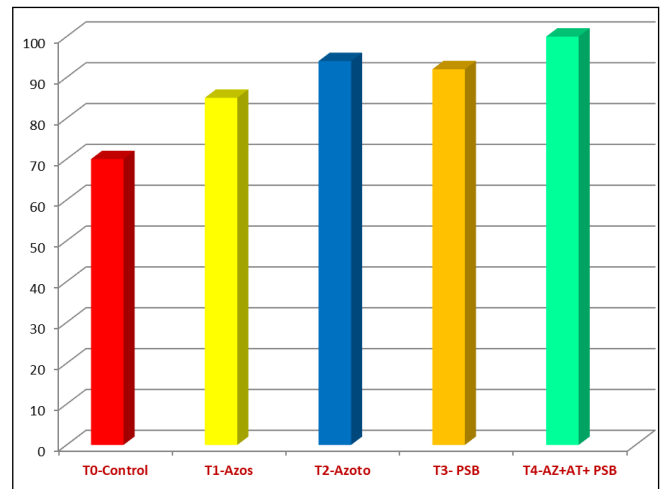


Fig 1: Response of biofertilizers on the percentage of seed germination in *Zea mays L.* Var. CO-2

Total chlorophyll continuously increased in all inoculations from day 0 to day 20, and then slowly decreased from day 21 to day 28. The control had a total chlorophyll content of 0.3000.002 mg/g on day 28. In mono inoculations, T1-Azotobacter, T2-Azospirillum, and T3-Phosphate Solublizing Bacteria (PSB) all showed 0.3730.002mg/g, 0.3790.004mg/g, and 0.3740.003mg/g of total chlorophyll, respectively. On day 20, the combined inoculation T4-Azotobacter+Azospirillum+Phosphate Solubilizing Bacteria (PSB) had the highest total chlorophyll content—0.5960.004 mg/g—when compared to mono and combination inoculations.

Table 2: Response of biofertilizers on the total chlorophyll content (mg/g) in *Zea mays L.* Var. CO-2

Biofertilizer	Total chlorophyll mg/g
T0-Control	0.300±0.002
T1-Azos	0.373±0.002
T2-Azoto	0.379±0.004
T3- PSB,	0.374±0.003
T4-Azot+Azos+ PSB.	0.596±0.004

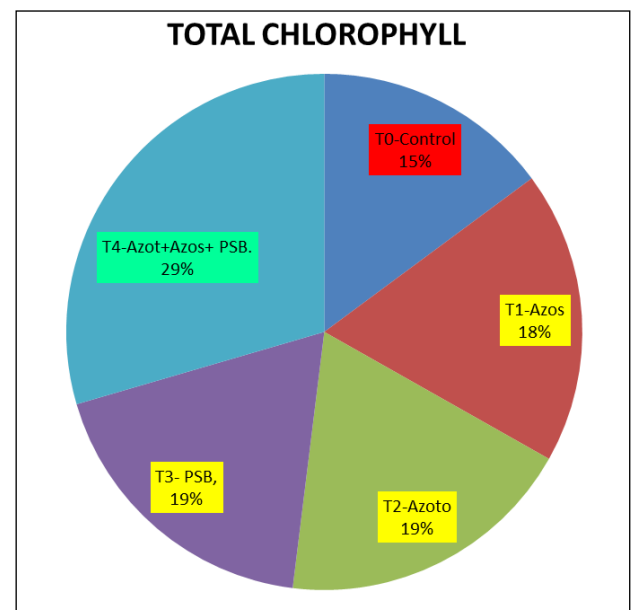


Fig 2: Response of biofertilizers on the total chlorophyll content (mg/g) in *Zea mays L.* Var. CO-2

Biofertilizers collected from Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, and India



Fig 3: Azospirillum



Fig 4: Azotobacter



Fig 5: Phospho Solubilizing Bacteria



Fig 6: Response of biofertilizers on the percentage of seed germination in Zea mays L. Var. CO-2



Fig 7: Overall field view mays cultivation

Discussion

Biofertilizers contain microorganisms, and how they are administered to the soil can have a big impact on how effective they are. Biofertilizers are more affordable, pollution-free, and naturally renewable (Jain and Singh, 2003) [9]. Biofertilizers are "Microbial inoculants" that boost a variety of crop plants by fixing atmospheric nitrogen. They are products made of live cells from various microorganisms that can convert inert, nutritionally significant elements into useable form through biological processes. In addition to chemical fertilizers, biofertilizers based on renewable energy sources can assist reduce the high investment required for fertilizer use in terms of nitrogen and phosphorus (Kushare *et al.*, 2009) [11]. The percentage of seeds that germinated both when infected with biofertilizers and when left untreated was examined. In comparison to the other inoculations and the control, the combination inoculation had the highest germination %. Biofertilizer generally preferred black gramme seed germination more than soil amendments made from green manure (Neelamegam *et al.*, 2007) [13]. Compared to control, biofertilizer inoculation significantly affected the seed germination. The combination of dual inoculation (Rhizobium and Vesicular arbuscular mycorrhiza) with one super phosphate (SSP) was shown to have the highest germination percentage (Pandey *et al.*, 2003) [14]. Inoculation of *Vicia faba* with Mycorrhizae had positive effect due to stimulatory effect on growth may be due to availability of phosphorus which enhances the metabolic processes such as photosynthesis, starch synthesis, glycolysis and synthesis of fats and proteins (Jan *et al.*, 2009) [10]. Mycorrhizal fungi interact with a wide range of other soil organism in the root, rhizosphere and in the bulk soil. (Boby *et al.*, 2007) [4]. Treatments of Azospirillum and Azotobacter plus 100% Urea resulted in significant increase in total chlorophyll. The chlorophyll content decreased during senescence stage due to the loss of greenness as the plant matures. The beneficial effects of bacterial inoculation on increased chlorophyll content might have been due to the supply of higher amount of nitrogen to the growing tissue and organs supplied by Nitrogen fixing Azospirillum and Azotobacter (Chandrasekar *et al.*, 2005) [5]. All the inoculated Chrysanthemum plants showed superior chlorophyll content compared to control (Singh *et al.*, 2008). The inoculation of all Arbuscular mycorrhizal fungus greatly increased the chlorophyll content over the control by 50% to 60%. (Ghosh *et al.*, 2008) [7]. Carotenoids are the auxiliary pigments in photosynthetic systems that give plant

components, especially flowers and fruits, their distinctive colours (Sadasivam and Manickam, 2008) [16]. Earlier research by Bahadur *et al.* (2006) [2] found that seedling inoculation with Vesicular Arbuscular Mycorrhizae (VAM) or Azotobacter boosted the carotenoid content in Chinese cabbage and broccoli, respectively. Plants inoculated with arbuscular mycorrhizae displayed a much higher carotenoid content than non-mycorrhizal plants (Paneerselvam and Thamizhiniyan, 2008) [15]. The carotenoid content of Glycine max is increased by the combined use of micronutrients and Rhizobium inoculants (Murugesan, 2008) [12]. The tomato plants treated with Azotobacter and Phosphobacterium had a higher carotenoid content (Selvarathi, *et al.*, 2010) [18]. Increased production and synthesis of hormones and vitamins (such as Vitamin B12 and other vitamins) with increased enzymatic activity in organically amended and microbial soil of nitrogen may explain the increased carotenoid content under Azotobacter and acid content with Vesicular Arbuscular Mycorrhizae (VAM) (Selvakumar *et al.*, 2009) [17]. In the current study, combined fertilizer inoculation outperformed other inoculations in terms of significance. It is connected to the 2009 research by Selvakumar *et al.*

Conclusion

In this investigation the combined effect of T4-Azotobacter+Azospirillum+Phosphate Solubilizing Bacteria (PSB) in Zea mays L. Var. CO-2 is more significant when compared to control and other inoculations. According to the findings of this study, biofertilizers can be used as a source of natural growth regulators to boost maize growth and photosynthetic pigments. It may also be a strategy to boost growth advantages while decreasing the frequency and cost of chemical fertilization.

Acknowledgement

Thanks to the Department of Botany Annamalai University for providing all the necessary helps.

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