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# IMPACT OF ORGANICS AND BIO- FERTILIZERS ON GROWTH ATTRIBUTES OF MAIZE (*Zea mays* L.)

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## ABSTRACT

A field experiment was carried out to study the "Impact of Organics and Bio-Fertilizers on Growth attributes of Maize (*Zea Mays* L.)" The experiment was laid out in randomized completely block design which comprises of 14 treatments and was replicated thrice viz., $T_1$ : 75% NP +FYM, $T_2$ : 75% NP + Enriched compost, $T_3$ : 75% NP + vermicompost, $T_4$ : 75% NP + *Azotobacter chroococcum* + *Bacillus megaterium* + FYM (7.0 t ha$^{-1}$), $T_5$ : 75% NP + *Azotobacter chroococcum* + *Pseudomonas fluorescence* + FYM (7.0 t ha$^{-1}$), $T_6$ : 75% NP + *Azotobacter chroococcum* + *Bacillus megaterium* + Enriched compost (7.0 t ha$^{-1}$), $T_7$ : 75% NP + *Azotobacter chroococcum* + *Pseudomonas fluorescence* + Enriched compost (7.0 t ha$^{-1}$), $T_8$ : 75% NP + *Azotobacter chroococcum* + *Bacillus megaterium* + vermicompost (3 t ha$^{-1}$), $T_9$ : 75% NP + *Azotobacter chroococcum* + *Pseudomonas fluorescence* + Vermicompost (3 t ha$^{-1}$), $T_{10}$ : Recommended dose of NPK with FYM (7.0 t ha$^{-1}$), $T_{11}$ : Recommended dose of NPK + *Azotobacter chroococcum* + *Bacillus megaterium* + *Pseudomonas fluorescence* + FYM, $T_{12}$ : Recommended dose of NPK + *Azotobacter chroococcum* + *Bacillus megaterium* + *Pseudomonas fluorescence* + Vermicompost, $T_{13}$ : Recommended dose of NPK + *Azotobacter chroococcum* + *Bacillus megaterium* + *Pseudomonas fluorescence* + Enriched compost, $T_{14}$ : *Azotobacter chroococcum* + *Bacillus megaterium* + *Pseudomonas fluorescence*. The study reveals that the highest plant height, plant dry matter and leaf area index was found in the treatment recommended dose of NPK + *Azotobacter chroococcum* + *Bacillus megaterium* + *Pseudomonas fluorescence* + Enriched compost ($T_{13}$) and it was statistically on par with treatment ($T_{12}$) recommended dose of NPK + *Azotobacter chroococcum* + *Bacillus megaterium* + *Pseudomonas fluorescence* + Vermicompost.

**Key words:** NP, NPK, Enriched compost, Vermicompost, Azotobacter, chroococum, Pseudomonas fluorescence, Bacillus megaterium.

## INTRODUCTION

Maize (*Zea mays* L.) is the third most important cereal crop in the world after wheat and rice. In India, maize is known

as 'Queen of cereals' because of its high production potential and wider adaptability. In India, it is cultivated on an area of 8.27 million hectares with a production of 19.30 million tones and the productivity of 2091 kg per hectare (Anon., 2017).

Among the cereals grown in India, maize is gaining significant importance on account of its growing demand for diversified uses, especially as animal feed and industrial raw material However, long term use of chemical fertilizers also led to a decline in crop yields and soil fertility in the intensive cropping systems (Dadhich e*t.al.,* 2011). More recently, a real challenge faces the workers in the agricultural research field to stop using the high rates of agro-chemicals which negatively affect human health and environment (El-Kholy *et.al.,* 2005, Kader *et al.,* 2002).The world agriculture in the last few decades has been heavily dependent on chemical fertilizers as source plant nutrients to meet the increasing demand for food. Biofertilizer is a natural input that can be applied as a complement to, or as a substituent of chemical fertilizer in sustainable agriculture (Ebrahimpour *et al.,* 2011). However, in the recent years, the environmentalists and agricultural scientists have realized that continued and unabated use of chemical fertilizers destroy the soil fertility, cause environmental pollution and imbalance the soil microbial activity. Thus, increasing awareness is being created on the use of organics including bio fertilizers to sustain the soil fertility and plant productivity.

Organic manures such as poultry manure and farmyard manure are important components of integrated nutrient management. Organic manures supply the traces amount of micronutrients, which are generally not supplied by the farmers as straight fertilizers. The biofertilizers are found positive contribution to soil fertility, resulting in an increase in crop yield without causing any environmental, water or soil pollution hazards. Nitrogen fixing and Phosphorus solubilizing bacteria play an important role in nitrogen mobilization and phosphorus solubilization for the benefit of plant growth.

Biofertilizers are the microbial agents, which are pre-selected effective microorganisms that have the ability to mobilize plant nutrients from non-usable forms through their diverse activities. Biofertilizers include nitrogen fixing microorganisms such as *Rhizobium, Azotobacter, Azospirillum* and cyanobacteria and phosphate solubilizers like *Bacillus megatherium var. phosphaticum* or *Bacillus subtillus* or *Pseudomonas florescence* and phosphorus mobilizing fungi like mycorrhizae, plant growth promoting rhizobacteria, organic matter decomposers, *etc*.

## MATERIALS AND METHODS

An field experiment was carried out during 2018-19 to study the "Impact of Organics and Bio-Fertilizers on Growth attributes of Maize (*Zea Mays* L.)". The topography of the land where the experiment was undertaken, medium high in situation endowed with good drainage facilities. The soil of the experimental field was sandy, clay and alluvial in texture. The physico-chemical properties of the experimental soil are Available Nitrogen (N) 43.12, Available Phosphorus ($P_2O_5$) 33.60 and Available Potash ($K_2O$) 100.7. The experiment was laid out in randomized completely block design which comprises of 14 treatments and was replicated thrice viz., $T_1$ : 75% NP +FYM, $T_2$ : 75% NP + Enriched compost, $T_3$ : 75% NP + vermicompost, $T_4$ : 75% NP + *Azotobacter chroococcum* + *Bacillus megaterium* + FYM (7.0 t $ha^{-1}$), $T_5$ : 75% NP + *Azotobacter chroococcum* + *Pseudomonas fluorescence* + FYM (7.0 t $ha^{-1}$), $T_6$ : 75% NP + *Azotobacter chroococcum* + *Bacillus megaterium* + Enriched compost (7.0 t $ha^{-1}$), $T_7$ : 75% NP + *Azotobacter chroococcum* + *Pseudomonas fluorescence* + Enriched compost (7.0 t $ha^{-1}$), $T_8$ : 75% NP + *Azotobacter chroococcum* + *Bacillus megaterium* + vermicompost (3 t $ha^{-1}$), $T_9$ : 75% NP + *Azotobacter chroococcum* + *Pseudomonas fluorescence* + Vermicompost (3 t $ha^{-1}$), $T_{10}$ : Recommended dose of NPK with FYM (7.0 t $ha^{-1}$), $T_{11}$ : Recommended dose of NPK + *Azotobacter chroococcum* + *Bacillus megaterium* + *Pseudomonas fluorescence* + FYM, $T_{12}$ : Recommended dose of NPK + *Azotobacter chroococcum* + *Bacillus megaterium* + *Pseudomonas fluorescence* + Vermicompost, $T_{13}$ : Recommended dose of NPK + *Azotobacter chroococcum* + *Bacillus megaterium* + *Pseudomonas fluorescence* + Enriched compost, $T_{14}$ : *Azotobacter chroococcum* + *Bacillus megaterium* + *Pseudomonas fluorescence.*

## Results and discussion

### Growth Parameters

### Plant height (cm)

The plant height as influenced by biofertilizers and different sources of organics differed significantly with growth stages. The plant height was maximum in the treatment of ($T_{13}$) recommended dose of NPK + *A. chroococcum* + *B. megaterium* + *P. fluorescence* + Enriched compost followed by ($T_{12}$) recommended dose of NPK + *A. chroococcum* + *B. megaterium* + *P. fluorescence* + Vermicompost and recommended dose of NPK + *A. chroococcum* + *B. megaterium* + *P. fluorescence* + FYM. The lowest plant height was recorded in ($T_{14}$) *A. chroococcum* + *B. megaterium* + *P.*

*fluorescence*. The increase in growth of maize could be attributed to the enhanced nutrient use efficiency in the presence of organic fertilizer. Many research studies have showed that the composted organic materials release nutrients slowly and may reduce the leaching losses particularly N (Paul and Clark, 1996, Muneshwar *et al*. 2001 and Naveed *et al*. 2008).

**Table 1. Effect of bio-fertilizers and different sources of organics on plant height (cm) of maize at different intervals.**

| Treatments | Plant height (cm) | | | |
|---|---|---|---|---|
| | 30 DAS | 60 DAS | 90 DAS | 120 DAS |
| $T_1$ : 75% NP +100% K + FYM | 20.87 | 141.17 | 145.43 | 146.77 |
| $T_2$ : 75% NP + 100% K + Enriched compost | 22.60 | 145.30 | 150.73 | 152.97 |
| $T_3$ : 75% NP +100% K + Vermicompost | 21.33 | 142.77 | 148.87 | 150.83 |
| $T_4$ : 75% NP + 100% K + *Azotobacter chroococcum* + *Bacillus megaterium* + FYM (7.0 t $ha_{-1}$) | 24.10 | 159.40 | 163.27 | 165.80 |
| $T_5$ : 75% NP + 100% K + *A. chroococcum* + *Pseudomonas fluorescence* + FYM (7.0 t $ha_{-1}$) | 22.77 | 158.33 | 162.30 | 163.57 |
| $T_6$ : 75% NP + 100% K + *A.chroococcum* + *B. megaterium* + Enriched compost (7.0 t $ha_{-1}$) | 27.43 | 165.23 | 170.17 | 171.07 |
| $T_7$ : 75% NP + 100% K + *A.chroococcum* + *P. fluorescence* + Enriched compost (7.0 t $ha_{-1}$) | 26.50 | 163.10 | 167.60 | 168.73 |
| $T_8$ : 75% NP + 100% K + *A.chroococcum* + *B. megaterium* + Vermicompost (3 t $ha_{-1}$) | 26.43 | 161.23 | 165.37 | 167.57 |
| $T_9$ : 75% NP + 100% K + *A.chroococcum* + *P. fluorescence* + Vermicompost (3 t $ha_{-1}$) | 26.17 | 160.53 | 164.03 | 165.47 |
| $T_{10}$ : RD of NPK with FYM (7.0 t $ha_{-1}$) | 28.23 | 168.40 | 171.63 | 173.10 |
| $T_{11}$ : RD of NPK + *A.chroococcum* + *B. megaterium* + *P. fluorescence* + FYM | 29.93 | 171.40 | 175.83 | 177.80 |
| $T_{12}$ : RD of NPK + *A.chroococcum* + *B. megaterium* +*P. fluorescence* + Vermicompost | 31.00 | 176.57 | 180.23 | 182.10 |
| $T_{13}$ : RD of NPK + *A.chroococcum* + *B. megaterium* +*P. fluorescence*+ Enriched compost | 32.90 | 182.13 | 187.27 | 189.33 |
| $T_{14}$ *: A. chroococcum* + *B. megaterium* + *P. fluorescence* | 20.57 | 138.07 | 141.13 | 142.57 |
| **F test** | **S** | **S** | **S** | **S** |
| **S.Em+** | **0.67** | **2.47** | **3.10** | **4.59** |
| **C.D. at 5%** | **1.94** | **7.19** | **9.02** | **13.35** |

**Plant dry weight (g)**

The plant dry weight as influenced by different treatment combination of biofertilizers and organics are significantly affected. The highest plant dry weight was recorded in the treatment of ($T_{13}$) recommended dose of NPK + *A. chroococcum* + *B. megaterium* + *P. fluorescence* + Enriched compost followed by ($T_{12}$) recommended dose of NPK + *A. chroococcum* + *B. megaterium* + *P. fluorescence* + Vermicompost and ($T_{11}$) recommended dose of NPK + *A. chroococcum* + *B. megaterium* + *P. fluorescence* + FYM. These three treatments did not differ significantly with each other. The lowest plant dry weight was recorded in ($T_{14}$) *A. chroococcum* + *B. megaterium* + *P. fluorescence.* Similar findings were reported by Meena *et.al.*, 2013.

**Table 2. Effect of bio-fertilizers and different sources of organics on plant dry weight (g) of maize at different intervals.**

| Treatments | Plant dry weight (g) | | | |
|---|---|---|---|---|
| | 30 DAS | 60 DAS | 90 DAS | 120 DAS |
| $T_1$ : 75% NP +100% K + FYM | 2.49 | 42.29 | 72.99 | 91.55 |
| $T_2$ : 75% NP + 100% K + Enriched compost | 2.55 | 42.33 | 73.00 | 91.72 |
| $T_3$ : 75% NP +100% K + Vermicompost | 3.53 | 52.50 | 81.43 | 101.67 |
| $T_4$ : 75% NP + 100% K + *Azotobacter chroococcum* + *Bacillus megaterium* + FYM (7.0 t $ha^{-1}$) | 2.60 | 42.45 | 73.15 | 92.24 |
| $T_5$ : 75% NP + 100% K + *A. chroococcum* + *Pseudomonas fluorescence* + FYM (7.0 t $ha^{-1}$) | 2.63 | 51.77 | 80.90 | 100.43 |
| $T_6$ : 75% NP + 100% K + *A.chroococcum* + *B. megaterium* + Enriched compost (7.0 t $ha^{-1}$) | 4.13 | 60.83 | 83.10 | 103.33 |
| $T_7$ : 75% NP + 100% K + *A.chroococcum* + *P. fluorescence* + Enriched compost (7.0 t $ha^{-1}$) | 3.00 | 54.33 | 81.72 | 101.56 |
| $T_8$ : 75% NP + 100% K + *A.chroococcum* + *B. megaterium* + Vermicompost (3 t $ha^{-1}$) | 3.90 | 54.43 | 82.20 | 102.93 |
| $T_9$ : 75% NP + 100% K + *A.chroococcum* + *P. fluorescence* + Vermicompost (3 t $ha^{-1}$) | 3.95 | 54.48 | 82.31 | 102.95 |
| $T_{10}$ : RD of NPK with FYM (7.0 t $ha^{-1}$) | 4.23 | 62.73 | 83.50 | 104.17 |
| $T_{11}$ : RD of NPK + *A.chroococcum* + *B. megaterium* + *P. fluorescence* + FYM | 4.33 | 65.63 | 85.50 | 105.57 |
| $T_{12}$ : RD of NPK + *A.chroococcum* + *B. megaterium* +*P. fluorescence* + Vermicompost | 4.37 | 72.20 | 92.87 | 110.00 |
| $T_{13}$ : RD of NPK + *A.chroococcum* + *B. megaterium* +*P. fluorescence*+ Enriched compost | 4.63 | 73.20 | 98.67 | 113.80 |
| $T_{14}$ *: A. chroococcum* + *B. megaterium* + *P. fluorescence* | 2.47 | 42.27 | 72.97 | 91.50 |
| **F test** | **NS** | **S** | **S** | **S** |
| **S.Em+** | **1.075** | **2.244** | **2.249** | **2.283** |
| **C.D. at 5%** | | **4.757** | **4.769** | **4.840** |

**Leaf Area Index (%)**

The leaf area index per pant is the important growth parameter. The data in Table 2 shows that the leaf area index increased fast between 30 and 60 days due to fast vegetative growth of plant during this period. The highest leaf area index was recorded in the treatment of ($T_{13}$) recommended dose of NPK + *A. chroococcum* + *B. megaterium* + *P. fluorescence* + Enriched compost followed by ($T_{12}$) recommended dose of NPK + *A. chroococcum* + *B. megaterium* + *P. fluorescence* + Vermicompost and ($T_{11}$) recommended dose of NPK + *A. chroococcum* + *B. megaterium* + *P. fluorescence* + FYM. These three treatments did not differ significantly with each other. The lowest leaf area index was recorded in ($T_{14}$) *A. chroococcum* + *B. megaterium* + *P. fluorescence.* Leaf area index was increased due to the substantial supply of nutrients by both inorganic and organic fertilizers increased and also biofertilizers played crucial role for converting unavailable nutrients to available forms.

**Table 3. Effect of bio-fertilizers and different sources of organics on leaf area index (LAI) of maize at different intervals.**

| Treatments | Leaf Area Index (%) | | |
|---|---|---|---|
| | 30 DAS | 60 DAS | 90 DAS |
| $T_1$ : 75% NP +100% K + FYM | 0.25 | 0.96 | 1.04 |
| $T_2$ : 75% NP + 100% K + Enriched compost | 0.37 | 1.08 | 1.15 |
| $T_3$ : 75% NP +100% K + Vermicompost | 0.36 | 0.94 | 1.07 |
| $T_4$ : 75% NP + 100% K + *Azotobacter chroococcum* + *Bacillus megaterium* + FYM (7.0 t $ha^{-1}$) | 0.34 | 1.04 | 1.13 |
| $T_5$ : 75% NP + 100% K + *A. chroococcum* + *Pseudomonas fluorescence* + FYM (7.0 t $ha^{-1}$) | 0.35 | 0.97 | 1.02 |
| $T_6$ : 75% NP + 100% K + *A.chroococcum* + *B. megaterium* + Enriched compost (7.0 t $ha^{-1}$) | 0.40 | 1.14 | 1.26 |
| $T_7$ : 75% NP + 100% K + *A.chroococcum* + *P. fluorescence* + Enriched compost (7.0 t $ha^{-1}$) | 0.38 | 1.12 | 1.26 |
| $T_8$ : 75% NP + 100% K + *A.chroococcum* + *B. megaterium* + Vermicompost (3 t $ha^{-1}$) | 0.45 | 1.04 | 1.17 |
| $T_9$ : 75% NP + 100% K + *A.chroococcum* + *P. fluorescence* + Vermicompost (3 t $ha^{-1}$) | 0.39 | 1.15 | 1.22 |
| $T_{10}$ : RD of NPK with FYM (7.0 t $ha^{-1}$) | 0.42 | 1.29 | 1.38 |
| $T_{11}$ : RD of NPK + *A.chroococcum* + *B. megaterium* + *P. fluorescence* + FYM | 0.50 | 1.26 | 1.36 |
| $T_{12}$ : RD of NPK + *A.chroococcum* + *B. megaterium* +*P. fluorescence* + Vermicompost | 0.56 | 1.35 | 1.43 |
| $T_{13}$ : RD of NPK + *A.chroococcum* + *B. megaterium* +*P. fluorescence*+ Enriched compost | 0.54 | 1.43 | 1.58 |
| $T_{14}$ *: A. chroococcum* + *B. megaterium* + *P. fluorescence* | 0.22 | 0.93 | 1.02 |
| **F test** | **S** | **S** | **S** |
| **S.Em+** | **0.030** | **0.070** | **0.090** |
| **C.D. at 5%** | **0.080** | **0.200** | **0.240** |

## Conclusion

The study shows that highest plant height, plant dry weight and leaf area index was found in the treatment recorded in the treatment of ($T_{13}$) recommended dose of NPK + *A. chroococcum* + *B. megaterium* + *P. fluorescence* + Enriched compost followed by ($T_{12}$) recommended dose of NPK + *A. chroococcum* + *B. megaterium* + *P. fluorescence* + Vermicompost and it was on par with ($T_{11}$) recommended dose of NPK + *A. chroococcum* + *B. megaterium* + *P. fluorescence* + FYM.

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