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# Impact of bacteria solubilizing both potassium and phosphorus on growth and yield of maize (*Zea mays* L.)

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**Abstract:** A pot culture experiment was conducted by using eight efficient isolates of *Bacillus* sp. (K-PSB 2, 20, 21, 28, 32, 36, 39, 50) which solubilize both potassium and phosphorus and further examined for their influence on growth and yield of maize under green house condition. The inoculated isolates K-PSB 32 with rock phosphate and mica recorded maximum dry matter content of 12.80, 44.2 and 235.7 g/plant at 30, 60, and at harvest stage respectively. K-PSB 50 with rock phosphate and mica recorded higher cob weight and grain yield of 144.9 g/plant and 52.93 g/plant respectively, as compare to other treatments. These results demonstrated that single bacterial strain can solubilize both potassium and phosphorus minerals and influence of growth of maize plant.

**Key words:** *Bacillus, Pseudomonas,* Aleksandrov medium

## Introduction

Phosphorus (P) and potassium (K) are the major essential macronutrients for biological growth and development of crop. The concentrations of soluble P and K in soil are usually very low and large proportion of P and K available in insoluble rocks, minerals and other deposits (Goldstein, 1994). These sources constitute the biggest reservoirs of P and K in soil, under appropriate conditions they can be solubilize and available for plants. In soil, the concentration of soluble K is usually very low (1 to 2% of total). However, the major portion of K is in the rocks and the minerals (98%) in insoluble forms. A large number of soil micro-flora can solubilize inorganic phosphate (including soil phosphate) with the production of inorganic (carbonic and sulfuric) and organic (citric, butyric, oxalic, malonic, lactic etc.) acids and phosphatase enzyme (Whitelaw *et al*., 1997; Sundara *et al*., 2001). A wide range of bacteria namely *Pseudomonas*, *Burkholderia*, *Acidothiobacillus ferrooxidans*, *Bacillus mucilaginosus*, *B. edaphicus, B. circulans* and *Paenibacillus sp*. had been reported to convert organic form of minerals to inorganic form in soils (Sheng, 2006 and Lin et al., 2002). In present study efferts are made to study the single bacterial strains which can able to solubalize both potassium and phosphorus minerals and influence growth of maize plant under pot culture condition.

## Material and Method

A pot culture experiment was conducted in main agricultural research station, Dharwad by seed tratement of maize seeds (cv. 900MGOLD) using eight efficient *Bacillus* sp isolates (K-PSB 2, 20, 21, 28, 32, 36, 39, 50) which solubilizing both potassium and phosphorus in comparison with local strain obtained from Department of Agricultural Microbiology, UAS Dharwad. The eight bacterial strains were grown on nutrient agar medium for 48 h at 30$^0$C. Colonies was scraped and thoroughly mixed with sterile 1 per cent carboxy methyl cellulose (CMC) and used for seed treatment. Seeds were surface sterilized with sodium hypochlorite (4%) for five min and then thoroughly rinsed twice with sterile water. The seeds were placed in CMC based culture suspension mixed uniformly and air dried overnight by placing in a laminar air flow chamber. Seeds were sown in pot containing mineral form of rock phosphate (P) and mica (K). The completely randomized design experiment includes fifteen treatments (Table1) with six replications designed, three replications used to record observation on plant growth parameters after 30, 60 days of plant growth and at harvest and three replication used to record dry biomass in each stage and yield at harvest. The chlorophyll content was measured by using a SPAD (Soil Plant Analysis Device) meter by selecting four leaves randomly at the centre of the leaves and the average worked out. The dry matter content of plant was recorded for uprooted plant, root and shoot portions. Yield recorded by taking weight of cob, grain and weight of 100 seeds from each treatments.

## Results and Discussion

The results of the present study revealed that significant increase in chlorophyll content, total dry matter and yield in inoculated treatments over the uninoculated fertilizer control (Table-1). The chlorophyll content of maize plant was recorded maximum for bacterial isolate K-PSB 50 with rock phosphate and mica treatment at 30, 60 DAS and at harvest (42.50, 44.27 and 43.43 SPAD value, respectively) as compared to other treatments (Table-1).

The total dry matter content of maize plant increased due to seed treatment of bacteria solubilizing both potassium and phosphorus. Among the different inoculants K-PSB 32 treated seeds of maize plants recorded significantly higher dry matter content at 30, 60 DAS and at harvest (12.80, 44.20 and 235.70 g/plant, respectively) and was on par with co-inoculation of local strains *Bacillus* sp. and *P.*

**Table-1:** Growth and yield of maize plants as influenced by seed treatment of bacteria solubilizing both P and K

| Tr. No. / Treatment | Dry matter (g/plant) | | | Chlorophyll (SPAD value) | | | Cob | Grain | Test |
|---|---|---|---|---|---|---|---|---|---|
| | 30 DAS | 60 DAS | At harvest | 30 DAS | 60 DAS | 90 DAS | weight (g/plant) | yield (g/plant) | weight (g /100 grain) |
| T1: Control (no inoculation and no fertilizer) | 5.57 | 12.10 | 156.60 | 30.90 | 34.23 | 33.90 | 75.40 | 23.80 | 19.63 |
| T2: Recommended Dose of Fertilizer | 12.37 | 41.80 | 233.00 | 41.00 | 42.60 | 42.30 | 112.60 | 51.03 | 26.33 |
| T3: Recommended Dose of potash with rock phosphate | 7.40 | 18.20 | 197.80 | 36.07 | 40.10 | 38.67 | 88.60 | 36.70 | 21.87 |
| T4: Recommended Dose of phosphorus with Mica | 7.21 | 18.70 | 195.90 | 35.90 | 39.53 | 37.13 | 85.40 | 38.57 | 22.57 |
| T5: Local strain of *Bacillus* (KSB-11) with RP and Mica | 8.55 | 27.50 | 208.57 | 38.27 | 41.07 | 40.97 | 93.50 | 32.03 | 26.60 |
| T6: Local strain of *P. striata* (PSB 98 (2)) with RP and Mica | 8.26 | 31.10 | 220.60 | 38.30 | 40.33 | 38.07 | 101.40 | 44.60 | 25.63 |
| T7: Co-inoculation of local strain of KSB-11 and PSB 98(2) with RP and Mica | 12.44 | 43.70 | 234.27 | 41.87 | 43.07 | 42.37 | 113.40 | 52.80 | 28.03 |
| T8: Isolate K-PSB 2 with RP and Mica | 8.30 | 41.40 | 230.90 | 39.10 | 40.40 | 38.70 | 109.80 | 45.93 | 23.50 |
| T9: Isolate K-PSB 20 with RP and Mica | 8.43 | 23.20 | 227.90 | 38.20 | 41.97 | 39.93 | 106.70 | 41.87 | 26.53 |
| T10: Isolate K-PSB 21 with RP and Mica | 8.81 | 35.60 | 211.20 | 39.47 | 40.10 | 37.20 | 91.30 | 39.60 | 25.93 |
| T11: Isolate K-PSB 28with RP and Mica | 9.26 | 25.70 | 209.70 | 39.87 | 41.97 | 39.87 | 96.40 | 37.77 | 26.83 |
| T12: Isolate K-PSB 32 with RP and Mica | 12.80 | 44.20 | 235.70 | 39.30 | 41.73 | 40.33 | 112.47 | 50.93 | 27.77 |
| T13: Isolate K-PSB 36 with RP and Mica | 10.35 | 39.69 | 218.90 | 39.80 | 42.10 | 40.47 | 105.80 | 46.50 | 24.23 |
| T14: Isolate K-PSB 39 with RP and Mica | 8.69 | 41.40 | 218.30 | 39.50 | 41.70 | 40.03 | 103.00 | 42.53 | 25.57 |
| T15: Isolate K-PSB 50 with RP and Mica | 10.35 | 42.10 | 232.37 | 42.50 | 44.27 | 43.43 | 114.90 | 52.93 | 28.63 |
| S Em ± | 0.15 | 0.18 | 0.40 | 0.49 | 0.91 | 0.39 | 0.23 | 0.19 | 0.21 |
| CD @1% | 0.52 | 0.60 | 1.42 | 1.60 | 2.86 | 1.25 | 0.78 | 0.72 | 0.75 |

*striata* and treatment with rock phosphate and mica (12.44, 43.70 and 2334.27 g/plant, respectively). Significantly increase in dry matter due to inoculation of mica with *B. mucilaginous* may be attributed to mobilization of K from waste mica because of secretion of organic acids by bacterial strains, which in turn increased the biomass yield (Wu *et al*., 2005 and Priyanka, and Sindhu, 2013).

The yield attributing characters like cob weight, grain yield and test weight of maize was significantly enhanced in the treatments receiving inoculation of bacteria solubilizing both potassium and phosphorus. Among the treatments isolate K-PSB 50 with rock phosphate and mica recorded significantly heightest cob weight of 114.90 g/plant and was on par with the treatment co-inoculated with local strains of *Bacillus* and *P. striata* with rock phosphate and mica (113.40 g/plant) over control. The grain yield of maize plant (52.93 g/plant) was significantly high with the treatment receiving inoculation of K-PSB 50 with rock phosphate and mica and was on par with the treatment co-inoculated with local strains of *Bacillus* and *P. striata* with rock phosphate and mica (52.80 g/plant) over other inoculants.

Test weight was found to be significantly high with the treatment receiving inoculation of K-PSB 50 with rock phosphate and mica (28.63 g/100 grain) and was on par with treatment with co-inoculated local strains of *Bacillus* and *P. striata* with rock phosphate and mica (28.03 g/100grain) and K-PSB 32 with rock phosphate and mica (27.77 g/100 grain). The yield and yield parameters of maize plant was influenced by inoculation of potassium and phosphorus solubilizing bacteria. Similarly, inoculation of potassium solubilizing bacteria *Bacillus mucilaginosa* had been reported to siginificantly increase the yield of maize (Alexandrov, 1967), sorghum (Vintikova, 1964), wheat (Muralikaman, 1996), tomoto (Kalaiselvi, 1999), brinjal (Zhang *et al.,* (2004) and chilli (Supanjani *et al.,* 2006).

It can be concluded that inoculation of bacteria solubilizing both potassium and phosphorus of K-PSB 32 and 50 improved the dry matter, cob weight, yield per plant of the maize plants as compared to control and reference strain inoculated single.

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