A field experiment was conducted for three consecutive years in four different locations to evaluate the effect of consortium of Rhizobium, PSB and potash mobilizing bacteria on growth and yield of mungbean. Among different inoculation treatments, seed inoculation with consortium of Rhizobium, PSB and potash mobilizing bacteria along with 75% per cent recommended nitrogen and phosphorus was found most effective as it recorded highest number of nodules (73.41 plant⁻¹), number of pods (37.93 plant⁻¹), grain yield (9.16 q ha⁻¹) and thousand grain weight (38.0 g) and found statistically at par with the treatment of consortium + 100% recommended dose of nitrogen and phosphorus for all growth and yield attributing characters. The results indicated saving of 25% chemical nitrogen and phosphorus fertilizer for mungbean.
bacteria (PSB) and Rhizobium have synergistic effect on legume crops (Cao et al., 2016). Development of consortia containing one strain of Rhizobium, PSB and PGPR has been attempted (Bansal 2015), whereas potash mobilizing bacteria increased ‘K’ availability in soils and increased mineral uptake by plants (Sheng and Huang 2002).

Biofertilizers keep the soil environment rich in all kinds of micro and macro nutrients via nitrogen fixation, phosphate solubilization, potash mobilization and release of plant growth regulating substances (Javaid 2009). Shete et al., (2019) formulated MS III culture medium for growth of nitrogen fixing, phosphate solubilizing and potash mobilizing bacteria in a consortium.

Keeping this in view, the present research work was undertaken to study effect of consortia of nitrogen fixing, phosphate solubilizing and potash mobilizing bacteria on growth and yield of mungbean.

**Materials and Methods**

**Experimental site**

A field experiment was conducted at four different locations viz., Biological Nitrogen Fixing Scheme, College of Agriculture, Pune; Agriculture Research Station, Kasbe-Digraj, Sangli; Oilseed Research Station, Jalgaon and Pulse Improvement Project, MPKV, Rahuri under the jurisdiction of Mahatma Phule Krishi Vidyapeeth, Rahuri Dist. Ahmednagar, Maharashtra during three consecutive kharif seasons viz., 2016-17, 2017-18 and 2018-19 to find out the efficacy of consortium of Rhizobium, PSB and potash mobilizing bacteria on growth parameters and yield of mungbean. The experiment was laid out in randomized block design with three replications and eight treatments.

**Treatment details**

- **T₁**: Uninoculated control
- **T₂**: 100% RDF
- **T₃**: Consortium of Rhizobium, PSB and KMB
- **T₄**: Consortium + 100% RDF
- **T₅**: 75% RDF
- **T₆**: Consortium + 75% RDF
- **T₇**: Rhizobium + 75% RDN + 100% RDP
- **T₈**: PSB + 75% RDP + 100% RDN

Note: RDF = Recommended dose of fertilizers (20:40:00 NPK kg ha⁻¹)

RDN = Recommended dose of nitrogen; RDP = Recommended dose of phosphorus
PSB = Phosphate solubilizing bacteria; KMB = Potash mobilizing bacteria

**Preparation of consortium**

A consortium of Rhizobium sp., phosphate solubilizing bacteria (Bacillus subtilis) and potash mobilizing bacteria (Fratureia aurantia) was prepared in selective medium MS III (Shete et al., 2019).

Lignite powder based formulations duly formulated by using consortium of Rhizobium, PSB and KMB (2 x 10⁷ cfu g⁻¹ lignite powder) was applied to mungbean as seed coating at the time of sowing.

The well decomposed farm yard manure @ 5 t ha⁻¹ and recommended dose of chemical fertilizers (20:40:00 NPK kg ha⁻¹) were applied for mungbean.

The observations on plant height (cm), number of branches plant⁻¹, number of pods plant⁻¹, 1000 grain weight (g), grain yield (q ha⁻¹), available N and P in soil at harvest (kg ha⁻¹), N and P uptake by plants at harvest (kg ha⁻¹) and microbial count of Rhizobium, PSB and KMB at flowering stage of the mungbean were recorded.
**Microbial analysis**

Fresh root nodules of mungbean at flowering stage were analyzed for rhizobial population on yeast extract mannitol agar media as described by Rajendran et al., (2008). Moreover, rhizospheric soil samples at flowering stage of mungbean were analyzed for microbial population of phosphate solubilizing bacteria (PSB) and potash mobilizing bacteria (KMB) using serial dilution of soil and agar plating method (Aneja, 2003).

The PSB and KMB population was enumerated on Pikovskaya’s media and Alexandrov’s agar media, respectively, at 10⁶ dilutions. The plates were incubated at 28±2 °C temperature for 72 hours and colonies were counted. The population was expressed as cfu g⁻¹ soil.

**Soil analysis**

Soil samples were collected from the experimental plot before and after harvesting of the mungbean for analysis of nutrient status of the soil. The collected soil samples were air dried, crushed in wooden Mortar and Pestle. Soil was sieved through 2 mm sieve. Then the soil samples were analyzed for their chemical properties by using standard analytical methods.

The available nitrogen was estimated by alkaline permanganate method (Subbiah and Asija 1956). The available phosphorus was estimated by sodium bicarbonate (0.5 M NaHCO₃) method (Olsen et al., 1954).

**Plant sample analysis**

The plant samples for total N, P, and K analysis were collected separately from each treatment plots at harvesting stage. The plant parts were then kept in paper bags and dried in hot air oven at 70°C for 48 hours. The dried plant parts were finely grounded in a mixer. This fine powder was again dried in oven at 60°C for a couple of hours and stored in properly till the samples were used for chemical analysis of nutrients.

Nitrogen content of plant was estimated by following Modified Kjeldahl’s process (Jackson 1973) and accordingly N uptake (kg ha⁻¹) was estimated as N% x total dry matter yield (kg ha⁻¹)/100.

Phosphorus content of plant was determined by colorimetric method (Jackson 1973) employing vandomolybdate phosphoric yellow color colorimetric method. Yellow color intensity was read in spectrophotometer at 470 nm and accordingly P uptake (kg ha⁻¹) was estimated as P% x total dry matter yield (kg ha⁻¹)/100.

**Statistical analysis**

The data recorded on various parameters was subjected to statistical analysis by following standard method of analysis of variance. The level of significance used in ‘F’ and ‘t’ tests was P = 0.05. Critical difference (CD) values were calculated where the ‘F’ test was found significant (Panse and Sukhatme 1985).

**Results and Discussion**

**Inoculation effect of consortium on growth parameters and yield of mungbean**

The pooled results in respect of growth and yield attributing characters of mungbean are presented in (Table 1 and 2). It was revealed from the pooled analysis that the growth parameters and grain yield differences were significant due to seed inoculation with consortium.
Table 1 Effect of consortium of *Rhizobium*, PSB and KMB on growth parameters of mungbean  
(Pooled: 2016-17, 2017-18 and 2018-19)

| Treatment                      | Plant height (cm) | Number of branches plant⁻¹ | Number of nodules plant⁻¹ |
|--------------------------------|-------------------|----------------------------|---------------------------|
|                                | BNF Pune          | ARS K’Digraj              | PIP Rahuri                | ORS Jalgaon               | Pooled mean | BNF Pune          | ARS K’Digraj              | PIP Rahuri                | ORS Jalgaon               | Pooled mean |
| T₁: Uninoculated control       | 50.35             | 53.51                     | 54.28                     | 53.20                     | 52.84         | 2.83             | 3.61                     | 3.26                     | 3.24                     | 3.24         |
| T₂: 100% RDF                   | 70.85             | 67.63                     | 61.87                     | 66.08                     | 66.61         | 6.12             | 4.97                     | 3.78                     | 4.00                     | 4.72         |
| T₃: Consortium                 | 67.92             | 60.74                     | 56.88                     | 57.72                     | 60.82         | 6.27             | 4.55                     | 3.30                     | 3.24                     | 4.34         |
| T₄: Consortium + 100% RDF      | 65.52             | 65.38                     | 62.66                     | 69.38                     | 65.74         | 6.21             | 4.79                     | 3.92                     | 4.31                     | 4.81         |
| T₅: 75% RDF                   | 60.05             | 62.90                     | 58.22                     | 64.17                     | 61.33         | 4.80             | 4.25                     | 3.35                     | 3.59                     | 4.00         |
| T₆: Consortium + 75% RDF       | 72.73             | 68.99                     | 64.74                     | 69.82                     | 69.07         | 6.93             | 5.37                     | 4.09                     | 4.55                     | 5.24         |
| T₇: *Rhizobium* + 75% N +100% P| 61.67             | 61.82                     | 60.06                     | 66.38                     | 62.48         | 5.49             | 4.42                     | 3.40                     | 3.96                     | 4.32         |
| T₈: PSB + 75% P + 100% N      | 68.54             | 67.40                     | 61.24                     | 67.01                     | 66.05         | 5.15             | 4.54                     | 3.69                     | 3.97                     | 4.34         |
| SEM ±                          | 2.26              | 2.66                      | 0.90                      | 1.54                      | 1.28          | 0.35             | 0.39                     | 0.09                     | 0.12                     | 0.24         |
| CD at 5%                       | 6.78              | 8.06                      | 2.73                      | 4.62                      | 3.75          | 1.05             | 1.18                     | 0.27                     | 0.36                     | 0.71         |

RDF- Recommended dose of fertilizers (20:40:00 NPK kg ha⁻¹)  
Consortium- Consortia of *Rhizobium*, PSB and KMB  
PSB- Phosphate solubilizing bacteria  
KMB- Potash mobilizing bacteria
Table 2: Effect of consortium of **Rhizobium**, PSB and KMB on growth parameters and yield of mungbean (Pooled:2016-17, 2017-18 and 2018-19)

| Treatment | Number of pods plant$^{-1}$ | 1000 grain weight (g plant$^{-1}$) | Grain yield (q ha$^{-1}$) |
|-----------|-----------------------------|----------------------------------|--------------------------|
|           | BNF Pune | ARS K'Digraj | PIP | ORS | Jalgaon | Pooled mean | BNF Pune | ARS K'Digraj | PIP | ORS | Jalgaon | Pooled mean | BNF Pune | ARS K'Digraj | PIP | ORS | Jalgaon | Pooled mean |
| T$_1$: Uninoculated control | 23.52 | 20.88 | 12.81 | 24.50 | 20.43 | 27.92 | 31.05 | 28.19 | 32.27 | 29.85 | 6.10 | 6.58 | 5.13 | 6.49 | 6.08 |
| T$_2$: 100% RDF | 37.95 | 34.22 | 24.88 | 38.87 | 33.98 | 37.53 | 36.98 | 29.73 | 39.92 | 36.04 | 9.03 | 8.75 | 8.30 | 8.32 | 8.60 |
| T$_3$: Consortium | 33.99 | 28.84 | 16.86 | 30.01 | 27.42 | 33.77 | 33.71 | 28.38 | 34.45 | 32.58 | 7.30 | 7.14 | 6.25 | 6.98 | 6.92 |
| T$_4$: Consortium + 100% RDF | 39.90 | 35.82 | 26.93 | 40.98 | 35.91 | 38.30 | 37.03 | 30.10 | 40.99 | 36.61 | 9.74 | 9.04 | 8.51 | 8.90 | 9.05 |
| T$_5$: 75% RDF | 32.10 | 29.37 | 19.53 | 33.97 | 28.74 | 33.94 | 36.06 | 28.54 | 37.87 | 34.10 | 8.01 | 8.32 | 7.32 | 7.44 | 7.77 |
| T$_6$: Consortium + 75% RDF | 40.45 | 37.68 | 31.40 | 42.18 | 37.93 | 39.58 | 38.77 | 31.64 | 41.99 | 38.00 | 9.79 | 9.13 | 8.63 | 9.08 | 9.16 |
| T$_7$: Rhizobium + 75% N+100% P | 36.63 | 33.71 | 20.21 | 36.96 | 31.88 | 35.25 | 36.19 | 29.26 | 39.12 | 34.96 | 8.64 | 8.43 | 7.55 | 7.97 | 8.15 |
| T$_8$: PSB + 75% P + 100% N | 36.01 | 30.02 | 20.64 | 36.76 | 30.86 | 35.52 | 35.84 | 29.37 | 38.98 | 34.93 | 8.66 | 8.19 | 8.14 | 8.05 | 8.26 |
| SEM ± | 3.40 | 1.53 | 1.61 | 1.56 | 0.70 | 1.05 | 0.74 | 0.31 | 0.34 | 0.61 | 0.33 | 0.13 | 0.31 | 0.16 | 0.13 |
| CD (P ≤ 0.05) | 10.20 | 4.64 | 4.83 | 4.68 | 2.05 | 3.15 | 2.24 | 0.93 | 1.83 | 1.80 | 0.99 | 0.41 | 0.97 | 0.48 | 0.38 |

Table 3: Effect of consortium of **Rhizobium**, PSB and KMB on N and P uptake by mungbean

| Treatment | ‘N’ uptake by plants (kg ha$^{-1}$) | ‘P’ uptake by plants (kg ha$^{-1}$) |
|-----------|----------------------------------|----------------------------------|
|           | BNF, Pune | PIP, Rahuri | ORS, Jalgaon | Pooled Mean | BNF, Pune | PIP, Rahuri | ORS, Jalgaon | Pooled Mean |
| T$_1$: Uninoculated control | 11.41 | 13.08 | 11.75 | 12.65 | 4.21 | 2.31 | 3.96 | 3.53 |
| T$_2$: 100% RDF | 19.41 | 23.16 | 15.97 | 19.69 | 8.22 | 5.64 | 5.49 | 6.45 |
| T$_3$: Consortium | 12.92 | 19.94 | 12.77 | 15.64 | 4.75 | 5.38 | 4.68 | 5.05 |
| T$_4$: Consortium + 100% RDF | 20.45 | 24.25 | 18.69 | 21.27 | 6.62 | 4.00 | 10.86 | 7.15 |
| T$_5$: 75% RDF | 18.34 | 24.38 | 14.06 | 19.43 | 6.33 | 5.56 | 4.39 | 5.52 |
| T$_6$: Consortium + 75% RDF | 22.81 | 30.12 | 18.61 | 24.00 | 12.04 | 4.32 | 9.99 | 8.61 |
| T$_7$: Rhizobium + 75% N+100% P | 20.48 | 22.50 | 15.78 | 19.89 | 8.55 | 5.36 | 5.42 | 6.44 |
| T$_8$: PSB + 75% P + 100% N | 20.61 | 25.15 | 15.30 | 20.32 | 10.31 | 5.54 | 5.15 | 6.94 |
| SEM ± | 0.07 | 0.45 | 0.06 | 0.18 | 4.21 | 2.31 | 3.96 | 3.53 |
| CD (P ≤ 0.05) | 0.21 | NS | 0.17 | NS | 0.04 | 0.03 | 0.17 | NS |
### Table 4 Effect of consortium of *Rhizobium*, PSB and KMB on available ‘N’ and ‘P’ after harvest in soil

| Treatment                                | Available ‘N’ (kg ha\(^{-1}\)) in soil after harvest | Available ‘P’ (kg ha\(^{-1}\)) in soil after harvest |
|------------------------------------------|-----------------------------------------------------|-----------------------------------------------------|
|                                          | BNF, Pune    | PIP, Rahuri | ORS, Jalgaon | Pooled Mean | BNF, Pune    | PIP, Rahuri | ORS, Jalgaon | Pooled Mean |
| T\(_1\): Uninoculated control            | 161.67       | 114.67      | 157.33       | 144.55       | 13.86        | 13.69        | 10.53        | 12.69        |
| T\(_2\): 100% RDF                       | 177.00       | 94.83       | 214.33       | 163.05       | 21.25        | 13.29        | 17.47        | 17.34        |
| T\(_3\): Consortium                      | 173.00       | 96.33       | 209.33       | 159.55       | 17.37        | 11.17        | 13.00        | 13.85        |
| T\(_4\): Consortium + 100% RDF          | 192.00       | 120.33      | 212.67       | 175.00       | 27.07        | 14.42        | 11.47        | 17.66        |
| T\(_5\): 75% RDF                        | 173.00       | 101.83      | 208.33       | 161.05       | 25.78        | 11.80        | 12.23        | 16.60        |
| T\(_6\): Consortium + 75% RDF           | 206.67       | 129.83      | 209.33       | 181.94       | 23.10        | 16.99        | 18.97        | 19.69        |
| T\(_7\): *Rhizobium* + 75% N + 100% P   | 180.33       | 114.83      | 217.33       | 169.83       | 17.28        | 15.41        | 13.47        | 15.39        |
| T\(_8\): PSB + 75% P + 100% N           | 177.00       | 104.17      | 209.00       | 163.39       | 19.68        | 14.67        | 15.13        | 16.49        |
| SEm ±                                    | 0.39         | 0.47        | 0.43         | 8.42         | 2.575        | 2.05         | 0.33         | 1.68         |
| CD (P < 0.05)                            | 1.18         | 1.54        | 1.36         | NS           | 7.786        | NS           | 1.00         | NS           |

### Table 5 Effect of consortium of *Rhizobium*, PSB and KMB on Microbial population at flowering stage of mungbean

| Treatment                                | Microbial population at flowering (x10\(^6\) cfu g\(^{-1}\) soil) |
|------------------------------------------|---------------------------------------------------------------|
|                                          | *Rhizobium* | PSB | KMB |
| T\(_1\): Uninoculated control            | 12.67       | 15.00 | 10.67 |
| T\(_2\): 100% RDF                        | 17.00       | 21.67 | 15.67 |
| T\(_3\): Consortium                      | 50.33       | 46.33 | 40.00 |
| T\(_4\): Consortium + 100% RDF           | 56.67       | 55.00 | 50.33 |
| T\(_5\): 75% RDF                         | 45.00       | 26.67 | 25.67 |
| T\(_6\): Consortium + 75% RDF            | 60.33       | 58.67 | 52.33 |
| T\(_7\): *Rhizobium* + 75% N + 100% P    | 50.00       | 36.67 | 32.67 |
| T\(_8\): PSB + 75% P + 100% N            | 41.67       | 45.33 | 37.33 |
| SEm ±                                    | 3.22        | 4.07  | 4.03  |
| CD (P < 0.05)                            | 9.74        | 12.30 | 12.18 |
Table 6: Economics as influenced by seed inoculation of consortium of *Rhizobium*, PSB and KMB in mungbean (Pooled: 2016-17, 2017-18 and 2018-19)

| Treatment                              | Grain yield (q ha\(^{-1}\)) | Gross Monitory Returns (Rs. ha\(^{-1}\)) | Cost of Cultivation (Rs. ha\(^{-1}\)) | Net Monitory Returns (Rs. ha\(^{-1}\)) | B:C ratio |
|----------------------------------------|-----------------------------|------------------------------------------|----------------------------------------|----------------------------------------|-----------|
| T\(_1\): Uninoculated control          | 6.08                        | 31531                                    | 29714                                  | 1817                                   | 1.06      |
| T\(_2\): 100% RDF                      | 8.60                        | 44641                                    | 31794                                  | 12847                                  | 1.40      |
| T\(_3\): Consortium                    | 6.92                        | 35944                                    | 30354                                  | 5590                                   | 1.18      |
| T\(_4\): Consortium + 100% RDF         | 9.05                        | 47060                                    | 32434                                  | 14626                                  | 1.45      |
| T\(_5\): 75% RDF                       | 7.77                        | 40388                                    | 31274                                  | 9114                                   | 1.29      |
| T\(_6\): Consortium + 75% RDF          | 9.16                        | 47632                                    | 31914                                  | 15718                                  | 1.49      |
| T\(_7\): Rhizobium + 75% N+100% P      | 8.15                        | 42313                                    | 31715                                  | 10598                                  | 1.33      |
| T\(_8\): PSB + 75% P + 100% N          | 8.26                        | 42928                                    | 31352                                  | 11576                                  | 1.37      |

Note: Consortium: *Rhizobium*, PSB and KMB consortium,
Selling rate of mungbean: 2016-17: Rs.5000 q\(^{-1}\), 2017-18: Rs.5200 q\(^{-1}\) and 2018-19: Rs.5400 q\(^{-1}\)
Total cost of cultivation excluding inorganic fertilizers: Rs. 29714 ha\(^{-1}\)

Among different inoculation treatments, the treatment T\(_6\) i.e. seed inoculation with consortium of *Rhizobium*, PSB and KMB + 75% per cent recommended nitrogen and phosphorus was found most effective as it recorded significantly highest nitrogen and phosphorus was found most effective as it recorded significantly highest plant height (69.07 cm), number of branches (5.24 plant\(^{-1}\)), number of nodules (73.41 plant\(^{-1}\)), number of pods (37.93 plant\(^{-1}\)), thousand grain weight (38.0 g) and grain yield (9.16 q ha\(^{-1}\)) of mungbean and found statistically at par with the treatment T\(_4\) (consortium + 100% recommended dose of nitrogen and phosphorus) for all growth and yield attributing characters. These results are in agreement with the results of Bansal R.K. (2009) who reported that pre-sowing inoculation of mungbean seeds with different inoculants (*Rhizobium*, PGPR and PSB) alone or in combination, significantly increased the nodulation and grain yield over uninoculated control. Moreover, Cao et al., (2016) reported that the application of rhizobial inoculant and/or PSB inoculant did not have significant difference with chemical fertilizer, they increased grain yield from 15 to 19% in comparison to control. A similar result was reported by Rajendran et al., (2008) and Qureshi et al., (2011).

**Nutrient uptake**

The pooled results in respect of N and P uptake by mungbean are presented in (Table 3). Although the data was found to be non-significant, the maximum N and P uptake (24.0 and 8.61 kg ha\(^{-1}\), respectively) was recorded in treatments T\(_6\) (Consortium + 75% RDF) followed by T\(_4\) (Consortium+100% RDF) (21.27 and 7.15 kg ha\(^{-1}\), respectively). Qureshi et al., (2011) reported that rizobial inoculation produced highest N-content in grains (3.23 and 3.24%) followed by co-inoculation (3.21 and 3.19%) at half and full dose of P fertilizer, respectively.

**Available soil nutrients:** After harvest of crop, soil was analyzed for available soil nutrients and the pooled data was analyzed and tabulated in (Table 4). The available soil N and P was found maximum (181.94 and 19.69 kg ha\(^{-1}\), respectively) under the treatment T\(_6\) (consortium+75% RDF) followed by T\(_4\) (Consortium+100% RDF) (175.0 and 17.66...
kg ha\(^{-1}\), respectively). Qureshi \textit{et al.}, (2011) reported that the highest soil N was observed with co-inoculation i.e. 0.037 and 0.039\% followed by \textit{Rhizobium} i.e. 0.036 and 0.037\% at 25 and 50 kg P ha\(^{-1}\), respectively.

\textbf{Inoculation effect of consortium on microbial population}

At flowering stage, soil samples were analyzed for microbial population of phosphate solubilizing bacteria (PSB) and potash mobilizing bacteria (KMB) and fresh root nodules of mungbean were analyzed for rhizobial population and data was analyzed and presented in (Table 5). Among different inoculation treatments, T\(_6\) (consortium+75\% RDF) recorded significantly highest population of \textit{Rhizobium}, PSB and KMB (60.33, 58.67 and 52.33 x 10\(^6\) cfu g\(^{-1}\) soil, respectively) at flowering stage of mungbean and was found statistically at par with the treatment T\(_4\) (Consortium + 100\% RDF) for microbial population of \textit{Rhizobium}, PSB and KMB (56.67, 55.00 and 50.33 x 10\(^6\) cfu g\(^{-1}\) soil, respectively). These results are in agreement with the results of Cao \textit{et al.}, (2016) who reported that the application of rhizobial inoculant and/or PSB inoculant to soybean significantly increased the population of \textit{Rhizobium} and PSB at flowering stage of soybean. Moreover, Swedrzynska and Sawicka (2001) reported that inoculation of cereals with \textit{Azospirillum brasilense} bacteria contributed to the increase in their population at different growth stages of crops and the counts were higher in inoculated treatments compared to uninoculated control.

\textbf{Cost: Benefit analysis}

The economics as influenced by seed inoculation of consortium of \textit{Rhizobium}, PSB and KMB in mungbean is presented in (Table 6). The highest net monetary returns (Rs.15718/- ha\(^{-1}\)) and B:C ratio (1.49) was observed in treatment T\(_6\) (Consortium + 75\% RDF) followed by treatment T\(_4\) (Consortium + 100\% RDF) (Rs.14626/- ha\(^{-1}\) and 1.45, respectively). Jilani \textit{et al.}, (2007) reported that integration of half dose of NP fertilizers with biofertilizers gave crop yield as with full rate of fertilizer and through reduced use of fertilizers, the production cost was minimized and the net return maximized.

In conclusion the seed inoculation with consortium of \textit{Rhizobium}, PSB and KMB+75\% per cent recommended nitrogen and phosphorus was found at par with the treatment of consortium + 100\% recommended dose of nitrogen and phosphorus for all growth and yield attributing characters of mungbean. The results indicated saving of 25\% chemical nitrogen and phosphorus fertilizer for mungbean.

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\textbf{References}

Aneja, K.R. 2003. Experiments in Microbiology, Plant Pathology and Biotechnology. New Age International Publishers, New Delhi, India. pp. 157-161.

Bansal, R.K. 2009. Synergistic effect of \textit{Rhizobium}, PSB and PGPR on nodulation and grain yield of mungbean. \textit{J. Food Legumes}. 22(1): 37–39.

Bansal, R.K. 2015. Synergistic effect of \textit{Rhizobium}, PSB and PGPR on nodulation and grain yield of mungbean. \textit{Int. J. Agric. Biol.} 15: 55–68.
Barker, W.W., Welch, S.A., Chu, S. and Banfield, J.F. 1998. Experimental observations of the effects of bacteria on aluminosilicate weathering. American Mineralogist. 83: 1551–1563.

Bennett, P.C., Choi, W.J. and Rogera, J.R. 1998. Microbial destruction of feldspars. Mineral Management. 8(62A): 149–150.

Cao, N.D., Duong, B.S., Nguyen, B.T. and Phan, V.H.L. 2016. Effects of rhizobia and phosphate-solubilizing bacteria on soybean (glycine max l. Merr.) cultivated on Ferralsols of daklak province, Vietnam. World J. Pharma. Pharmaceutical Sci. 5(4): 318-333.

Jackson, M.L. 1973. Soil Chemical Analysis. Prentice Hall of India, New Delhi, India. pp. 134-139.

Javaid, A. 2009. Growth, nodulation and yield of black gram [Vigna mungo (L.) Hepper] as influenced by biofertilizers and soil amendments. African J. Biotechnol. 8: 5711-5717.

Jilani, G., Akram, A., Ali, R.M., Hafeez, F.Y., Shamsi, I.H., Chaudhary, A.N. and Chaudhary, A.G. 2007. Enhancing crop growth, nutrients availability, economics and beneficial rhizosphere microflora through organic and biofertilizers. Annals Microbiol. 57: 177-183.

Olsen, S.R., Cole, C.V., Watanabe, F.S. and Dean, L.A. 1954. Estimation of Available Phosphorus in Soils by Extraction with Sodium Bicarbonate. U. S. Department of Agriculture Circular No.939. Banderis A D, Barter D H and Anderson K. Agricultural and Advisor.

Panse, V.S. and Sukhatme, P.V. 1985. Statistical Methods for Agricultural Workers, ICAR, New Delhi.

Qureshi, M.A, Shakir, M.A., Iqbal, A., Akhtar, N. and Khan, A. 2011. Coinoculation of phosphate solubilizing bacteria and rhizobia for improving growth and yield of mungbean (Vigna Radiata L.). J. Animal Plant Sci. 21(3): 491-497.

Rajendran, G., Singh, F., Desai, A.J. and Archana, G. 2008. Enhanced growth and nodulation of pigeonpea by coinoculation of Bacillus sp. Bioresource Tech. 99: 4544–4550.

Sheng, X.F. and Huang, W.Y. 2002. Mechanism of potassium release from feldspar affected by the strain NBT of silicate bacterium. Acta Pedologica Sinica. 39: 863–871.

Shete, M.H., Murumkar, D.R., Tirmali, A.M. and Landge, K.B. 2019. Formulation of culture media for growth of nitrogen fixing, phosphate solubilizing and potash mobilizing bacteria in a consortium. J. Plant Dis.Sci. 14(1): 41-46.

Subbiah, B.V. and Asija, G.L. 1956. A rapid procedure for the determination of available nitrogen in soil. Curr. Sci. 25:259-260.

Swedrzynska, D. and Sawicka, A. 2001. Effect of inoculation on population numbers of Azospirillum bacteria under winter wheat, oat and maize. Polish J. Environ. Studies. 10(1): 21-25.

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