**Effect of phosphorus management on growth, yield attributes and yield of cowpea [*Vigna unguiculata* (L.) Walp.]**

**ABSTRACT**

 A field experiment was conducted at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar to evaluate the Phosphorus Management in Cowpea [*Vigna unguiculata* (L.) Walp] in Loamy Sand. The experiment consisting nine treatment combinations were evaluated in Randomized Block Design with four replications.Results revealed that significantly higher plant height at 30 DAS,plant height at harvest, number of branches, number of nodules, fresh weight, dryweight of nodules and number of pods per plant was recorded under the treatment 30 kgP2O5 ha-1 + enriched compost (1t ha -1) + Mycorrhiza application(T9)as compared to rest of the treatments. Significantly higher values of all the above parameters were recorded which ultimately reflectedin higher seed (1497 kg ha-1) and stover (2257 kg ha-1) yields, but it was remained at par with all the other treatments except T1, T2 and T3.

***Key words:*** *PSB, Mycorriza, enriched compost, integrated phosphorus management, available phosphorus.*

**Introduction**

 Phosphorus plays a significant role in various physiological processes like root growth and drymatter production, nodulation and nitrogen fixation. In pulse crop, it helps in establishing seedling quickly andalso hastens maturity as well as improves the quality of pulse crop. The mostobvious effect of phosphorus is on the root system of plants. It promotes the formation oflateral and fibrous roots, which facilitates to bacteria for nodulation and ultimatelyincreases the atmospheric nitrogen fixation in leguminous crops. Phosphorus is one of theimportant and major nutrients required by the crops and the soil conditions affect theavailability of phosphorus. In India, the consumption of phosphaticfertilizers is still less and it ranges between 4 to 5 million metric tonnes (FAO, 2005). Dueto intensive cultivation and adoption of high yielding varieties in irrigated agriculture, thecurrent farming practices are dependent on large quantities of fertilizers uses, phosphorus isno exception. In general, Indian soils are poor in phosphorus content and therefore, externalapplication of phosphorus is must for good harvest.

Inadequate and imbalanced application of phosphatic fertilizers by farmers is one of themost important limiting factors in pulse crop production. It is now increasingly beingrealized that no single nutrient source could fully meet the nutritional requirement of crop.It has been established that judicious use of chemicals enhances the soil and plant health. Inthis context, use of alternative sources of plant nutrients such as enriched compost, PSBand bio-fertilizers are the need of the time.

 The integration of enriched compost with inorganic fertilizers results in increased productivity, reduced expenditure on expensive fertilizer inputs, improved soil physical properties, increased efficiency of added nutrients, and improved soil health, as well as an environmentally friendly approach. Given the above facts and the lack of sufficient experimental evidence, this investigation was conducted.

**Material and Method**

A field experiment was carried out at during *kharif* season of 2019 to study the phosphorus management in cowpea [*Vigna unguiculata* (L.) Walp.] in loamy sand. The experiment was laid out at Agronomy Instructional Farm, CPCA, SDAU, Sardarkrushinagar, District: Banaskantha, Gujarat. The experimental area was situated at 24o 19' N latitude and 72o 19' E longitude with an elevation of 154.52 meter above the mean sea level and falls under North Gujarat Agro-climatic Region. Climate of this region is sub-tropical monsoon type and falls under semi-arid region, in general, the monsoon is warm and moderately humid, winter is fairly cold and dry, while summer is largely hot and dry. The soil of the experimental plot was neutral in reaction, loamy sand in texture and normal in salt content, low in organic carbon & available nitrogen; and medium in available phosphorus & available potash. Nine treatments namely, T1: Absolute control (No. P2O5); T2 : PSB alone; T3 : Mycorrhiza alone; T4 : 40 kg P2O5 ha-1; T5 : 30 kg P2O5 ha-1 + enriched compost (1 t ha-1); T6 : 30 kg P2O5ha-1 + PSB; T7 :30 kg P2O5 ha-1 + enriched compost (1 t ha-1) + PSB; T8 :30 kg P2O5 ha-1 + Mycorrhiza and T9: 30 kg P2O5 ha-1 + enriched compost (1 t ha-1) + Mycorrhiza, where in source of P2O5 was DAP; RDF : 20 : 40 : 00 kg NPK ha-1, Mycorrhizae and PSB were used for seed treatment. Castor shell compost was enriched with 2% urea and 0.5% SSP and the nutrient content was 3.0 % N, 1.0 % P, 1.4 % K was provided from Castor and Mustard Research Station, SDAU, Sardarkrushinagar.Cowpea var. GC 4 was sown on 9th July, 2019 using recommended seed rate of 20 kg/ha and keeping 45 cm distance between two rows and seeds were sown manually at the depth of about 4-5 cm. Seeds were treated by sprinkling PSB @ 6 ml per 1 kg seeds and dried in the shade before sowing.Mycorrhiza culture (Arbuscular mycorrhiza 3000 IP/gm) was applied to the seed @ 40-50 ml water and 100 g mycorrhiza per kg seeds. All the seeds were treated uniformly and were dried in the shade before sowing.

**Result and Discussion**

**Effect on growth parameters**

**Plant height at 30 DAS and at harvest (cm)**

An appraisal of data given in Table no. 1 showed that significantly maximum plant height(43.9 cm) at 30 DAS was recorded under the 30 kg P 2 O 5 /ha + enrichedcompost (1 t/ha) + Mycorrhiza (T9) and it was remained at par with the treatment T 4 (40 kgP 2 O 5 /ha), T 5 (30 kg P 2 O 5 /ha + enriched compost), T 6 (30 kg P 2 O 5 /ha + PSB), T 7 (30 kgP 2 O 5 /ha + enriched compost (1 t/ha) + PSB), T 8 (30 kg P 2 O 5 /ha + Mycorrhiza).

Treatment receiving 30 kg P 2 O 5 /ha + enriched compost (1 t/ha) + Mycorrhiza (T 9 )recorded significantly maximum plant height (62.9 cm) at harvest and it was remained atpar with the treatment T 6 (30 kg P 2 O 5 /ha + PSB), T 7 (30 kg P 2 O 5 /ha + enriched compost (1t/ha) + PSB), T 8 (30 kg P 2 O 5 /ha + Mycorrhiza).The increase in plant height might be due to the enriched compost improves thephysical, chemical and biological properties of soil as well as the availability of almost allthe essential plant nutrients for the growth and development of plant and mycorrhizaeallows plant to draw more nutrients and water from the soil. Thus, thebalanced nutrition under favorable environment might haveeventually increased the plantheight. These results are confirmatory to reveal by Meena (2017)and Patra *et al.* (2013).

**Table 1: Effect of phosphorus on plant height at 30 DAS and at harvest**

|  |  |
| --- | --- |
| **Treatments** | **Plant height (cm)** |
| **At 30 DAS** | **At harvest** |
| **T1:** Absolute control (No. P2O5) | 25.5 | 49.6 |
| **T2:** PSB alone | 33.3 | 50.3 |
| **T3:** Mycorrhiza alone | 27.5 | 52.6 |
| **T4:** 40 kg P2O5 ha-1 | 41.1 | 54.3 |
| **T5:** 30 kg P2O5 ha-1 + enriched compost (1 t ha-1) | 42.0 | 55.6 |
| **T6:** 30 kg P2O5 ha-1 + PSB | 41.4 | 56.8 |
| **T7:** 30 kg P2O5 ha-1 + enriched compost (1 t ha-1) + PSB | 41.6 | 58.3 |
| **T8:** 30 kg P2O5 ha-1 + Mycorrhiza | 41.2 | 58.0 |
| **T9:** 30 kg P2O5 ha-1 + enriched compost (1 t ha-1) +Mycorrhiza | 43.9 | 62.9 |
| S.Em.(±) | 2.29 | 2.26 |
| C.D. at 5% | 6.697 | 6.60 |

**Number of branchesper plant**

The data given pertaining to number of branches per plantas influenced by different treatments are presented in Table no. 2 revealed thatsignificantly higher number of branches per plant(7.9) was recorded by the application of 30 kg P2O5/ha + enriched compost (1 t/ha) + Mycorrhiza (T9) and it was remained at par with T6 (30 kg P2O5/ha + PSB), T7 (30 kg P2O5/ha + enriched compost (1 t/ha) + PSB).The increased number of branches might be due to enriched compost and mycorrhizae as they provided the better utilization of other nutrients which facilitated in production of new cells and tissue and eventually increased the number of branches. The results are similar to those reported by Brar *et al*. (2019) and Meena (2017).

**Number of nodules per plant**

The mean data on number of nodules per plant of cowpea is presented in Table no. 2. An application of 30 kg P2O5/ha + enriched compost (1 t/ha) + Mycorrhiza (T9) recorded significantly higher number of nodules per plant (102.50) and it was remained *at par* with T7 (30 kg P2O5/ha + enriched compost (1 t/ha) + PSB), T6 (30 kg P2O5/ha + PSB), T8 (30 kg P2O5/ha + Mycorrhiza) Application of enriched compost and mycorrhizae increased the favourable condition for the microorganisms or helped to make a conducive soil in for proliferation of microbes in soil that resulted in increased number of nodules. Similar observations were also observed by Ditta *et al.* (2018) and Kumar *et al*. (2016).

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| **Table 2** | **:Effect of phosphorus on number of branches and number of nodules per plant** |
|  |  |  |
| **Treatments** | **Number of branches** | **Number of nodules per plant** |
| **T1** | **:** | Absolute control (No. P2O5) | 5.5 | 77.7 |
| **T2** | **:** | PSB alone | 6.4 | 81.5 |
| **T3** | **:** | Mycorrhiza alone | 7.0 | 79.6 |
| **T4** | **:** | 40 kg  P2O5 ha-1 | 5.7 | 85.8 |
| **T5** | **:** | 30 kg P2O5 ha-1 + enriched compost (1 t ha-1) | 6.7 | 86.7 |
| **T6** | **:** | 30 kg  P2O5 ha-1 + PSB | 7.1 | 92.5 |
| **T7** | **:** | 30 kg P2O5 ha-1 + enriched compost (1 t ha-1) + PSB | 7.2 | 97.2 |
| **T8** | **:** | 30 kg P2O5 ha-1 + Mycorrhiza | 6.9 | 92.9 |
| **T9** | **:** | 30 kg P2O5 ha-1 + enriched compost (1 t ha-1) +Mycorrhiza | 7.9 | 102.5 |
| S.Em.(±) | 0.31 | 4.74 |
| C.D. at 5% | 0.93 | 13.85 |

**Fresh and dry weight of nodules per plant**

Data regarding the Fresh and dry weight of nodules per plant asinfluenced bydifferent treatments and is outlined in Table no. 3. An application of 30 kg P2O5/ha + enriched compost (1 t/ha) + Mycorrhiza (T9) recorded significantly higher fresh and dry weight of root nodules per plant which remained at par with T7 (30 kg P2O5/ha + enriched compost (1 t/ha) + PSB), T8 (30 kg P2O5/ha + Mycorrhiza) in case of fresh weight of nodules, but in case of dry weight of nodules it was at par with rest of the treatments except T2 (PSB alone) and T3 (Mycorrhizae alone). Improvement in weight of root nodules may be attributed to favourable soil condition like aeration and moisture regime made favourable due to integration of enriched compost and mycorrhizae. The results are similar to those reported by Ditta *et. al.* (2018).

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| **Table 3** | **: Effect of phosphorus on fresh and dry weight of nodules per plant** |
|  |  |  |
| **Treatments** | **Weight of nodules(g)** |
| **Fresh weight** | **Dry weight** |
| **T1** | **:** | Absolute control (No. P2O5) | 1.25 | 0.26 |
| **T2** | **:** | PSB alone | 1.60 | 0.36 |
| **T3** | **:** | Mycorrhiza alone | 1.63 | 0.33 |
| **T4** | **:** | 40 kg  P2O5 ha-1 | 1.48 | 0.47 |
| **T5** | **:** | 30 kg P2O5 ha-1 + enriched compost (1 t ha-1) | 1.50 | 0.46 |
| **T6** | **:** | 30 kg  P2O5 ha-1 + PSB | 1.60 | 0.45 |
| **T7** | **:** | 30 kg P2O5 ha-1 + enriched compost (1 t ha-1) + PSB | 2.23 | 0.49 |
| **T8** | **:** | 30 kg P2O5 ha-1 + Mycorrhiza | 2.20 | 0.45 |
| **T9** | **:** | 30 kg P2O5 ha-1 + enriched compost (1 t ha-1) +Mycorrhiza | 2.33 | 0.50 |
| S.Em.(±) | 0.11 | 0.02 |
| C.D. at 5% | 0.32 | 0.07 |

**Effect on yield attributes and yield**

**Number of pods per plant**

Data regarding the number of pods per plant asinfluenced bydifferent treatments and is outlined in Table 4. Significantly higher number pods per plant (14.75) was recorded under anapplication of 30 kg P2O5/ha + enriched compost (1 t/ha) + Mycorrhiza (T9) which was remained at par with T7 (30 kg P2O5/ha + enriched compost (1 t/ha) + PSB).This was largely attributed to better growth of plant which resulted in adequate supply of photosynthates for development of sink under higher level of phosphorus availability by the application of enriched compost and mycorrhizae. The results are similar to those reported by Meena (2017), Abhishek (2018) and Brar*et al*. (2019).

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| **Table 4** | **:Effect of phosphorus on number of pods per plant, seed and stover yield (kg/ha)** |
|  |  |  |
| **Treatments** | **No. of pods/****plant** | **Seed yield** | **Stover yield** |
| **T1** | **:** | Absolute control (No. P2O5) | 10.50 | 1052 | 1646 |
| **T2** | **:** | PSB alone | 11.50 | 1237 | 1853 |
| **T3** | **:** | Mycorrhiza alone | 11.25 | 1247 | 1888 |
| **T4** | **:** | 40 kg  P2O5 ha-1 | 12.00 | 1323 | 1976 |
| **T5** | **:** | 30 kg P2O5 ha-1 + enriched compost (1 t ha-1) | 11.75 | 1398 | 1981 |
| **T6** | **:** | 30 kg  P2O5 ha-1 + PSB | 12.50 | 1424 | 2011 |
| **T7** | **:** | 30 kg P2O5 ha-1 + enriched compost (1 t ha-1) + PSB | 13.00 | 1472 | 2168 |
| **T8** | **:** | 30 kg P2O5 ha-1 + Mycorrhiza | 12.75 | 1449 | 2124 |
| **T9** | **:** | 30 kg P2O5 ha-1 + enriched compost (1 t ha-1) + Mycorrhiza | 14.75 | 1497 | 2257 |
| S.Em.(±) | 0.68 | 70.73 | 100.47 |
| C.D. at 5% | 1.97 | 206.46 | 293.25 |

**Seed yield and stover yield (kg ha-1)**

An appraisal of data given in Table 4 showed that significantly highest seed yield (1497kg ha-1) and stover yield (2257 kg ha-1) was recorded under the treatment 30 kg P2O5/ha + enriched compost (1 t/ha) + Mycorrhiza (T9), but it was remained at par with all the other treatments except T2 (PSB alone) and T3 (Mycorrhiza alone). This was largely attributed to better growth of plant which resulted in adequate supply of photosynthates for development of sink under higher level of phosphorus availability. Positive responses in terms of yield attributes to phosphorus application have also been reported by Manna *et al.*(2001), Nishanth and Biswas (2007),Bhople *et al*. (2016) and Dania *et al.* (2013).

**Conclusion**

On the basis of present study, it could be concluded that application of enriched@ compost 1 t/ha and mycorrhiza (100 g per kg seed) along with 30 kg/ha P2O5(DAP) in loamy sand gavesignificantly higher plant height, number of branches, number of nodules, fresh weight, dryweight of nodules and number of pods per plant which result higher seed and stover yield.

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