**Effect of Organic Manures and Biofertilizers on Chemical Analysis and Available NPK Status in Soil after Harvest of Mung Bean (*Vigna radiata*)**

**Mung Bean (*Vigna Radiata*) Manuring and Biofertilization Impact On NPK Uptake and Availability in Soil After Harvest**

**ABSTRACT**

 A field experiment was conducted during the *summer* season of 2024 at Research Farm, School of Agriculture, OM Sterling Global University, Hisar. Seven treatment combinations comprising of organic manures and biofertilizers were tested in randomized block design in three replications. The results revealed that chemical analysis *viz*., nitrogen content in grain (3.21 %) and straw (0.82 %), phosphorus content in grain (0.97 %) and straw (0.36 %), potassium content in grain (0.97 %) and straw (1.16 %); nitrogen uptake in grain (38.45 kg ha-1) and straw (16.70 kg ha-1), phosphorus uptake in grain (11.61 kg ha-1) and straw (8.42 kg ha-1), potassium uptake in grain (11.61 kg ha-1) and in straw (27.09 kg ha-1); total nitrogen uptake by plant (57.66 kg ha-1), total phosphorus uptake by plant (20.02 kg ha-1) and total potassium uptake by plant (38.69 kg ha-1), available nitrogen (143.29 kg ha-1), phosphorus (14.84 kg ha-1) and potassium (145.84 kg ha-1)in soil after harvest were significantly higher in the treatment of Jeevamrutha @ 3000 l ha-1 through three splits at sowing, 30 and 45 DAS + Rhizobium +PSB. Whereas, significantly minimum value of N content in grain (2.26 %) and straw (0.60 %), phosphorus content % in grain (0.78) and straw (0.25 %), potassium content in grain (0.89 %) and straw (1.01 %); nitrogen uptake in grain (18.63 kg ha-1) and straw (10.59 kg ha-1), phosphorus uptake in grain (6.39 kg ha-1) and straw (4.35 kg ha-1), potassium uptake in grain (7.35 kg ha-1) and straw (17.64 kg ha-1); total nitrogen uptake by plant (29.21 kg ha-1), total phosphorus uptake by plant (10.74 kg ha-1) and total potassium uptake by plant (24.99 kg ha-1), lower available nitrogen (122.17 kg ha-1), phosphorus (8.02 kg ha-1) and potassium (114.11 kg ha-1) in soil after harvest were recorded under control (T1).

***Keywords:*** Mung Bean, Organic Manures, Biofertilizers, Chemical Analysis and NPK Status in Soil

1. **INTRODUCTION**

Pulses are wonder gift of nature to the living universe and the real gateway of sustainable agriculture. Pulses occupy a unique position in agriculture and are rich in protein, ranging from 17-27%. Besides being a rich source of protein, they maintain soil fertility through biological nitrogen fixation in soil and thus play a vital role in furthering sustainable agriculture. India is the major pulse growing country in the world accounting about 33%, 25%, 27% and 14% area, production, consumption and import of pulses in the world, respectively. Green gram is grown on 4.5 million hectares in India, with a production of 2.5 million tonnes and a productivity of 548 kg per hectare (Anonymous, 2020). Green gram (*Vigna radiata* L. Wilczek), commonly known as mung bean, is one of the most important leguminous crops grown in arid and semi-arid regions of India. It is a short duration pulse crop belonging to the family Fabaceae. Green gram is indigenous to India and widely grown in Indian subcontinent, particularly in India, Bangladesh, China, Pakistan, Myanmar, Thailand and Sri Lanka. Green gram is cultivated throughout the country *viz.,* in Northern, Central and Western India during summer season (March–June) and *kharif* season (June–September) and in South-Eastern parts of India during *Rabi* season (November–April) (Rawal and Navarro, 2019). It is warm season legume which requires high temperature and less humidity during crop season. It is a short day plant which requires 12-13 hours of photoperiod to induce flowering. It is considered to be the hardiest among all pulse crops because of its low water requirement and capacity to withstand harsh climate. It has ability to fix atmospheric nitrogen through symbiotic association with *Rhizobium* thus enriches soil nitrogen and rejuvenates soil fertility. It is also used as green manuring crop and provides excellent fodder to the animals.

Organic nutrient sources such as FYM, vermicompost, green manure and biofertilizers are low-cost inputs supplying both macro and micronutrients. They increase soil organic matter and available nutrient content, improve soil structure and water holding capacity, suppress soil-borne pathogens and promote growth of beneficial microorganisms (Gohain and Kikon, 2017), thus improve the physico-chemical and biological properties of the soil and seed yield and quality (Shariff et al., 2017). Besides, supplying nutrients to the crop applied, these manures also show significant carry-over effect on subsequent crops (Das et al*.*, 2015). Incorporation of organic manures improves phosphorus availability by lowering down the fixation, thus maintains soil health and increases yield potential of crop (Mohbe et al., 2018).

Organic manures act as good substrate for microbial growth and help in maintaining nutritional balance in soil. Application of vermicompost enriches the soil with microbial diversity and improves microbial activity which boosts up soil nutrient status and nutrient uptake (Gadi et al*.*, 2017).

Jeevamrutha is a traditional fermented liquid organic concoction commonly used as soil microbial enhancer in natural farming. It is a rich source of Bacteria, Fungi, Actinomycetes and contains other beneficial microorganisms. It is stated that the application of jeevamrutha stimulates crop growth and repels some of the insect-pests. The sugars present in jaggery acts as ready source of energy for growing microbes, while pulse flour acts as a nitrogen source in the formulation. Cow dung and urine provide nitrogen and other essential nutrients for growing microorganisms. Soil, cow urine and dung provide the culture of beneficial microbes in the jeevamrutha.

Biofertilizers *viz*., *Rhizobium,* and PSB (Phosphorus Solubilizing Bacteria) contain living cells of agriculturally beneficial microorganisms that colonize the rhizosphere of the plant and play important role in promoting plant growth and improving soil health. They are eco-friendly and organic in nature which play vital role in conversion of unavailable form of essential elements to available form (Kumar et al., 2018). These microbial formulations increase nutrient availability and supply to the crop through enhanced biological nitrogen fixation and phosphorus solubilization when applied to seed, soil or plant surfaces (Bhattacharjee and Dey, 2014). Therefore, the present work aimed to ………

1. **MATERIALS AND METHODS**

The present study was carried out during *summer* season of 2024 at Research Farm, School of Agriculture, OM Sterling Global University, Hisar. Situated in the subtropics at 29°10′ N latitude and 75°46′ E longitudes at an elevation of 215.2 meters above mean sea level in Haryana, India. The place has a typical semi-arid climate with severe cold during winter and hot, dry desiccating winds during summer. The meteorological data recorded during crop season of 2024 indicated that the weekly highest and lowest maximum mean temperature were recorded 37.1 ºC and 14.2 in 3rd and 17th and highest and lowest minimum mean temperature were recorded 4.9 ºC and 18.8 in 3rd and 17th meteorological standard weeks, respectively. The weekly mean lowest and highest wind velocity was 1.6 km hr-1 and 5.5 km hr-1 in 7th and 8th standard weeks, respectively. The weekly mean minimum and maximum relative humidity was recorded 55.5 % and 99.6% in morning during 3rd and 15th standard weeks and 18.1 % and 79 % in evening during 15th and 5th standard weeks, respectively. Weekly mean maximum and minimum sun shine of 9.1 hrs and 1.7 hrs per day were recorded on 17th and 5th weeks, respectively. The data show that the total amount of rainfall received during the crop growing period was 9.0 mm. The soil of the experimental field was sandy loam in texture, low in organic carbon and available nitrogen, medium in available phosphorus and high in available potassium. The experimental treatments include ~~consisting of~~ ~~seven treatment combinations~~ *viz.,* T1 (control), T2. [Farmyard Manure (FYM) @ 10 t/ ha], T3 [Vermicompost (VC) @ 5 t/ ha], T4 [Poultry Manure (PM) @ 5 t/ha], T5 (50% FYM @ 5 t/ha + 50% VC @ 2.5 t/ha +Rizobium+PSB), T6 (50% FYM @ 5 t/ ha + 50% PM @ 2.5 t/ha + Rizobium+PSB) and T7 (Jeevaamrtha @ 3000 l ha-1 through three splits at sowing, 30 and 45 DAS + Rizobium+PSB) comprising of organic manures and biofertilizers were tested in randomized block design in three replications. During the experiment, the standard package of practices was considered for mung bean crop. The plot size maintained was 3.6 m\*2.0 m and high yielding MH 1142 variety was taken for the study. The plant to plant spacing was 10 cm and row to row spacing was 30 cm. The farmyard manure, poultry manure and vermicompost doses were calculated according to the treatment for each plot. FYM, poultry manure and vermicompost were applied 15 days before sowing and incorporated five days before sowing in respective plots as per treatment specification.

Jivamrutha solution was prepared by thoroughly mixing cow dung (fresh) (10 kg) + cow urine (10 liter ) + jaggery (2 kg)+ pulse flour (cow pea) (2 kg ) + sajiv soil (1 kg ) + water (200 liter ) in a container and stirred well. Allowed the mixture to ferment for 7 days under tree shade. The mixture was stirred twice (morning and evening) every day in a clockwise direction. The container was kept under well-ventilated open shed. The mouth of container was tied with thin cotton cloth to enable proper aeration in the container and after prepared applied as per treatments. Rhizobium and PSB inoculation: 25 g of jaggery was boiled in one half liter water and then cooled, 50 g of culture was mixed in jaggery solution. The required quantity of seed was thoroughly mixed with the paste of culture to inoculate them with Rhizobium/PSB, then the seeds were allowed to dry in shade and after dried applied as per treatments. Weeding, hoeing and plant protection measures were carried out as per recommendations at appropriate times. Data were recorded on chemical analysis *viz*., nitrogen, phosphorus and potassium content in grain and straw; nitrogen uptake, phosphorus uptake and potassium uptake in grain and in straw; total nitrogen uptake, total phosphorus uptake and total potassium uptake by plant, available nitrogen, phosphorus and potassium in soil after harvest. Data collected during the study were statistically analyzed by using the technique of analysis of variance (ANOVA) described by (Cochran and Cox, 1959).

**3. RESULTS AND DISCUSSION**

**3. 1. Chemical Analysis**

The data related to NPK content, uptake and total uptake in grain and straw, of mung bean affected by different organic manures and biofertilizers treatments are presented in Tables 1, 2, and 3. Among treatments, maximum nitrogen content in grain (3.21%) and straw (0.82%), phosphorus content in grain (0.97 %) and straw (0.36 %), potassium content in grain (0.97 %) and straw (1.16 %); nitrogen uptake in grain (38.45 kg ha-1) and straw (16.70 kg ha-1), phosphorus uptake in grain (11.61 kg ha-1) and straw (8.42 kg ha-1), potassium uptake in grain (11.61 kg ha-1) and in straw (27.09 kg ha-1); total nitrogen uptake by plant (57.66 kg ha-1), total phosphorus uptake by plant (20.02 kg ha-1) and total potassium uptake by plant (38.69 kg ha-1) were recorded under application of Jeevamrutha @ 3000 l ha-1 through three splits at sowing, 30 and 45 DAS + Rhizobium +PSB (T7) which was significantly higher as compared to other treatments. The minimum value of N content (2.26 %) in grain and straw (0.60 %), phosphorus content in grain (0.78%) and straw (0.25 %), potassium content in grain (0.89 %) and straw (1.01 %); nitrogen uptake in grain (18.63 kg ha-1) and straw (10.59 kg ha-1), phosphorus uptake in grain (6.39 kg ha-1) and straw (4.35 kg ha-1), potassium uptake in grain (7.35 kg ha-1) and straw (17.64 kg ha-1); total nitrogen uptake by plant (29.21 kg ha-1), total phosphorus uptake by plant (10.74 kg ha-1) and total potassium uptake by plant (24.99 kg ha-1) were recorded under treatment control (T1). The reason behind the significant result for the NPK uptake by seed and stover could be that these parameters were calculated based on their respective yield and nutrient content. These results were accordance with the results of Patil and Udmale (2016), who reported that application of FYM + vermicompost (50% each) + jeevamrutha (2 times *i.e.,* at 30 and 45 DAS) gave significantly higher uptake of N, P and K by soybean. Chaudhary et al. (2022) also reported that application of jeevamrutha @ 500 l ha-1 gave significantly higher uptake of NPK with soybean. Combined applications of different organic manures and biofertilizers or both significantly increased the N, P, K content in green gram, haulms and seed. This might be due to combined application of organics and biofertilizers enhance root growth and cell multiplication leading to more absorption of nutrients from deeper layers of soil ultimately resulting in increased N, P, K concentrations. Similar findings were reported by (Thenua and Sharma 2001; Dhakal et al., 2016; Kumawat et al., 2021). Beneficial effects of organic manures along with biofertilizers on nutrients uptake were noticed by Meena et al.(2013). PSB inoculation increased the nutrient uptake. This could be due to increased root nodulation through better root development and more nutrient availability, resulting in better absorption and utilization of all plant nutrients (Rana et al*.,* 2013). Nutrient uptake also increased by increasing inorganic P level might be due to well-developed system, increased N fixation and its availability to plants. Similar findings have been reported by (Rathour et al*.,* 2014; Rani et al., 2016).

1. **2. Available NPK status in soils after harvest**

The available nitrogen in soil as affected by organic manures and biofertilizers are presented in Table 4. The availability of nitrogen in soil was significantly affected by different sources of organic nutrients. Significantly higher available nitrogen (143.29 kg ha-1),phosphorus (14.84 kg ha-1) and potassium (145.84 kg ha-1)in soil after harvesting of mung bean was recorded with treatment of Jeevamrutha @ 3000 l ha-1 through three splits at sowing, 30 and 45 DAS + Rhizobium +PSB (T7) which was significantly higher as compared to other treatments. The significantly lower available nitrogen (122.17 kg ha-1), phosphorus (8.02 kg ha-1) and potassium (114.11 kg ha-1) in soils after harvesting of mung bean was recorded with control (T1).

Increased nodulation and microbial population due to the application of *Rhizobium* and organic manures converted the organic N portion into available form and thus improved the availability of N to crops as well as contributed to soil N pool after decomposition of the root nodules. Similar results were reported by (Neha et al., 2019). Similarly, PSB play a vital role in nutrient transformation in soil and improves soil physico-chemical properties which facilitated solubilization of native phosphorus and also reduces P fixation which was validated by the findings (Gorade *et al*. 2014). *Rhizobium* not only enhanced the availability of nitrogen but also increased the phosphorus and potassium availability due to synergistic effects which was confirmed by (Singh et al., 2009). Seed inoculation with biofertilizers helps in increasing the availability of nutrients to the plant whereas application of FYM and organic manures facilitates the microbial activities by providing favorable soil physical, chemical and biological properties. The present results ~~of the study was~~ were in conformity with (Patel et al., 2016; Rekha et al., 2018). Ahmed et al. (2017) revealed that adoption of organic cultivation practice of greengram significantly increased the available nitrogen, phosphorus and potassium in the soil. Application of vermicompost reduces nutrient leaching in soil and helps in sustaining soil health and crop productivity, (Kumar et al. (2020). Lahariya et al. (2013) recorded the maximum available N, P, K content in the soil after harvesting of crop as compared to control when ~~application of~~ jeevamrutha @ 500 l ha-1 was applied.

1. **CONCLUSION**

 Treatment T7 (Jeevamrutha @ 3000 l ha-1 through three splits at sowing, 30 and 45 DAS + Rhizobium +PSB) was found most suitable in terms of chemical analysis *viz*., nitrogen, phosphorus and potassium content, total uptake ~~in~~ by grain, straw and whole plant. ~~; nitrogen, phosphorus and potassium uptake in grain and in straw; total nitrogen, total phosphorus and total potassium uptake by plant,~~in the same time, available nitrogen, phosphorus and potassium in soil after harvest was enhanced by the same treatment comparing to others. ~~among all treatments, it can be~~ In conclusion, ~~that among the treatment tested, treatment~~ T7 (Jeevamrutha @ 3000 l ha-1 through three splits at sowing, 30 and 45 DAS + Rhizobium +PSB) could be recognized as enhancer and responsible for increasing ~~may be grown for better helps in enhanced and increasing~~ the availability of nutrients content in soil ~~and uptake~~ as well as to the plant ~~and maximum available of N, P, K content in soil after harvesting~~.

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Table 1: Effect of organic manures and biofertilizer on nutrient content of mung bean crop.

|  |  |  |  |
| --- | --- | --- | --- |
| **Treatments**  | **Nitrogen** **(%)** | **Phosphorus** **(%)** | **Potassium** **(%)** |
| **Grain** | **Straw** | **Grain** | **Straw** | **Grain** | **Straw** |
| T1: Control | 2.26 | 0.60 | 0.78 | 0.25 | 0.89 | 1.01 |
| T2: Farmyard Manure (FYM) @ 10 t/ ha  | 2.88 | 0.64 | 0.89 | 0.27 | 0.91 | 1.10 |
| T3:Vermicompost (VC) @ 5 t/ ha  | 2.89 | 0.67 | 0.89 | 0.29 | 0.92 | 1.13 |
| T4: Poultry Manure (PM) @ 5 t/ ha  | 2.91 | 0.69 | 0.90 | 0.30 | 0.93 | 1.14 |
| T5: 50 % FYM @ 5 t/ha + 50 % VC @ 2.5 t/ha +Rizobium+PSB | 3.07 | 0.71 | 0.92 | 0.31 | 0.93 | 1.14 |
| T6: 50 % FYM @ 5 t/ha+50 % PM @ 2.5 t/ha + Rhizobium +PSB | 3.12 | 0.74 | 0.93 | 0.32 | 0.94 | 1.14 |
| T7: Jeevamrutha @ 3000 l ha-1 through three splits at sowing, 30 and 45 DAS + Rhizobium +PSB | 3.21 | 0.82 | 0.97 | 0.36 | 0.97 | 1.16 |
| **SE (m) ±** | **0.01** | **0.02** | **0.01** | **0.01** | **0.01** | **0.001** |
| **CD at 5 %** | **0.03** | **0.05** | **0.03** | **0.03** | **0.03** | **0.01** |

Table 2: Effect of organic manures and biofertilizer on N, P and K uptake kg ha-1 of mung bean crop.

|  |  |  |  |
| --- | --- | --- | --- |
| **Treatments**  | **Nitrogen uptake****kg ha-1** | **Phosphorus uptake****kg ha-1** | **Potassium uptake****kg ha-1** |
| **Grain** | **Straw** | **Grain** | **Straw** | **Grain** | **Straw** |
| T1: Control | 18.63 | 10.59 | 6.39 | 4.35 | 7.35 | 17.64 |
| T2: Farmyard Manure (FYM) @ 10 t/ ha  | 31.68 | 14.48 | 9.81 | 6.20 | 10.02 | 24.87 |
| T3: Vermicompost (VC) @ 5 t/ ha  | 32.22 | 15.22 | 9.95 | 6.60 | 10.29 | 25.64 |
| T4: Poultry Manure (PM) @ 5 t/ ha  | 33.19 | 15.81 | 10.24 | 6.98 | 10.58 | 25.99 |
| T5: 50% FYM @ 5 t/ha + 50 % VC @ 2.5 t/ha +Rizobium++PSB | 34.81 | 16.06 | 10.41 | 6.94 | 10.59 | 25.79 |
| T6: 50 % FYM @ 5 t/ha+50 % PM @ 2.5 t/ha + Rhizobium +PSB | 35.49 | 16.70 | 10.62 | 7.35 | 10.68 | 25.89 |
| T7: Jeevamrutha @ 3000 l ha-1 through three splits at sowing, 30 and 45 DAS + Rhizobium +PSB | 38.45 | 19.21 | 11.61 | 8.42 | 11.61 | 27.09 |
| **SE (m) ±** | **0.17** | **0.37** | **0.13** | **0.21** | **0.10** | **0.20** |
| **CD at 5 %** | **0.53** | **1.16** | **0.40** | **0.66** | **0.34** | **0.63** |

Table 3: Effect of organic manures and biofertilizers on total N, P and K uptake kg ha-1 of mung bean crop.

|  |  |  |  |
| --- | --- | --- | --- |
| **Treatments** | **Total Nitrogen****Uptake (kg/ha)** | **Total Phosphorus****Uptake (kg/ha)** | **Total Potassium****Uptake (kg/ha)** |
| T1: Control | 29.21 | 10.74 | 24.99 |
| T2: Farmyard Manure (FYM) @ 10 t/ ha  | 46.16 | 16.01 | 34.89 |
| T3: Vermicompost (VC) @ 5 t/ ha  | 47.45 | 16.55 | 35.93 |
| T4: Poultry Manure (PM) @ 5 t/ ha  | 49.00 | 17.22 | 36.58 |
| T5: 50% FYM @ 5 t/ha + 50% VC @ 2.5 t/ha +Rhizobium++PSB | 50.86 | 17.36 | 36.39 |
| T6: 50 % FYM @ 5 t/ha+50 % PM @ 2.5 t/ha + Rhizobium +PSB | 52.20 | 17.97 | 36.57 |
| T7: Jeevamrutha @ 3000 l ha-1 through three splits at sowing, 30 and 45 DAS + Rhizobium +PSB | 57.66 | 20.02 | 38.69 |
| **SE (m) ±** | **0.37** | **0.28** | **0.22** |
| **CD at 5 %** | **1.16** | **0.88** | **0.70** |

Table 4: Effect of organic manures and biofertilizers on root shoot ratio on weight basis at all growth stages of mung bean crop.

|  |  |
| --- | --- |
| **Treatments** | **Available NPK in Soil after harvest** |
| **Available N** | **Available P** | **Available K** |
| T1: Control | 122.17 | 8.02 | 114.11 |
| T2: Farmyard Manure (FYM) @ 10 t/ ha  | 138.26 | 10.06 | 137.04 |
| T3: Vermicompost (VC) @ 5 t/ ha  | 140.75 | 11.27 | 140.22 |
| T4: Poultry Manure (PM) @ 5 t/ ha  | 141.79 | 11.63 | 141.350 |
| T5: 50 % FYM @ 5 t/ha + 50 % VC @ 2.5 t/ha +Rhizobium+PSB | 139.49 | 12.02 | 142.32 |
| T6: 50 % FYM @ 5 t/ha+50 % PM @ 2.5 t/ha + Rhizobium +PSB | 141.09 | 13.11 | 143.32 |
| T7: Jeevamrutha 3000 l ha-1 through three splits at sowing, 30 and 45 DAS + Rhizobium +PSB | 143.29 | 14.84 | 145.84 |
| **SE (m) ±** | **0.70** | **0.46** | **0.77** |
| **CD at 5 %** | **2.17** | **1.45** | **2.41** |

Fig. 1: Effect of organic manures and biofertilizers on nutrient content of mung bean crop

Fig. 2: Effect of organic manures and biofertilizers on total NPK uptake by plant (kg ha-1) of mung bean crop