The Pharma Innovation Journal 2021; 10(9): 382-386

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(9): 382-386

www.thepharmajournal.com
Received: 12-06-2021
Accepted: 23-08-2021

Abhitej Singh Shekhawat
Ph.D., Research Scholar, Department of Soil Science and Agricultural Chemistry, MPUAT, Udaipur, Rajasthan, India

HS Purohit
Emeritus Professor, Department of Soil Science and Agricultural Chemistry, MPUAT, Udaipur, Rajasthan, India

Dilip Singh
Professor and Dean, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan, India

Jitendra Kumar Sharma
Ph.D., Research Scholar, Department of Soil Science and Agricultural Chemistry, MPUAT, Udaipur, Rajasthan, India

Jitendra Singh Bamboriya
Ph.D., Research Scholar, Department of Soil Science and Agricultural Chemistry, MPUAT, Udaipur, Rajasthan, India

Kiran Doodhwal
Ph.D., Research Scholar, Department of Soil Science and Agricultural Chemistry, MPUAT, Udaipur, Rajasthan, India

Ramdas Meena
Ph.D., Research Scholar, Department of Soil Science and Agricultural Chemistry, MPUAT, Udaipur, Rajasthan, India

Corresponding Author:
Abhitej Singh Shekhawat
Ph.D., Research Scholar, Department of Soil Science and Agricultural Chemistry, MPUAT, Udaipur, Rajasthan, India

Yield of black gram and uptake of primary nutrients as influenced by integrated nutrient management on typic Haplustept soil of Rajasthan

Abhitej Singh Shekhawat, HS Purohit, Dilip Singh, Jitendra Kumar Sharma, Jitendra Singh Bamboriya, Kiran Doodhwal and Ramdas Meena

Abstract
A field experiment was conducted on the Instructional Farm of Rajasthan College of Agriculture, Udaipur during *kharif* 2016 with the objective to see the effect of integrated nutrient management on uptake of primary nutrients and yield of Black gram. The results of the study reveals that the application of chemical fertilizers along with vermicompost and biofertilizers gaves the best results in terms of yield of Black gram as well as nutrient uptake by Black gram. Seed yield (1246.66 kg ha^{-1}), straw yield (1442.16 kg ha^{-1}) and biological yield (2688.81 kg ha^{-1}) of Black gram was found maximum with the application of 40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} + *Rhizobium* + PSB (T_9). Total uptake of nitrogen (68.88 kg ha^{-1}), phosphorus (9.14 kg ha^{-1}) and potassium (46.33 kg ha^{-1}) was also found maximum with the application of 40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} + *Rhizobium* + PSB (T_9).

Keywords: Black gram, INM, Nutrient uptake, PSB, rhizobium, vermicompost

Introduction
Black gram is important pulse crop among the grain legumes grown in India. It contains 24% protein, 60% carbohydrate, 1.3% fat and is richest in phosphoric acid among the pulses being five to ten times richer than in others. It is commonly known as “urd” or “urd bean”. Black gram plays an important role in maintaining and improving the soil fertility through its ability to fix atmospheric nitrogen in the soil through root nodules which possesses *Rhizobium* bacteria. In India, Black gram is grown on 35.53 lakh Hactare area with a production of 19.64 lakh tonne (DES 2019) [4]. Black gram is a rainfed crop predominantly grown in *kharif* in the state of Rajasthan. In Rajasthan, black gram occupies area of 5.02 lakh hectare with a production of 1.28 lakh tone (DOA 2019) [5]. It is mainly cultivated in arid and semi-arid districts including Bhilwara, Chittorgarh, Udaipur, Ajmer, Jhalawar, Kota, Bundi, Baran etc. One of the important reasons of low productivity is poor fertility of soil and lack of seriousness about pulse production. The problem is compounded by the fact that the majority of farmers in rainfed areas are resource poor with low risk bearing capacity and they generally do not apply recommended dose of fertilizers, either through organic or inorganic sources. Hence, our research efforts should be aimed to remove the constraints which are responsible for its low productivity. Farmers of south and south-eastern Rajasthan grow black gram without applications of fertilizers or use less then recommended dose of nutrients. This imbalanced nutrient supply adversely affects the seed yield of black gram, soil health, and even the profit to the farmers (Laddha *et al.*, 2006) [12]

The supply of phosphorus to legumes is more important than of nitrogen because, nitrogen is being fixed by symbiosis with *Rhizobium* bacteria. The beneficial effects of phosphorus on nodulation, growth, yield and general behavior of legume crop have been well established because it plays an important role in root development. Phosphorus application to legumes plays a key role in the formation of energy rich phosphate bonds, phospholipids and for development of root system (Tisdale *et al.*, 1985) [20]. It also improves the crop quality and resistance to diseases. Phosphorus application to legumes not only benefits the particular crop but also improves the soil nitrogen content for the succeeding non-legume crops which require lower doses of nitrogen application. It is also an essential constituent of majority of enzymes which are of great importance in the transformation of energy, carbohydrate metabolism, fat metabolism and also in respiration (catabolism of carbohydrates) in plants. It is closely related to cell division and development.

Phosphorus stimulates seed setting, hastens maturity and enhanced protein content. It plays an important role in the nutrition of legumes and also improves biological nitrogen fixation and quality of grains (Kumar *et al.,* 2009) [9]. It gives rapid and vigorous start to plants, strengthens straw and decreases lodging tendency.

There is evidence of stagnation or low productivity of black gram and other *kharif* pulses even with the recommended dose of NPK fertilizers (Athokpam *et al*., 2009) [1]. Depletion of soil organic carbon, lower moisture retention, reduction in water stable aggregates and available Zn and Fe status have been identified as reason of low productivity (Saviour and Stalin, 2013) [18]. Hence, the complementary and supplementary role of organic manures in sustained production is clear. Next to nitrogen, phosphorus is paramount importance for increasing yield. The application of phosphorus at the rate of 40 kg ha^{-1} was found optimum for black gram (Kumawat *et al.,* 2013) [10]. It is now well realized that to protect soil health, use of judicious combination of organic and inorganic source of nutrients is essential (Mohan and Chandaragiri, 2007) [14]. Integration of recommended dose of fertilizer along with vermicompost would result in better yield of black gram in rainfed condition (Sutaria *et al*., 2010) [19].

Materials and Methods

The soil of the experimental site was sandy clay loam in texture, slightly alkaline in reaction, medium in available nitrogen and phosphorus and high in potassium and zinc. The experiment consisted of 9 treatments comprising different combinations of chemical fertilizers, organic manure and biofertilizers *viz*., T_1 –Contol, T_2-20 kg P_2O_5 ha^{-1}, T_3-40 kg P_2O_5 ha^{-1}, T_4 -20 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1}, T_5 -40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1}, T_6 -20 kg P_2O_5 ha^{-1} + *Rhizobium* + PSB, T_7 -40 kg P_2O_5 ha^{-1} + *Rhizobium* + PSB, T_8 -20 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} + *Rhizobium* + PSB and T_9 -40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} + *Rhizobium* + PSB. These treatments were evaluated under randomized block design (RBD) with four replications. Black gram cultivar (T - 9) was taken as test crop. Further, the treatments were grouped (excluding control) into four parts *viz.*, G_1 [T_2 & T_3 (chemical fertilizer)], G_2 [T_4 & T_5 (chemical fertilizer + organic manure)], G_3 [T_6 & T_7 (chemical fertilizer + biofertilizer)] and G_4 [T_8 & T_9 (chemical fertilizer + organic manure + biofertilizer)], respectively.

Results and Discussion

It is explicit from the data (Table 1) that seed yield varied from 651.12 kg ha^{-1} to 1246.66 kg ha^{-1} during study by applying various treatments to supply nutrients. The application of 40 kg P_2O_5 ha^{-1} + Vermicompost 2.5 t ha^{-1} + *Rhizobium* + PSB (T_9) recorded significantly highest seed yield (1246.66 kg ha^{-1}) and which was followed by (1132.69 kg ha^{-1}) 20 kg P_2O_5 ha^{-1} + Vermicompost 2.5 t ha^{-1} + *Rhizobium* + PSB (T_8) which represents 91.46 and 75.96 percent increase in seed yield over control (651.12 kg ha^{-1}). Among groups, seed yield was found significantly higher in G_4 (1189.67 kg ha^{-1}) which was 46.97 percent more over G_1 (809.42 kg ha^{-1}), 30.56 percent higher over G_3 (9111.18 kg ha^{-1}) and 21.04 percent more over G_2 (982.88 kg ha^{-1}), respectively. Based on data it can be inferred that straw yield of black gram varied from 900.67 kg ha^{-1} to 1442.16 kg ha^{-1}. Significant enhancement in straw yield was recorded by application of various treatments supplying nutrients. The highest straw yield (1442.16 kg ha^{-1}) was recorded by application of 40 kg P_2O_5 ha^{-1} + Vermicompost 2.5 t ha^{-1} + *Rhizobium* + PSB (T_9) and which was followed by (1428.86 kg ha^{-1}) 20 kg P_2O_5 ha^{-1} + Vermicompost 2.5 t ha^{-1} + *Rhizobium* + PSB (T_8) which represents 60.12 and 58.64 percent increase in straw yield over control (900.67 kg ha^{-1}). The straw yield was found significantly higher in group G_4 (1435.51 kg ha^{-1}), which was followed by G_2 (1229.80 kg ha^{-1}), G_3 (1199.90 kg ha^{-1}) and G_1 (1082.66 kg ha^{-1}), respectively. Examination of data reveals that there is significantly increase in biological yield of black gram varied from 1551.79 kg ha^{-1} to 2688.81 kg ha^{-1} by enriching the soil with various treatments over no fertilization. The application of 40 kg P_2O_5 ha^{-1} + Vermicompost 2.5 t ha^{-1} + *Rhizobium* + PSB (T_9) showed highest biological yield (2688.81 kg ha^{-1}) and which was followed by (2561.56 kg ha^{-1}) 20 kg P_2O_5 kg ha^{-1} + Vermicompost 2.5 t ha^{-1} + *Rhizobium* + PSB (T_8) which represents 73.27 and 65.07 percent increase in biological yield over control (1551.79 kg ha^{-1}). Between the groups, the biological yield was found significantly higher in G_4 (2625.18 kg ha^{-1}), which was 38.75 percent more over G_1 (1892.0 kg ha^{-1}), 24.35 percent higher over G_3 (2111.08 kg ha^{-1}) and 18.64 percent more over G_3 (2212.68 kg ha^{-1}), respectively.

Application of integrated nutrient as 40 kg P_2O_5 ha^{-1} + Vermicompost 2.5 t ha^{-1} + *Rhizobium* + PSB (T_9) increased yield components of black gram crop significantly over control and significantly at par with (1132.69 kg ha^{-1}) 20 kg P_2O_5 ha^{-1} + Vermicompost 2.5 t ha^{-1} + *Rhizobium* + PSB (T_8) (Table 1). The significant interactive effect as a consequence of biofertilizers, vermicompost and fertilizer application is attributed to the favorable nutritional status of the soil resulting into increased biomass production of the crop. This may also be attributed to favorable effect of vermicompost and biofertilizer on microbial and root proliferation on soil which caused solubilizing effect on native phosphorus and other nutrients. Integrative chemical fertilizers, organic manure and biofrtilizers was, however, found to be quite promising not only in maintaining higher productivity but also in providing greater stability in crop production by synergistic effect of vermicompost and biofertilizers on improving efficiency of optimum dose of Phosphorus. The results of the present study that Combined use of biofertilizer, organic manure and chemical fertilizer has been found to be providing higher productivity with those reported by Kumar *et al.* 2003, Khatkar *et al*. 2007, Kumar and Elamathi, 2007, Bakthavathsalam and Deivanayaki 2007, Rekha *et al*. 2013 & Nalwade and Bhalerao 2015 [8, 6, 7, 2, 17, 15].

The data (Table 2) indicates that addition of plant nutrients in balanced or integrated forms proved significantly superior in increasing total N content (seed + straw) in black gram over no fertilization. Maximum N content (5.267%) in black gram at harvest was recorded in 40 kg P_2O_5 ha^{-1} + Vermicompost 2.5 t ha^{-1} + *Rhizobium* + PSB (T_9) applied treatment and which was followed by (5.102%) 20 kg P_2O_5 ha^{-1} + Vermicompost 2.5 t ha^{-1} + *Rhizobium* + PSB (T_8) which represents 20.75 and 16.96 percent increase N content in seed over control (4.362%). Among groups, the nitrogen content in seeds was found significantly higher in G_4 (5.190%), which was followed by G_3 (4.980%), G_2 (4.760%) and G_1 (4.600%), respectively. Total P content (seed + straw) in black gram at harvest was found maximum (0.693%) under the application of 40 kg P_2O_5 ha^{-1} + Vermicompost 2.5 t ha^{-1} + *Rhizobium* + PSB (T_9) and which was followed by (0.648%) 40 kg P_2O_5 ha^{-1} + *Rhizobium* + PSB (T_7) which represents 35.88 and 27.06

percent increase in P content in seed over control (0.510%). The phosphorus content in grain was found significantly higher in group G_4 (0.670%), which was followed by G_3 (0.650%), G_2 (0.580%), G_1 (0.560%), respectively. In comparison to control, enrichment of soil by various combinations and sources of plant nutrients resulted in significantly higher total K content (seed + straw) in black gram. The maximum K content (3.380%) was accounted in soil fortified with 40 kg P_2O_5 ha^{-1} + Vermicompost 2.5 t ha^{-1} + *Rhizobium* + PSB (T_9) and which was followed by (3.374%) 20 kg P_2O_5 ha^{-1} + Vermicompost 2.5 t ha^{-1} + *Rhizobium* + PSB (T_8) which represents 5.62 and 5.44 percent increase in K content in seed over control (3.200%). The highest potassium content in seeds was found highest in group G_4 (3.380%) which was followed by G_2 (3.360), respectively.

The data (Table 3) clearly indicate superiority of balanced and integrated supply of nutrients with respect to Total N uptake by black gram at harvest. Maximum N uptake (68.88 kg ha^{-1}) by black gram was obtained by conjugant application of 40 kg P_2O_5 ha^{-1} + Vermicompost 2.5 t ha^{-1} + *Rhizobium* + PSB (T_9) and which was followed by (62.45 kg ha^{-1}) 20 kg P_2O_5 ha^{-1} + Vermicompost 2.5 t ha^{-1} + *Rhizobium* + PSB (T_8) which represents 117.97 and 97.63 percent increase in N uptake over control. The minimum N uptake (31.60 kg ha^{-1}) by seed was recorded in control. Nitrogen content by black gram was found significantly higher in group G_4 (66 kg ha^{-1}), which was followed by G_3 (50 kg ha^{-1}), G_2 (50 kg ha^{-1}) and G_1 (41 kg ha^{-1}). The conjoint application of 40 kg P_2O_5 ha^{-1} + Vermicompost 2.5 t ha^{-1} + *Rhizobium* + PSB (T_9) brought about maximum enhancement in P uptake (9.14 kg ha^{-1}) by black gram which was followed by (8.06 kg ha^{-1}) 20 kg P_2O_5 ha^{-1} + Vermicompost 2.5 t ha^{-1} + *Rhizobium* + PSB (T_8) which represents 138.08 and 109.89 percent increase in P uptake over control (3.84 kg ha^{-1}). Among the groups, P uptake by black gram was significantly higher in G_4 (8.60 kg ha^{-1}), which was followed by G_3 G_2 and G_1. The crop under influence of 40 kg P_2O_5 ha^{-1} + Vermicompost 2.5 t ha^{-1} + *Rhizobium* + PSB (T_9) accumulated highest uptake of K (46.33 kg ha^{-1}) by black gram at harvest, which was followed by (44.59 kg ha^{-1}) 20 kg P_2O_5 ha^{-1} + Vermicompost 2.5 t ha^{-1} + *Rhizobium* + PSB (T_8) which represents 78.81 and 72.09 percent increase in K uptake over control (25.91 kg ha^{-1}). Between the groups, G_4 (45.46 kg ha^{-1}) recorded significantly higher K uptake by seed, which was followed by G_2 (38.32 kg ha^{-1}), G_3 (36.64 kg ha^{-1}) and G_1 (32.95 kg ha^{-1}), respectively.

Data presented in Table 2 and 3 shows that integration of chemical fertilizer with Vermicompost 2.5 t ha^{-1} + *Rhizobium* + PSB (Group G_4) brought about significant improvement in N, P, K content and uptake over unfertilized control. This indicated a favourable soil micro climate regime induced by the incorporation of vermicompos and biofertilizer. Application of vermicompost reduce P fixation by releasing considerable aborints and variety of organic acids during decomposition and as well as inducing chelating effects on micronutrients which probably enhanced the availability of phosphorus. Application of vermicompost not only increases the availability of micronutrients but also contains significant amount of N, P and K. Thus application of vermicompost has resulted in an overall significant increase in uptake of nutrients at lesser cost but longer in durability or duration. Biofertilizers like PSB solublizes the unsoluble phosphorus or fixed phosphorus and make it available to the plants in the easily uptakable ionic form. On other hand *Rhizobium* fixes the atmospheric nitrogen which can be utilizes by the plants for their metabolic processes. These are in confirmation with findings of Chakrabarti *et al.* 2007, Kumpawat, 2010, Patil *et al.* 2010 & Mehta *et al.* 2015 [3, 11, 16, 13].

Table 1: Effect of INM on yield of black gram

Treatments/Groups	Seed Yield (kg ha^{-1})	Straw Yield (kg ha^{-1})	Biological yield (kg ha^{-1})
T_1	651.12	900.67	1551.79
T_2	791.79	1064.16	1855.95
T_3	827.04	1101.15	1928.19
T_4	930.25	1200.39	2130.64
T_5	1035.50	1259.21	2294.71
T_6	854.69	1172.22	2026.91
T_7	967.67	1227.58	2195.25
T_8	1132.69	1428.86	2561.56
T_9	1246.66	1442.16	2688.81
G_1	809.42	1082.66	1892.07
G_2	982.88	1229.80	2212.68
G_3	911.18	1199.90	2111.08
G_4	1189.67	1435.51	2625.18
S.Em±	26.30	52.30	46.34
CD (P=0.05)	76.76	152.65	135.26

Table 2: Effect of INM nutrient content of black gram

Treatments/Groups	Nitrogen Content (%)	Phosphorus Content (%)	Potassium Content (%)
T_1	4.362	0.510	3.200
T_2	4.562	0.545	3.347
T_3	4.634	0.590	3.352
T_4	4.727	0.557	3.357
T_5	4.790	0.611	3.362
T_6	4.900	0.634	3.355
T_7	5.047	0.670	3.331
T_8	5.102	0.648	3.374
T_9	5.267	0.693	3.380
G_1	4.600	0.560	3.350

G_2	4.760	0.580	3.360
G_3	4.980	0.650	3.340
G_4	5.190	0.670	3.380
S.Em±	0.065	0.008	0.041
CD (P=0.05)	76.76	152.65	0.189

Table 3: Effect of INM on nutrients uptake by black gram

Treatments/Groups	Nitrogen Uptake (kg ha^{-1})	Phosphorus Uptake (kg ha^{-1})	Potassium Uptake (kg ha^{-1})
T_1	31.60	3.84	25.91
T_2	39.80	4.92	32.32
T_3	42.16	5.51	33.59
T_4	47.92	5.80	37.06
T_5	52.94	6.85	39.59
T_6	46.71	6.18	35.49
T_7	52.88	7.13	37.80
T_8	62.45	8.06	44.59
T_9	68.88	9.14	46.33
G_1	41	5.21	32.95
G_2	50	6.32	38.32
G_3	50	6.66	36.64
G_4	66	8.60	45.46
S.Em±	1.32	0.16	1.12
CD (P=0.05)	3.85	0.47	3.27

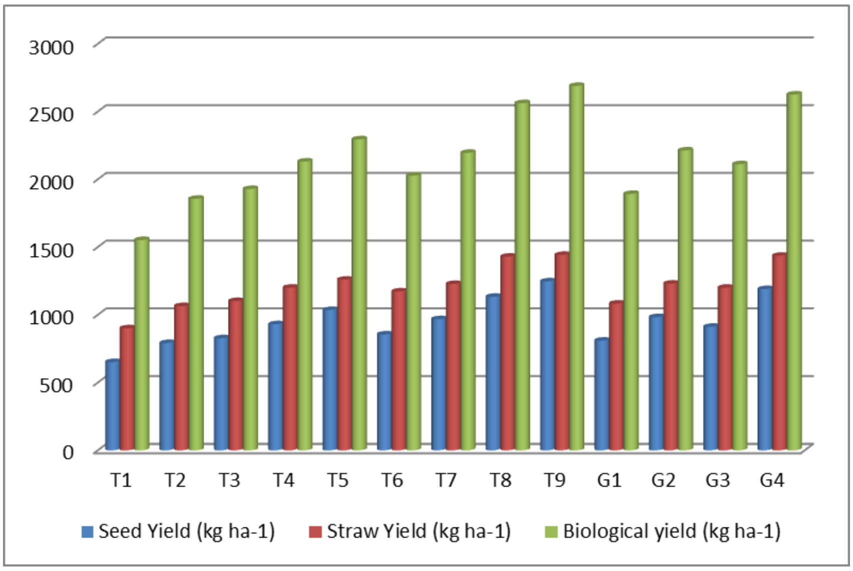

Fig 1: Effect of INM on yield of black gram

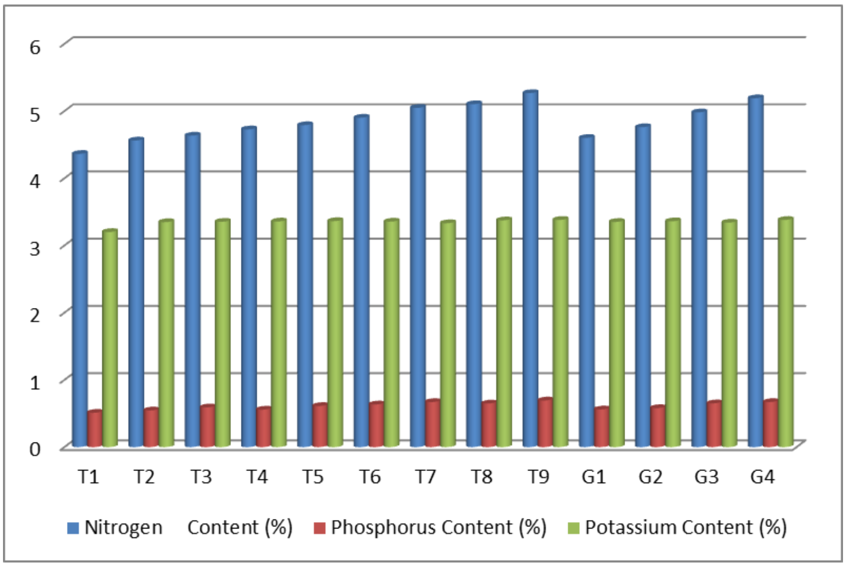

Fig 2: Effect of INM on nutrient content of black gram

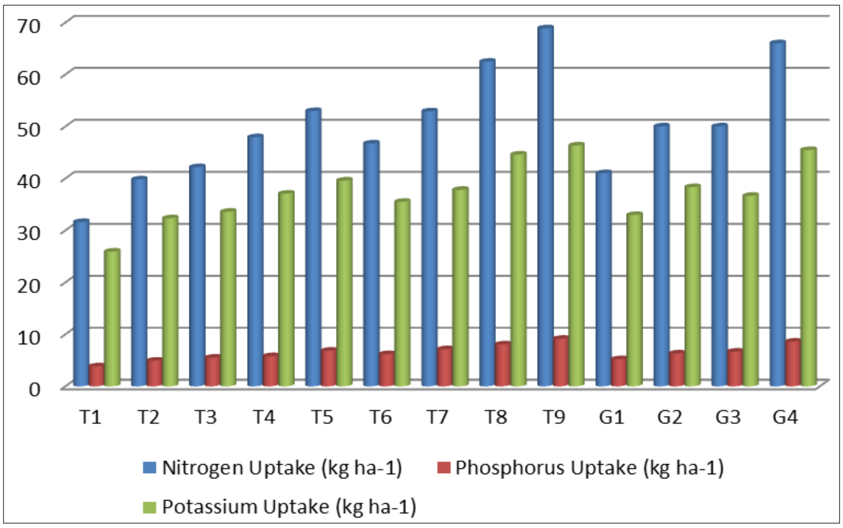

Fig 3: Effect of INM on nutrient uptake by black gram

Conclusion

According to the results of the study it can be concluded that combined use of chemical fertilizers along with vermicompost and biofertilizers not only increases the yield of black gram but also enhances the nutrient content and their uptake by black gram as compared to the sole application of chemical fertilizers and control.

References

1. Athokpam HS, Chongtham N, Singh RKK, Singh NG, Singh NB. Effect of nitrogen, phosphorus and potassium on growth, yield and nutrient uptake by blackgram (*Vigna mungo* L.). Environment and Ecology 2009;27(2):682-684.
2. Bakthavathsalam R, Deivanayaki M. Effect of *Rhizobium* on growth and yield of blackgram (*Vigna mungo*) cultivated in pots under different nutrient media. Environment and Ecology 2007;25(2):360-368.
3. Chakrabarti J, Chatterjee NC, Dutta S. Interactive effect of VAM and *Rhizobium* on nutrient uptake and growth of *Vigna mungo*. International journal of Mycopathological Research 2007;45(2):289-291.
4. DES. Commodity profit-pulses, Directorate of Economics and Statistics, Department of Agriculture and Co-operation and Department of Commerce 2019.
5. DOA. Rajasthan Agricultural Statistics – At a Glance, Directorate of Agriculture, Statistical Cell, Rajasthan, Jaipur 2019.
6. Khatkar, Rahul., Abraham, Thomas, Joseph, Shalu Ann. Effect of biofertilizers and sulphur levels on growth and yield of black gram (*Vigna mungo* L.). Legume Research 2007;30(3):233-234.
7. Kumar A, Elamathi S. Effect of nitrogen levels and *Rhizobium* application methods on yield attributes, yield and economics of blackgram (*Vigna mungo* L.). International Journal of Agricultural Sciences 2007;3(1):179-180.
8. Kumar S, Singh RC, Kadian VS. Performance of mungbeam as influenced by seed inoculation with *Rhizobium* and levels of inorganic sources of nutrients. Indian Journal of Pulses Research 2003;16:67-68.
9. Kumar V, Dwivedi VN, Tiwari DD. Effect of phosphorus and iron on yield and mineral nutrition in chickpea. Annals of Plant and Soil Research 2009;11:16-18.
10. Kumawat PK, Tiwari RC, Golada SL, Godara AS, Gharwal RS, Choudhary R. Effect of Phosphorus sources, levels and Biofertilizers on yield attributes, yield and economics of black gram (*Phaseolus mungo* L.). Legume Research 2013;36(1):70-73.
11. Kumpawat BS. Integrated nutrient management in blackgram (*Vigna mungo*) and its residual effect on succeeding mustard (*Brassica juncea*) crop. Indian Journal of Agricultural Science 2010;80(1):76-79.
12. Laddha KC, Sharma RK, Sharma SK, Jain PM. Integrated nitrogen management in maize and its residual effect on blackgram under dry land conditions. Indian Journal of Dryland Agricultural Research and Development 2006;21(2):177-184.
13. Mehta, Harish Kumar, Reddy, Subash R, Jayamma P, Kumar R *et al*. Influence of biofertilizers, vermicompost and chemical fertilizers on growth, nodulation, nutrient uptake, seed yield and economics of black gram. International Journal of Applied Biology Pharmaceutical Technology 2015,6(3).
14. Mohan SC, Chandaragiri KK. Effect of organic manures on growth and yield attributes in cotton + blackgram intercropping system. International Journal of Plant Sciences 2007;2(1):156-160.
15. Nalwade, Amit, Bhalerao, Satish. Response of black gram (*Vigna mungo* L. Hepper) to biofertilizer. International Journal of Life Sciences 2015;3(1):81-84.
16. Patil DS, Khistaria MK, Padmani DR. Effect of nutrient management biofertilizer on quality, NPK content and uptake of blackgram in medium black soil. International Journal of Agricultural Sciences 2010;6(1):167-168.
17. Rekha GS, Valivittan K, Kaleena PK. Studies on the influence of Vermicompost and Vermiwash on the Growth and Productivity of Black Gram (*Vigna mungo*). Advances in Biological Research 2013;7(4):144-121.
18. Saviour MN, Stalin P. Influence of Zinc and Boron in Residual Blackgram Productivity. Indian Journal of Science and Technology 2013;6(8):5105-5108.
19. Sutaria GS, Akbari KN, Vora VD, Padmani DR. Residual effect of nutrient management on the soil fertility and yield of blackgram under dryland conditions. Legume Research 2011;4(1):62-64.
20. Tisdale SL, Nelson WS, Beaton. Soil fertility and fertilizers. McMillan Publishers Company, New York 1985.