Effect of Organic Sources of Nutrients and Bio inoculants on Diversity of Microbes in Chickpea (*Cicer arietinum* L .)

ABSTRACT

A field experiment was conducted during two consecutive seasons of 2022-23 and 2023-2024 at Research Farm, Department of environmental science, college of Sehore, Mansarovar Global university Sehore (MP). The experiment was laid out in a split plot design with sixteen treatment combinations and replicated thrice. The study on the effect of organic sources of nutrient and bio-inoculants on diversity of microbe under chickpea. It is clear from the data that the highest microbial cells counts like *Rhizobium* (16.43 x 10^{6} cfu g^{-1} soil), PSB (19.03 x 10^{6} cfu g^{-1} soil) was recorded under application of vermicompost @ 2 t ha^{-1} followed by FYM @ 5 t ha^{-1} along with *Rhizobium* and PSB (12.25 x 10^{6} cfu g1 soil) and (17.72 x 10^{6} cfu g-1 soil), respectively. Whereas, highest fungi and actinomycetes count were observed under FYM @ 5 t ha^{-1} in combination with bio-inoculants and recorded 41.30 x 10^{4} cfu g^{-1} and 12.92 x 10^{3} cfu g^{-1} soil, respectively followed by vermicompost @ 2 t ha^{-1} with same inoculants. Whereas the lowest population of fungi was recorded under control along with combined application of bio-fertilizers (29.23 x 10^{4} cfu g^{-1} and 7.25 x 10^{3} cfu g^{-1}).

Keywords : *Rhizobium,* PSB, actinomycetes, fungi, FYM, vermicompost, NPK.

1. INTRODUCTION

Chickpea (*Cicer arietinum* L.) is the third largest produced food legume, having wider adaptability under varied agro-climatic conditions. Pulses play an important role in nutritional security of ever burgeoning population of India. In, India, per capita availability of pulses is low (41.9 g day^{-1}) as per the recommendation of World Health Organization (80 g $capita^{-1}$) [1]. The pulses are the major source of protein in Indian diet and the demand for pulses continues to grow at 2.8% per annum [2]. This huge gap between demand and supply of pulses may be overcome by increasing the productivity of pulses. Chickpea plays a significant role in improving soil fertility by fixing atmospheric nitrogen. The phosphorus requirement of legume crops is generally higher due to higher energy consumption during the process of symbiotic nitrogen fixation [3]. Hence, the phosphorus requirement is higher for healthy crop growth with efficient root system and profuse nodulation. Phosphorus is essential for pod filling and also to increase the grain yield. The phosphatic fertilizers are very costly and their utilization efficiency is very low particularly in rain-fed areas. Use of biofertilizers like phosphate solubilizing bacteria (PSB), symbiotic N-fixing bacteria and Arbuscular mycorrhizal (AM) fungi are needed for enhancing plant growth. These biofertilizers are used in leguminous crops due to higher cost and hazardous effects of chemical fertilizers [4 & 5]. PSB solubilizes the insoluble forms of phosphates like tricalcium, iron and aluminum phosphates into available forms by exerting organic acids, production of chelating substances, mineral acids, siderophores and proton extrusion mechanism [6]. The efficiency of these bio agents may be increased upto the extent of 50 % with the use of organic substances. The organics enhances the microbial activities and maintenance of soil aggregate structure [7], building up a macro pore structure of soil that allows for easier penetration of water and air as well as prevents erosion. Keeping in view the above facts and need to increase the productivity of chickpea, attempt has been made to study the Effect of organic sources of nutrients and bio inoculants on diversity of microbes under chickpea (*Cicer arietinum* L .)

2. MATERIAL AND METHODS

A field experiment was conducted two consecutive seasons of 2022-23 and 2023-2024 at Research Farm, Department of environmental science, college of sehore, Mansarovar Global university Sehore, (MP). The soil of experiment field was medium black which is neutral in reaction (7.20) pH, normal in EC (0.37) medium in organic carbon (0.58%) available nitrogen (282.5 Kg /ha), phosphorus (13.8 Kg / ha) and medium in potassium (277.4 Kg /ha). Sixteen treatment combinations consisted of four organic sources of nutrient (Control, Vermicompost @ 2 t/ ha, FYM @ 5 t /ha and NPK 100% RDF) put under main plot and four bio fertilizers (Control, *Rhizobium* @ 10 g/kg seed, PSB @10 g/kg seed and *Rhizobium* + PSB @ 5g each /kg seed) allotted under sub plots. Samples of rhizospheric soil were used as fresh without grinding, sieving or any modifications. The collected sample were collected and kept in low density polyethene bags and stored in refrigerator at 4℃. Population of microbes were determined by following YEMA (*Rhizobium*), Pikpvskayas (PSB) and Casenak agar medium [8]. Number of microbial cells were computed by following formula.

Value cells (CFU g/soil) = $\frac{\text{Number of colonies}}{\text{1 g of soil}}$ X Dilution factor

3. RESULTS AND DISCUSSION

3.1 Microbial counts under different sources of Nutrients

Study on change in counts of microbe under different treatments recorded after two year of experimentation (Table 1). Data reveal that the counts of *Rhizobium* and PSB cells significantly increased over initial value of 6.85 X 10^6 and 5.30 / X 10^6 cfu g soil, respectively. The organic source consisted of vermicompost and FYM both were found significantly superior over control and 100% dose of NPK. Further it was observed that the counts of *Rhizobium* and PSB under control (9.06 and 12.8 X 10^6 cfu /g soil) and 100 % RD of NPK (8.59 and 13.40 X 10^6 cfu /g soil) were significantly lower to vermicompost as well as FYM. However, the over all counts of Rhizobium and PSB under control were statistically at par to 100%

NPK but higher over initial value. These finding are in accordance with the observations recorded by Barik *et al.,* 2006 [9] and Gulaiya *et. al.,* 2023 [10]. who reported that the inoculation of *rhizobium* and PSB bring out significant changes in counts of rhizobium and PSB cells in soil after even harvest of crops. The counts of *Rhizobia* increased under both the conditions of single inoculation as well as combined inoculation of *rhizobium* and PSB both either with the application of vermicompost (22.80 and 24.27 X 10^6 g /soil) or FYM (15.33 and 17.20 X 10^6 g / soil) respectably, for single and combined inoculation. Moreover, microbial counts were significantly higher under combined inoculation of *Rhizobium* and PSB together. Similar result were observed in case of PSB counts and recorded 25.77 and 30.69 X 10^6 g/soil under signal PSB and combined inoculation of PSB and *Rhizobium*, respectably. However, the counts of PSB recorded markedly higher (22.81 X 10^6 cfu /g soil) under FYM over control and 100% RD of NPK. The counts of PSB were (22.81 X 10^6 CFU /g soil) for single and combined inoculation (29.10 X 10^6 CFU/g soil). The variations between vermicompost and FYM were not significant for PSB. These result are corroborated with the findings of Kiran *et al.,* 2016 [11].

Table :1 Effect of Different organic sources of nutrient and bo inoculants on *Rhizobium* counts (10^6 cfu /g soil) in post-harvest soils.

Bio inoculants as seed inoculation / Sources of nutrient	**Control**	***Rhizobium***	**PSB**	**Rhi+PSB**	**Mean**
Control	7.15	11.12	4.82	13.15	**9.06**
Vermicompost @ 2 t/ha	8.00	22.80	10.65	24.27	**16.43**
FYM @ 5 t /ha	7.83	15.33	8.67	17.20	**12.25**
100 % RD NPK	6.85	10.17	4.56	12.80	**8.59**
Mean	**7.45**	**14.85**	**7.17**	**16.85**	
		SEm±		**CD at (0.05)**	
Nutrient sources S		0.39		0.98	
Bio inoculants B		0.45		1.03	
Factor B at same level of S		0.74		1.88	
Factor S at same level of B		0.88		2.05	

Initial counts 6.85 X 10^6 cfu /g soil

Table :2 Effect of different organic sources of nutrient and bio inoculants on PSB counts (10^6 cfu /g soil) in post-harvest soils.

Bio inoculants as seed inoculation / Sources of nutrient	**Control**	***Rhizobium***	**PSB**	**Rhi+PSB**	**Mean**
Control	6.67	7.80	16.17	20.61	**12.81**
Vermicompost @ 2 t/ ha	9.14	10.55	25.77	30.69	**19.03**
FYM @ 5 t /ha	8.85	10.15	22.81	29.10	**17.72**
100 %RD NPK	7.80	8.70	18.55	18.56	**13.40**
Mean	**7.99**	**9.30**	**20.82**	**24.24**	
		SEm±		**CD at (0.05)**	
Nutrient sources S		**o.91**		2.79	
Bio inoculants B		**0.98**		2.96	

Factor B at same level of S	**0.88**	2.81
Factor S at same level of B	**0.93**	2.95

Initial counts 5.30 X 10^6 cfu /g soil

Table :3 Effect organic sources of nutrient and bioinoculants on counts of fungi (10^4 cfu /g soil) and actinomycetes (10^3 cfu /g soil) in post harvest soils.

Treatments	**Fungal Counts**	**Actinomycetes Counts**
Initial value	26.25	5.65
Organic sources		
Control	29.23	7.25
Vermicompost@ 2 t/ ha	35.46	9.97
FYM @ 5 t /ha	41.30	12.92
100 RD NPK	32.18	9.45
SEm±	**1.45**	**1.94**
CD(0.05)	**3.92**	**NS**
Bio Inoculants		
Control	30.71	7.05
Rhizobium	35.11	9.25
PSB	37.92	12.34
Rhizobium+ PSB	30.73	9.19
SEm±	1.29	2.02
CD(0.05)	**3.02**	**NS**

The population of total fungi and actinomycetes recorded after two year of study assessed in the post harvest soil presented in Table3. Data showed the total fungal counts and counts of initial values of 26.25 X 10^4 and 5.65 X 10^3 /g soil. However, variation between treatment for actinomycetes were not significant. The population of fungi changed with the sources of nutrient and bioinoculants both. The significantly higher population of fungi were observed under FYM (41.30 X 10^4 /g soil) over remaining all the sources . Moreover, the fungal population was significantly higher under vermicompost (35.46 X 10^4 /g soil) and stood significantly superior over control and 100 % RD of NPK. The counts of fungi were significantly higher under inoculation of *Rhizobium* (35.11 X 10^4 /g soil) and PSB (37.92 X 10^4 /g soil) but the variations between control and 100% RD Of NPK were not significant. The variation between sources of nutrient and inoculation were found to be non significant. These finding are accordance with the finding Das and Verma (2011) [12].

4. CONCLUSION

Based on forgoing discussions, it was concluded that addition of vermicompost and FYM @ 2 and 5 t ha^{-1} respectively, showed the favourable impact on proliferation of *Rhizobium* as well as PSB cell, FYM and vermicompost also showed the favourable effect on fungal and actinomycetes count as observed under post-harvest soil. The cells of fungi proliferate at faster rate in FYM. Moreover, the combined application of

Rhizobium and PSB proved to be the best for enhancing the microbial diversity of rhozospheric soil under the chickpea ecosystem.

REFERENCES

1. Anonymous. 2013. Per capita availability of pulses in India. www.financialexpress.com
2. Chauhan JS, Singh B B, and Gupta S. Enhancing pulses production in India through improving seed and variety replacement rates. Indian Journal of Genetics. 2016; 76:1–10.
3. Schulze J, Temple G, Temple SJ, Beschow H, and Vance C P. Nitrogen fixation by white lupin under phosphorus deficiency. Annals of Botany. 2006;98 (4):731–40
4. Mukherjee P K, and Rai R K. Effect of vesicular arbuscular mycorrhizae and phosphate solubilizing bacteria on growth, yield and phosphorus uptake by wheat (Triticum aestivum) and chickpea (Cicer arietinum). Indian Journal of Agronomy 2000;45:602–607.
5. Thiyagarajan T M, Backiyavathy M R and Savithri P. Nutrient management for pulses: A review. *Agricultural Review*, 2003;24:40–8.
6. Prajapati B J, Gudadhe N, Gamit V R and Chhaganiya H J. Effect of integrated phosphorus management on growth, yield attributes and yield of chickpea. Farming and Management. 2017;2 (1):36–40.
7. Carneiro, MAC, Ferreira DA, Souza EDD, Paulino HB, Junior OJS and Siqueira J O. Arbuscular mycorrhizal fungi in soil aggregates from fields of "murundus" converted to agriculture. Pesquisa Agropecuaria Brasileira. 2015;50 (4):313–21.
8. Rao NS. Biofertilizers in Agriculture. Oxford and IBH, Publishing Company Private Limited, New Delhi. 1988.
9. Barik AK, Das Arindam, Giri AK, Chattopadhyaya GN. Effect of integrated plant nutrient management on growth, yield and production economics of wet season rice. Indian Journal of Agriculture Science. 2006;76:657 - 660. 4.
10. Gulaiya S, Agrawal SB, Kochale Priya, Verma Badal, Patel KK, Sharma A, Singh Vivek, Kumar A and Singh SK. Effect of various nutrients sources and bio-fertilizers on soil microbial diversity under late sown chickpea (*Cicer arietinum* L.), *The Pharma Innovation Journal.* 2023;12(8): 1014-1017
11. Kiran, Satyanarayana R, Ramesh and Kumar C. Effect of nutrient management practices through organics on growth, yield & economics of chickpea under rainfed condition. Green Farming. 2016;7 :880 -883.
12. Das SK and Varma A. Role of enzymes in maintaining soil health. In: Shukla G, Varma A. (Eds.) Soil Enzymology , Soil Biology 22, Springer -Verlag Berlin Heidelberg USA; 2011