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Effect of Various Potassium Levels and Organic Sources on Soil Health and Nutrient Content of Cluster Bean under Semi-arid Eastern Plain Zone of Rajasthan, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

With the advent of high-yielding crop varieties/hybrids and the gradual intensification of agriculture, soil potassium reserves are being depleted at a quicker rate. Furthermore, due to uneven fertiliser application, potassium deficit is becoming one of the most significant restrictions in crop

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productivity. A field experiment was conducted to study the influence of potassium and organic sources on soil properties and nutrient content of cluster bean (*Cyamopsis tetragonoloba* L.) during *Kharif*, 2024 at Instructional Farm, SKNAU, Jobner, Jaipur (Raj.). The study comprised treatments with different potassium levels Control, 100% RDK @ (20 kg K ha^{-1}) (SA), 75% RDK @ (15 kg ha^{-1}) (SA) + KSB (5ml/kg seed) (ST) + KSB (SA) (2.5L/ha), 50% RDK @ (10 kg K ha^{-1}) (SA) KSB (5ml/kg seed) (ST) + KSB (SA) (2.5L/ha) and KSB (5ml/kg seed) (ST) + KSB (SA) (2.5L/ha)) and organic sources Control, 100% RDFYM (FYM @ 5 t/ha), 100% RDV (Vermicompost @ 2.5 t/ha) and 50% RDFYM (FYM @ 2.5 t/ha) + 50% RDV (Vermicompost @ 1.25 t/ha) arranged in a factorial randomized block design with three replications and 20 treatment combinations. The results of the experiment revealed that potassium application had no significant effect on soil pH, EC, bulk density, organic carbon, available nitrogen and phosphorus; however, available potassium improved significantly (218.72 kg ha^{-1} under 100% RDK), however Treatment 75% RDK + KSB (217.90 kg ha^{-1}) was found statistically at par. Organic sources significantly improved soil organic carbon (0.269 % under FYM@ 5 t/ha), reduced bulk density (1.46 Mg m^{-3} under FYM @ 5 t/ha), and enhanced available N (152.04 kg ha^{-1}), P (23.15 kg ha^{-1}) and K (217.87 kg ha^{-1}) under vermicompost @ 2.5 t/ha. 100% RDFYM stimulated the highest microbial population and DHA (21.84 µg TPF g^{-1}), however, 50% RDFYM (FYM @ 2.5 t/ha) + 50% RDV (Vermicompost @ 1.25 t/ha) was found at par. Nutrient content in seed and straw was significantly influenced by potassium and organic sources. Maximum seed N (3.48%), K (0.516%) and straw N (0.72%), K (1.18%) occurred under 100% RDK, while Vermicompost @ 2.5 t/ha recorded highest seed N (3.49%), P (0.478%) and K (0.501%) content, however 50% RDFYM (FYM @ 2.5 t/ha) + 50% RDV (Vermicompost @ 1.25 t/ha) was found at par. The interactive effect K_1O_2 (100% RDK + vermicompost @ 2.5 t/ha) gave maximum seed N (3.60%) and K (0.552%) content, though K_2O_2 (75% RDK + KSB + vermicompost @ 2.5 t/ha) was found statistically at par with K_1O_2. It may be concluded that 75% RDK + KSB + vermicompost @ 2.5 t/ha not only saved 25% mineral K fertiliser but also sustained soil health and productivity, representing a sustainable nutrient management option for cluster bean in the semi-arid eastern plain zone of Rajasthan.

Keywords: Potassium sources; organic sources; soil health; nutrient content; Cluster bean.

1. INTRODUCTION

"Cluster bean (*Cyamopsis tetragonoloba* L.) popularly known as 'Guar' is a drought-hardy, deep-rooted and annual legume crop in India" (Meena *et al.,* 2016), "grown during rainy season in semi-arid and arid regions of India for various purposes *viz.*, vegetables, greenfodder, green manuring and seed" (Grestaa *et al.,* 2013). "It is a drought-resistant plant which belongs to the family Leguminaceae and subfamily Papilionaceae and is known to improve soil fertility (Bhoi et al., 2024). The major cluster bean cultivating countries are India, Pakistan, the USA, Sudan, South Africa, Brazil, Malawi and Australia. India is the largest producer of guar with 80% of the world production, followed by Pakistan with 10-15%" (Anonymous, 2022-23).

"Potassium is the major nutrient, it is suggested as a solution for improving plant nutritive; enzyme activation, maintaining cell turgor; transportation of sugars and starches; improving crop quality; increasing resistance against stress conditions such as pests and diseases. Though it is most abundant element in soils but K content varies from place to place based on physio-chemical properties of soil and minerals make up more than 90 to 98 per cent of soil potassium and most of it is unavailable for plant uptake and the issue of sustainable management of potassium in soil has partly been ignored during the last decades when the focus was aimed with use of nitrogen and phosphorus (Biswash et al., 2014; Chintha et al., 2021). With the introduction of high-yielding crop varieties/hybrids and the progressive intensification of agriculture, the soils are getting depleted in potassium reserve at a faster rate (Chaudhary et al., 2020). Moreover, due to imbalanced fertiliser application, potassium deficiency is becoming one of the major constraints in crop production (Chhonkar, 2002; Fasusi et al., 2021; Kherawat et al., 2013). Biofertilizer is a substance that contains living microorganisms that, when applied to soil, colonise the rhizosphere or the interior of the plant and promote growth by increasing the supply or availability of primary nutrients to the host plant (Kumar et al., 2014). Pseudomonas and Bacillus, which are known as KSB in silicate form, play an important role in the case of potassium" (Narula *et al.,* 2005; Choudhary et al., 2024; Fisher & Yates, 1963). "KSB plays an essential role in improving soil fertility and reducing the amount of chemical fertilisers" (Zhang *et al.,* 2013). "Usage of Organic manures like farm yard manure, vermicompost and poultry manure showed an increased growth in terms of height and yield of the plant; it could be a better alternative to inorganic fertilisers" (Ramanjineyulu *et al.,* 2024). "The organic manures contain plant nutrients in small quantities as compared to the fertiliser. The presence of growth-promoting substances like enzymes and hormones, besides plant nutrients, makes them essential for the improvement of soil fertility and productivity (Goud et al., 2014; Rout et al., 2017). Vermicompost would not only increase the organic carbon status of the soil but also increase the soil water holding capacity, flocculation of soil and availability of all micro and macronutrients. Thus, making the soil sustainable" (Rajkhowa *et al.,* 2000; Parthasarathi et al., 2008). "FYM, besides rich sources of micronutrients, also helps in improving the physical condition of the soil. FYM is an important primary source of organic matter and nutrients" (Lal, 2016; Inwati et al., 2022).

Hence, research efforts are required to find out the ideal combination of organic manure and potassium fertiliser with KSB to improve soil health. Keeping these points in view, the present investigation was carried out to investigate the effect of potassium and organic sources on soil properties and plant nutrient content.

2. MATERIALS AND METHODS

The field experiment was conducted at the Instructional Farm, S.K.N. College of Agriculture, Jobner (Rajasthan) during the *kharif* season of the year 2024. The experiment was laid out in FRBD with three replications. The experimental soil was analyzed for the physico-chemical properties. The soil was loamy sand in texture, alkaline in reaction (pH 8.12), low in organic carbon (0.21 %), and available nitrogen (144.61 kg/ha), medium in available phosphorus (21.69 kg/ha), and potassium (194.25 kg /ha). The experiment conducted under five level of potassium K_0(Control), K_1[100% RDK @ (20 kg K ha^{-1}) (SA)], K_2 [75% RDK @ (15 kg ha^{-1}) (SA) + KSB (5ml/kg seed) (ST) + KSB (SA) (2.5L/h), K_3 (50% RDK @ (10 kg K ha^{-1}) (SA) KSB (5ml/kg seed) (ST) + KSB (SA) (2.5L/ha)], K_4 [KSB (5ml/kg seed) (ST) + KSB (SA) (2.5L/ha)] and four levels of organic sources viz., O_0(Control), O_1[100% RDFYM (FYM @ 5 t/ha)], O_2 [100% RDV (Vermicompost @ 2.5 t/ha)], O_3 [50% RDFYM (FYM @ 2.5 t/ha) + 50% RDV (Vermicompost @ 1.25 t/ha)] and thereby, making 60 treatment combinations.

Soil samples were collected from 0-15 cm depth after harvest of cluster bean from all plots. Soil samples were air-dried, ground and passed through a 2 mm sieve. They were further analysed by pursuing different standard analytical procedures. The pH of the post-harvest soil in 1:2 soil and water solution was determined with the help of a glass electrode pH meter (Piper, 1950). The electrical conductivity in the suspension of soil and water (1:2 ratio) was determined with the help of an electrical conductivity meter (Piper, 1950). Organic carbon in the soil was estimated by the Walkley and Black (1934) method. This method involved oxidation of organic matter with chromic acid, and the unutilized potassium dichromate was back-titrated against ferrous ammonium sulphate. Soil samples were analysed for available N using alkaline potassium permanganate, which oxidised and hydrolysed the organic matter present in the soil (Subbiah and Asija, 1956). Available phosphorus was determined spectrophotometrically by extracting the soil with 0.5 N $NaHCO_3$ at pH 8.5 (Olsen *et al.,* 1954) and measuring the intensity of blue colour developed by ammonium molybdate-stannous chloride at 660 nm using by spectrophotometer. Available K in soil was determined by extracting the soil with 1N neutral ammonium acetate (Jackson, 1973) and measuring the concentration in the filtrate using a flame photometer. For estimation of nitrogen, phosphorus, and potassium of representative samples of seed and straw were taken at the time of threshing. The samples were air-dried and kept in an oven at 70 ˚C for drying until they attained constant weight. Each dried samples were separated into parts wise ground to a fine powder in a grinder having stainless steel blades. Nutrient content in seed and straw was estimated by using standard methods. The experimental data recorded were subjected to statistical analysis in accordance with the "Analysis of Variance" technique suggested by Fisher (1950).

3. RESULTS AND DISCUSSION

3.1 Effect of Potassium Sources

Potassium sources exhibited no significant effect on soil pH, EC, available nitrogen, available phosphorus, organic carbon and bulk density; however, the available potassium content in soil was improved significantly with potassium sources (Table 1 and 2). The highest available potassium was obtained under K_1 (100% RDK @ (20 kg K ha-1) (SA), whereas treatment K_2 (75% RDK @ (15 kg/ha) (SA) + KSB (5 ml/kg seed) (ST) + KSB (SA) (2.5 L ha-1) remained statistically at par with treatment K_1 (Table 2), as KSB converts unavailable indigenous potassium present in soil into available form. The results of the current experiment are in agreement with the findings of Meena et al. (2016), who reported that the application of potassium-solubilising bacteria (KSB) significantly enhanced the availability of potassium in the soil by solubilising fixed forms of potassium. Their study demonstrated that the inoculation of soil or seeds with KSB not only improved potassium solubility but also increased plant uptake, leading to improved soil fertility and crop yield. The synergistic effect observed when combining KSB with reduced doses of chemical potassium fertilisers supports the present observation where the KSB-treated plots with 75% recommended dose of potassium performed on par with 100% chemical potassium application.

Table 1. Effect of potassium and organic sources on soil pH, EC, organic carbon and bulk density after harvest of cluster bean

Treatment	pH	EC (dS m^{-1})	OC (%)	BD (Mgm^{-3})
Potassium Sources				
K_0 - Control	8.18	0.40	0.242	1.50
K_1 - 100% RDK @ (20 kg K ha^{-1}) (SA)	7.97	0.40	0.252	1.48
K_2 - 75% RDK @ (15 kg ha^{-1}) (SA) + KSB (5 ml/kg seed) (ST) + KSB (SA) (2.5 L ha^{-1})	8.05	0.40	0.251	1.48
K_3 - 50% RDK @ (10 kg K ha^{-1}) (SA) KSB (5 ml/kg seed) (ST) + KSB (SA) (2.5 L ha^{-1})	7.90	0.39	0.246	1.49
K_4 - KSB (5 ml/kg seed) (ST) + KSB (SA) (2.5 L ha^{-1})	7.98	0.40	0.245	1.50
SEm$\pm$	0.07	0.00	0.004	0.01
CD (P=0.05)	NS	NS	NS	NS
Organic sources				
O_0–Control	8.03	0.39	0.230	1.52
O_1 - 100% RDFYM (FYM @ 5 t ha^{-1})	8.00	0.39	0.269	1.46
O_2-100% RDV (Vermicompost @ 2.5 t ha^{-1})	8.01	0.40	0.249	1.49
O_3 -50% RDFYM (FYM @ 2.5 t ha^{-1}) + 50% RDV (Vermicompost @ 1.25 t ha^{-1})	8.02	0.40	0.263	1.48
Sem $\pm$	0.06	0.00	0.003	0.01
CD (P=0.05)	NS	NS	0.008	0.02

Table 2. Effect of potassium and organic sources on soil available nitrogen, phosphorus and potassium content after harvest of cluster bean

Treatment	Available nutrients (Kg ha^{-1})		
	Nitrogen	Phosphorus	Potassium
Potassium Sources			
K_0 - Control	144.61	21.69	203.18
K_1 - 100% RDK @ (20 kg K ha^{-1}) (SA)	148.67	22.80	218.72
K_2 - 75% RDK @ (15 kg ha^{-1}) (SA) + KSB (5 ml/kg seed) (ST) + KSB (SA) (2.5 L ha^{-1})	148.66	22.64	217.90
K_3 - 50% RDK @ (10 kg K ha^{-1}) (SA) KSB (5 ml/kg seed) (ST) + KSB (SA) (2.5 L ha^{-1})	148.50	22.59	212.85
K_4 - KSB (5 ml/kg seed) (ST) + KSB (SA) (2.5 L ha^{-1})	146.53	22.03	208.02
SEm$\pm$	1.21	0.42	1.62
CD (P=0.05)	NS	NS	4.39
Organic sources			
O_0 – Control	141.72	21.09	203.14
O_1 - 100% RDFYM (FYM @ 5 t ha^{-1})	145.52	22.08	207.59
O_2-100% RDV (Vermicompost @ 2.5 t ha^{-1})	152.04	23.15	217.87
O_3 -50% RDFYM (FYM @ 2.5 t ha^{-1}) + 50% RDV (Vermicompost @ 1.25 t ha^{-1})	150.29	23.07	215.08
SEm$\pm$	0.94	0.33	1.53
CD (P=0.05)	2.69	0.93	4.40

Potassium application significantly enhanced nitrogen content in seed and straw, and potassium content in seed and straw. N and K content in seed and straw was highest under K_1 (100 % RDK @ 20 kg ha^{-1} SA), however, K_2 (75% RDK @ (15 kg ha^{-1}) (SA) + KSB (5 ml/kg seed) (ST) + KSB (SA) (2.5 L ha^{-1}) was statistically at par with K_1 (Table 3), this can be attributed to the adequate supply of potassium through K_1, which plays a vital role in improving nutrient translocation, enzyme activation and protein synthesis. "The comparable performance of K_2 indicates that the integration of potassium-solubilising bacteria (KSB) with a reduced potassium dose in K_2 enhanced nutrient availability and uptake efficiency, thereby improving seed quality even at lower chemical input levels" (Yaghoubi *et al.,* 2018). Also, potassium supports protein synthesis by enhancing nitrate reductase activity and amino acid transport. It is driven by improved nitrogen assimilation, photosynthesis and source-sink dynamics. These insights support K's strategic role not just in yield enhancement, but also in improving nutritional quality.

3.2 Effect of Organic Sources

Application of organic sources exhibited no significant effect on soil pH and EC; however, significantly improved soil organic carbon, soil bulk density, available nitrogen, available phosphorus and available potassium (Tables 1 and 2). Treatment O_1 recorded the highest values for OC and the lowest for B.D. However, in the case of OC treatment, O_3 was statistically at par with O_1. The available N (152.04 kg ha^{-1}), P (23.15 kg ha^{-1}) and K (217.87 kg ha^{-1}).

recorded highest in O_2 (100% RDV (Vermicompost @ 2.5 t ha^{-1}) however, treatment O_3 (50% RDFYM (FYM @ 2.5 t ha^{-1}) + 50% RDV (Vermicompost @ 1.25 t ha^{-1}) was statistically at par with O_2. These organic sources enhance soil aggregation and porosity. It can be attributed to the greater mass and fibrous nature of FYM, applied at a higher rate (5 t ha^{-1}), which contributes substantial organic residues that enhance soil aggregation and porosity, microbial population and enzyme activity over time. This improves soil aeration and water infiltration, thereby lowering bulk density. Additionally, the decomposition of FYM promotes the buildup of stable organic matter, leading to increased soil organic carbon. The nutrient availability in soil is highest with the application of vermicompost; this can be attributed to the highly decomposed and nutrient-rich nature of vermicompost. Vermicompost contains readily mineralizable organic matter and a higher proportion of humic substances, which enhance nutrient solubility and availability in the soil. Its fine texture and microbial activity also accelerate the mineralisation of nutrients,

Table 3. Effect of potassium and organic sources on N, P & K content in seed and straw of cluster bean

Treatment	N content (%)		P content (%)		K content (%)	
Potassium sources	**Seed**	**Straw**	**Seed**	**Straw**	**Seed**	**Straw**
K_0 - Control	3.16	0.59	0.444	0.143	0.432	1.01
K_1 - 100% RDK @ (20 kg K ha^{-1}) (SA)	3.48	0.72	0.453	0.150	0.516	1.18
K_2 - 75% RDK @ (15 kg ha^{-1}) (SA) + KSB (5 ml/kg seed) (ST) + KSB (SA) (2.5 L ha^{-1})	3.43	0.71	0.452	0.149	0.513	1.16
K_3 - 50% RDK @ (10 kg K ha^{-1}) (SA) KSB (5 ml/kg seed) (ST) + KSB (SA) (2.5 L ha^{-1})	3.33	0.67	0.450	0.148	0.461	1.11
K_4 - KSB (5 ml/kg seed) (ST) + KSB (SA) (2.5 L ha^{-1})	3.22	0.63	0.446	0.144	0.447	1.105
SEm±	0.02	0.01	0.010	0.004	0.002	0.01
CD (P=0.05)	0.06	0.02	NS	NS	0.006	0.03
Organic sources						
O_0 – Control	3.15	0.57	0.412	0.141	0.428	1.00
O_1 - 100% RDFYM (FYM @ 5 t ha^{-1})	3.26	0.68	0.439	0.145	0.462	1.11
O_2-100% RDV (Vermicompost @ 2.5 t ha^{-1})	3.49	0.73	0.478	0.157	0.501	1.16
O_3 -50% RDFYM (FYM @ 2.5 t ha^{-1}) + 50% RDV (Vermicompost @ 1.25 t ha^{-1})	3.47	0.72	0.467	0.156	0.498	1.15
SEm±	0.01	0.01	0.007	0.001	0.002	0.01
CD (P=0.05)	0.03	0.02	0.021	0.002	0.005	0.02

Table 4. Interactive effect of K sources and organic sources on N content in seed

Source	O_0	O_1	O_2	O_3
K_0	2.880	2.990	3.240	3.100
K_1	3.280	3.390	3.601	3.490
K_2	3.272	3.385	3.597	3.500
K_3	3.165	3.282	3.494	3.399
K_4	3.060	3.181	3.370	3.297
	SEm±	CD		
K×O	0.03	0.100		

Table 5. Interactive effect of K sources and organic sources on K content in seed

Source	O_0	O_1	O_2	O_3
K_0	0.374	0.403	0.461	0.450
K_1	0.469	0.503	0.552	0.541
K_2	0.463	0.502	0.549	0.533
K_3	0.428	0.466	0.529	0.502
K_4	0.404	0.444	0.480	0.470
	SEm±	CD		
K×O	0.002	0.007		

Table 6. Interactive effect of K sources and organic sources on K content in straw

Source	O_0	O_1	O_2	O_3
K_0	0.970	1.009	1.052	1.049
K_1	1.132	1.162	1.232	1.195
K_2	1.100	1.131	1.230	1.169
K_3	1.069	1.101	1.162	1.137
K_4	1.037	1.069	1.12	1.098
	SEm±	CD		
K×O	0.013	0.037		

especially nitrogen and phosphorus, while organic acids released during decomposition may mobilise both exchangeable and fixed forms of potassium. These factors collectively contribute to improved nutrient dynamics and greater immediate availability of essential macronutrients in the soil under vermicompost application.

Application of organic sources significantly improved nitrogen, phosphorus and potassium content in seed and straw (Table 3). NPK content was highest under O_2 (100% RDV (Vermicompost @ 2.5 t ha^{-1}) whereas, O_3 (50% RDFYM (FYM @ 2.5 t ha^{-1}) + 50% RDV (Vermicompost @ 1.25 t ha^{-1}) was found statistically at par with O_2. This can be attributed to vermicompost's superior nutrient availability, microbial richness and soil structure improvement, which enhance nutrient mineralisation and plant uptake. Vermicompost provides readily available N, P and K while supporting beneficial soil microbes, leading to greater absorption by plants, as reflected in the elevated nutrient concentrations in seed and straw. The synergistic effect of organic sources in O_3 also maintained comparable performance due to improved nutrient release patterns and reduced losses.

3.3 Interaction Effect of Potassium and Organic Sources

Significant improvements in the content of nitrogen (N) in seed and potassium (K) content in both seed and straw were observed under K_1O_2, whereas K_2O_2 was observed statistically at par with K_1O_2 (Table 4 to Table 6). Potassium fertilisation enhances the efficiency of nitrogen assimilation by activating key enzymes like nitrate reductase, and vermicompost helps in solubilising native potassium reserves, increasing its availability.

4. CONCLUSION

Based on the one year experiment, it may be concluded that highest nutrient content was obtained under treatment combination K_1O_2 (100% RDK @ 20 kg K ha-1 with Vermicompost @ 2.5 t ha^{-1}), however, treatment combination K_2O_2 (75% RDK @ 15 kg ha^{-1} + KSB (5 ml/kg seed) + KSB (2.5 L ha^{-1}) with Vermicompost @

2.5 t ha^{-1}) was found equally effective, alongside this the combination K_2O_2 was found to save the mineral K application by 25% and found beneficial in improving soil health and productivity of cluster bean.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

Directorate of Economics & Statistics, Rajasthan. (2023). Agricultural Statistics of Rajasthan, 2022-23. Directorate of Economics & Statistics, Rajasthan. https://des.rajasthan.gov.in/content/raj/planning/directorate-of-economics-and-statistics/en/publications/agriculture-statistics.html

Bhoi, P., Swaroop, N., Thomas, T., Mohanta, S. R., & Thomas, A. (2024). Impact of NPK and vermicompost on physico-chemical properties of soil of cluster bean (Cyamopsis tetragonoloba L.) cv. Pusa Navbahar. International Journal of Plant and Soil Science. https://doi.org/10.9734/ijpss/2024/v36i74767

Biswash, M. R., Rahman, M. W., Haque, M. M., Sharmin, M., & Barua, R. (2014). Effect of potassium and vermicompost on the growth, yield and nutrient contents of mungbean (*BARI Mung 5*). *Open Science Journal of Bioscience and Bioengineering*. http://archive.saulibrary.edu.bd:8080/xmlui/handle/123456789/1991

Chaudhary, S. B., Patel, M. V., More, S. G., Chaudhary, S. S., & Rabari, S. S. (2020). Effect of organic sources of nutrients on n, p & k uptake, available n, p & k and yield of okra [Abelomoschus esculentus (L.) Moench] cv. GAO 5. The Pharma Innovation Journal. https://www.thepharmajournal.com/archives/2020/vol9issue3/PartF/9-3-69-1.pdf

Chhonkar, P. K. (2002). Soil research in India: Some oversights and failures. *Journal of the Indian Society of Soil Science*, *50*(4), 328-332. http://117.239.75.72/bib/68863

Chintha, H. B., Swaroop, N., Thomas, T., Barthwal, A., Harit, H., & Amjad, A. (2021). Effect of nitrogen, phosphorus, potassium, sulphur and zinc on soil health parameters of cluster bean (Cyamopsis tetragonoloba L.). The Pharma Innovation Journal, 10(11), 1955-1961. https://www.thepharmajournal.com/archives/?year=2021&vol=10&issue=11&ArticleId=9209

Choudhary, M., Thomas, T., Swaroop, N., Mohanta, S. R., & Thomas, A. (2024). Response of NPK, vermicompost and FYM on physical and chemical properties of soil under cluster bean (Cyamopsis tetragonoloba L.). Journal of Advances in Biology & Biotechnology. https://doi.org/10.9734/jabb/2024/v27i6954

Fasusi, O. A., Cruz, C., & Babalola, O. O. (2021). Agricultural sustainability: Microbial biofertilizers in rhizosphere management. Agriculture. https://doi.org/10.3390/agriculture11020163

Fisher, R. A. (1950). Statistical methods for research workers. *Oliver and Boyd.*

Fisher, R. A., & Yates, F. (1963). Statistical tables for biological, agricultural and medical research. Oliver & Boyd https://www.scispace.com/paper/statistical-tables-for-biological-agricultural-and-medical-research-edited-by-r-a-fisher-and-f-yates-6th-ed-2000000000000000000000000000000

Goud, V. V., Konde, N. M., Mohod, P. V., & Kharche, V. K. (2014). Response of chickpea to potassium fertilization on yield, quality, soil fertility and economic in vertisols. Legume Research. https://doi.org/10.5958/j.0976-0571.37.3.047

Gresta, F., Sortino, O., Santonoceto, C., Issi, L., Formantici, C., & Galante, M. (2013). Effects of sowing times on seed yield, protein and galactomannans content of four varieties of guar (Cyamopsis tetragonoloba L.) in a Mediterranean environment. Industrial Crops and Products. https://doi.org/10.1016/j.indcrop.2012.04.007

Inwati, D. K., Dixit, B. K., Dwivedi, B. S., Thakur, R., Sharma, A., & Singh, V. (2022). Effect of long term fertilizer and FYM application on soil potassium fractions in a Vertisol under soybean–wheat cropping system. The Pharma Innovation Journal. https://www.thepharmajournal.com/archives/2022/vol11issue8/PartAD/11-8-10-830.html

Jackson, M. L. (1973). Soil chemical analysis. Prentice Hall of India Pvt. Ltd. http://krishikosh.egranth.ac.in/handle/1/5810135824

Kherawat, B. S., Lal, M., Agarwal, M. A. H. E. S. H., Yadav, H. K., & Kumar, S. (2013). Effect of applied potassium and manganese on yield and uptake of nutrients by cluster bean (*Cyamopsis tetragonoloba*). *Journal of Agricultural Physics*, *13*(1), 22-26.

Kumar, P., Kumar, P., Singh, T., Singh, A. K., & Yadav, R. I. (2014). Effect of different potassium levels on mungbean under custard apple based agri-horti system. African Journal of Agricultural Research. https://doi.org/10.5897/AJAR2013.7883

Lal, R. (2016). Managing soil and water resources for sustainable intensification of agroecosystems in India. *Indian Journal of Fertilizers*.

Meena, V. K., Kaushik, M. K., Singh, M., Kumar, R., Meena, R. K., Meena, B. L., Meena, B. P., Ram, H., Kumar, U., Yadav, M. R., Makarana, G., Kumar, S., & Joshi, D. (2016). Performance of cluster bean cultivars under the application of various agrochemicals in Sub - Humid area of Rajasthan. Legume Research. https://doi.org/10.18805/lr.v39i6.6644

Meena, V. S., Maurya, B. R., Verma, J. P., & Meena, R. S. (2016). Potassium solubilizing microorganisms for sustainable agriculture. Springer https://doi.org/10.1007/978-81-322-2776-2

Narula, N., Saharan, B. S., Kumar, V., Bhatia, R., Bishnoi, L. K., Lather, B. P. S., & Lakshminarayana, K. (2005). Impact of the use of biofertilizers on cotton (Gossypium hirsutum) crop under irrigated agro-ecosystem. Archives of Agronomy and Soil Science. https://doi.org/10.1080/03650340400029275

Olsen, S. R., Cole, C. V., Watanabe, F. S., & Dean, L. A. (1954). Estimation of available phosphorus in soils by extraction with sodium bicarbonate. United States Department of Agriculture. https://books.google.com/books/about/Estimation_of_Available_Phosphorus_in_So.html?id=2_0yAQAAIAAJ

Parthasarathi, K., Balamurugan, M., & Ranganathan, L. S. (2008). Influence of vermicompost on the physico-chemical and biological properties in different types of soil along with yield and quality of the pulse crop—blackgram. Iranian Journal of Environmental Health Science and Engineering. https://jehse.tums.ac.ir/index.php/jehse/article/view/103

Piper, C. S. (1950). *Soil and plant analysis*. University of Adelaide.

Rajkhowa, D. J., Gogoi, A. K., Kandali, R., & Rajkhowa, K. M. (2000). Effect of vermicompost on greengram nutrition. *Journal of the Indian Society of Soil Science*, *48*(1), 207-208.

Ramanjineyulu, M., Sainath Rao, M., Basavaraj, T., Akhila, K., & Vaishnavi, S. V. (2024). Response of integrated nutrient management on growth and yield of cluster bean (Cyamopsis tetragonoloba L.) under semi-arid tracts of Andhra Pradesh, India. European Journal of Nutrition & Food Safety https://doi.org/10.9734/ejnfs/2024/v16i91521

Rout, P. P., Chandrasekaran, N., Arulmozhiselvan, K., & Padhan, D. (2017). Effect of long-term fertilization on soil K dynamics and uptake by hybrid maize in an irrigated Inceptisol under intensive cropping. International Journal of Current Microbiology and Applied Sciences. https://doi.org/10.20546/ijcmas.2017.610.127

Subbiah, B. V., & Asija, G. L. (1956). A rapid procedure for the estimation of available nitrogen in soils. Current Science. https://www.currentscience.ac.in/Volumes/25/08/0259.pdf

Walkley, A., & Black, I. A. (1934). An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. Soil Science. https://doi.org/10.1097/00010694-193401000-00003

Yaghoubi Khanghahi, M., Pirdashti, H., Rahimian, H., Nematzadeh, G. A., & Ghajar Sepanlou, M. (2018). Nutrient use efficiency and nutrient uptake promoting of rice by potassium solubilizing bacteria (KSB). Cereal Research Communications. https://doi.org/10.1556/0806.46.2018.042

Zhang, A. M., Zhao, G. Y., Gao, T. G., Wang, W., Li, J., Zhang, S. F., & Zhu, B. C. (2013). Solubilization of insoluble potassium and phosphate by Paenibacillus kribensis CX-7: A soil microorganism with biological control potential. African Journal of Microbiology Research. https://doi.org/10.5897/AJMR12.1485

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