E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; SP-7(8): 537-540
Received: 18-06-2024
Accepted: 25-07-2024

R Sampath Kumar
M.Sc. Scholar, Department of Agronomy, Naini Agricultural institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Vikram Singh
Professor, Department of Agronomy, Naini Agricultural institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Shruti George
Ph.D. Scholar, Department of Agronomy, Naini Agricultural institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Amit Kumar
Ph.D. Scholar, Department of Agronomy, Naini Agricultural institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Corresponding Author:
R Sampath Kumar
M.Sc. Scholar, Department of Agronomy, Naini Agricultural institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Effect of biofertilizers and goat manure on growth and yield of chickpea (*Cicer arietinum* L.)

R Sampath Kumar, Vikram Singh, Shruti George and Amit Kumar

DOI: https://doi.org/10.33545/2618060X.2024.v7.i8Sg.1328

Abstract
A field experiment was conducted during *Rabi* at the Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). Entitled on "Effect of biofertilizers and goat manure on growth and yield of Chickpea (*Cicer arietinum* L.)", experiment was laid out in Randomized Block Design and there were 10 treatments each being replicated thrice. To study treatments consisted of Biofertilizers *viz.* PSB 20 g/kg Seed, Rhizobium 20 g/kg Seed, Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed and Goat manure *viz*. 3 t/ha, 5 t/ha, 7 t/ha. The results revealed that significant and higher in plant height (54.57 cm), No. of Nodules/plant (10.51), plant dry weight (35.35 g), number of pods/plant (34.21), test weight (24.61 g), seed yield (1.94 kg/ha) and stover yield (4.07 kg/ha) were recorded in treatment-9 Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed with Goat manure 7 t/ha compared to other treatments. Maximum in gross returns (1,57,217.00 INR/ha), net returns (107071.80 INR/ha) and B:C ratio (2.21) was also recorded in the same treatment – 9 [Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed with Goat manure 7 t/ha].

Keywords: Goat manure, Bio fertilizers, PSB, Rhizobium, Chickpea, Economics, Growth parameters, Yield parameters

Introduction
Chickpea (*Cicer arietinum* L.*)* is the largest produced food legume in South Asia and the third largest produced food legume globally, after common bean (*Phaseolus vulgaris* L.) and field pea (*Pisum sativum* L.). Chickpea is grown in more than 50 countries (89.7% area in Asia, 4.3% in Africa, 2.6% in Oceania,2.9% in Americas and 0.4% in Europe). Chickpea (*Cicer arietinum* L.) belongs to the family Fabaceae, within the tribe *Cicerae.* It is a self-pollinated, diploid, annual grain legume crop. The global production of chickpea is nearly 11 million tones and India is the major producer accounting for 64% of the total chickpea production (FAOSTAT, 2012) [2]. It is a major source of high-quality protein in human diet and also provides high quality crop residues for animal feed. India ranked first in area and production in the world. Chickpea also plays an important role in sustaining soil productivity by improving its physical, chemical and biological properties and trapping atmospheric nitrogen in their root nodules. Because of its nutritional benefits chickpea cultivation is gaining importance not only in India, but also all over the world. Nutritive value of chickpea is Protein (18-22%), Carbohydrate (61-62%), Fat (4.5%), Calcium (280 mg/100 g) Iron (12.3 mg/100 g) and Phosphorus (301 mg/100 g).
Goat manure which is rich in nutrients like nitrogen (N), phosphorus (P) and potassium (K) rather than obtaining from farm yard manure. The goat manure is expected to add nutrients to soil and it also makes a change in the physical properties of the soil. Goat manure is a good organic fertilizer for soils, because it provides high nutrient contents for plants, and is a low cost alternative. The effect of Goat manure on improving soil fertility and increasing crop yields has long been known. Goat manure does not possess an exceptionally high nutritional content, but this sort of fertilizer could enhance the soil's physical features such as its transparency, properties, composition, and water retention power well as soil cations. The nutrient content of goat manure contains relatively higher potassium than other Manure. In addition, goat manure has a high level of N elements. It was stated that goat manure has a nitrogen content of 0.7% and a carbon to nitrogen ratio of 20-25 (Jakoni *et al.* 2022) [5].

Chickpea, like most legumes, establishes a symbiotic association with a compatible strain of Rhizobium. The Rhizobium-legume symbiosis is a well-organized system involving many steps; signal exchange and recognition of the symbiotic partners; attachment of the Rhizobia to the plant root hairs; root hair deformation; invasion of the root hair by Rhizobia; infection thread formation; nodule initiation; bacteriod development; and formation and fixing of nodules. Rhizobium is one of the classical Nitrogen fixing bacteria which fix atmospheric nitrogen by the symbiotic association with leguminous plants. It has been estimated that 20-35% of the nitrogen fixed by the biological agencies comes through fixation by legume Rhizobium symbiosis (Katiyar *et al*. 2020) [7].

One such way is development and use of phosphorus solubilizing biofertilizers. Phosphorus solubilizing biofertilizers contain microorganisms having the ability to solubilize insoluble phosphates and make it available to plants. By this, we can supply low grade insoluble rock phosphate in combination with phosphorus solubilizing microorganisms which is an alternative cost effective way against costly phosphatic fertilizers like single super phosphate. (Dakshayini *et al.* 2016) [1].

Materials and Methods

A field experiment was conducted during *Rabi*-2023-24 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of the experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), organic carbon (0.75%), available N (267.96 kg/ha), available P (33.10 kg/ha) and available K (331kg/ha). The treatments consisting of Bio-Fertilizers *viz*. PSB 20 g/kg Seed, Rhizobium 20 g/kg seed, Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed and Goat Manure *viz*, 3 t/ha, 5 t/ha, 7 t/ha. The experiment was laid out in Randomized Block Design with ten treatments each replicated thrice. The treatment combinations treatment 1 - PSB 20 g/kg Seed + Goat manure 3 t/ha, treatment 2 - Rhizobium 20 g/kg seed + Goat manure 3 t/ha, treatment 3 Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed + Goat manure 3 t/ha, treatment 4 - PSB 20 g/kg Seed + Goat manure 5 t/ha, treatment 5 - Rhizobium 20 g/kg seed + Goat manure 5 t/ha, treatment 6 Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed + Goat manure 5 t/ha, treatment 7 - PSB 20 g/kg Seed + Goat manure 7 t/ha, treatment 8 - Rhizobium 20 g/kg seed + Goat manure 7 t/ha, treatment 9 Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed + Goat manure 7 t/ha, treatment 10 - Control (FYM 10 t/ha). The growth parameters and yield, production was recorded at harvest from randomly selected plants in each plot. The data was computed and analysed by following statistical method of Gomez and Gomez (1984) [3].

Results and Discussion

Growth parameters: Plant height (cm) the data revealed that, significantly higher plant height (54.57 cm) was recorded with treatment Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed + Goat manure 7 t/ha and was found to be significant. However, the treatments PSB 20 g/kg Seed + Goat manure 7 t/ha and Rhizobium 20 g/kg seed + Goat manure 7 t/ha were found to be statistically at par with Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed + Goat manure 7 t/ha. Rhizobium + PSB seems to be on account of their impact on nutritional environment and involvement in various physiological processes in the plant system which are considered to be pre-requisits for growth of the crop reported by Tripathi *et al.* (2021) [13]. Significantly higher plant height was observed with the application of Goat manure (7 t/ha) is thought to be because goat manure has N nutrients that can be sufficient for the vegetative growth of plants. Goat manure has a higher nitrogen content than other fertilizers and has been shown to promote increased vegetative development in plants. This is also due to the application of Manure, which functions to keep water available in the soil. similar results were reported by Jakoni *et al*. (2022) [5].

Plant dry weight (g) the data observed that, significantly the maximum dry matter accumulation (35.35 g) was recorded in treatment with Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed + Goat manure 7 t/ha and was observed to be significant. However, the treatments Rhizobium 20 g/kg seed + Goat manure 7 t/ha and PSB 20 g/kg Seed + Goat manure 7 t/ha were found to be statistically at par with Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed + Goat manure 7 t/ha. Coinoculation of *Rhizobium* and PSB recorded significantly higher plant dry weight and its fresh as well as dry weight than *Rhizobium* and PSB alone. The increase in dry weight might be due to synergistic effect of the two types of microorganisms for biological nitrogen fixation as against their individual application. It is also due to the fact that phosphate solubilizing bacteria by virtue of their property of producing organic acids solubilize insoluble or fixed form of phosphorus in the rhizosphere and make it available to the growing plants, which promotes root development in plants. Significant response of dual inoculation with *Rhizobium* and PSB was observed with respect to shoot dry weight per plant reported by Tagore *et al.* (2013) [12]. Significantly higher plant dry weight was observed with the application of Goat manure (7 t/ha) might be due to the K element contained in goat manure can meet the nutrient needs of plant dry weight, compared to other manure, goat manure contains higher K nutrients, while N and P nutrients are almost the same as other manures. Potassium (K) serves to stimulate the development of hearts and flowers which increase in plant dry weight. similar results were reported by Jakoni *et al*. (2022) [5].

Number of nodules/plant the data revealed that, significantly maximum number of nodules/plant (54.57 cm) was recorded with treatment Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed + Goat manure 7 t/ha and was found to be significant. However, the treatments PSB 20 g/kg Seed + Goat manure 7 t/ha and Rhizobium 20 g/kg seed + Goat manure 7 t/ha were found to be statistically at par with Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed + Goat manure 7 t/ha. Significantly increase in number of nodules/plant was found due to combination of PSB and Rhizobium inoculation, better nodulation in combined inoculation might be due to increased P availability through PSB and enhanced biological N2 fixation. Synergism in Rhizobium and PSB might have also resulted in better nodulation with their dual inoculation as against single inoculation reported by Tagore *et al.* (2013) [12]. Significantly maximum number of nodules/plant was observed with the application of Goat manure (7 t/ha) might be due to goat manure has N, Nitrogen is a critical element in the development of plants and is beneficial to the vegetative growth of plants. Vegetative growth can be defined as an increase in the number of nodules/plant. Nitrogen is an essential nutrient for plant growth. Nitrogen nutrients are beneficial for the vegetative growth of plants, and vegetative growth can be in the form of an increase in the number of nodules/plant. similar results were reported by Jakoni *et al*. (2022) [5].

Yield & Yield attributes

Number of Pods/plant the data observed that, Significantly higher number of number of pods/plant was observed with the Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed + Goat manure 7 t/ha, (34.21). However, the treatments Rhizobium 20 g/kg seed + Goat manure 7 t/ha and PSB 20 g/kg Seed + Goat manure 7 t/ha, were found to be statistically at par with Rhizobium 20 g/kg Seed

+ PSB 20 g/kg Seed + Goat manure 7 t/ha. Might be due to the efficient development of a symbiotic relationship results in higher nitrogen fixation and protein accumulation. In addition, studies have shown that rhizobium and PSB inoculation significantly increased the mean pods/plant and seed/pod protein content compared to uninoculated plants reported by Kandil *et al.* (2023) [6]. It is believed that this is because the nutrients found in goat manure, in particular N, can fulfill the necessary nutrients for the growth of plant branches. increasing the amount of goat manure added to the soil will lead to an increase in the number of pods/ plants reported by Puspasari *et al*. (2018) [9] and Jakoni *et al*. (2022) [5].

Seed Index (g) the data revealed that, the treatment Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed + Goat manure 7 t/ha, (24.61 g) recorded significantly highest seed index. However, the treatments Rhizobium 20 g/kg seed + Goat manure 7 t/ha and PSB 20 g/kg Seed + Goat manure 7 t/ha, were found to be statistically at par with Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed + Goat manure 7 t/ha. It might be due to the prospect further revealed that the inoculation of Rhizobium and PSB increase the test weight significantly improved the test weight of grain as comparison to rest of the treatment. Increased in morphological parameters which were responsible for the photosynthetic capacity of the plant. There by increased test weight of chickpea. similar results were reported by Singh *et al.* (2023) [8]. Goat manure can boost the number of microorganisms in the soil, which is necessary for developing soybean seeds. This is in addition to providing nutrients for plants. Manure will gradually be decomposed, and the nutrients from the decomposition process will slowly also be available to plants. The weight of 100 seeds belongs to properties that have a low variety and a high heritability value similar results were reported by Jakoni *et al*. (2022) [5]. Seed yield (t/ha) the data revealed that, significantly higher seed yield was observed with the Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed + Goat manure 7 t/ha (1.94 t/ha). However, the treatments Rhizobium 20 g/kg seed + Goat manure 7 t/ha and PSB 20 g/kg Seed + Goat manure 7 t/ha, were found to be statistically at par with Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed + Goat manure 7 t/ha. Significantly higher seed yield owing to combined effect of PSB and Rhizobium might be due to better growth and yield attributes. The favorable effect of bacterial inoculation could be attributed to the increased supply of the nutrients in inoculation plants resulting into more uptake of nutrients, thereby enhanced the grain and straw yield reported by Singh *et al*. (2023) [8]. In the process of tissue differentiation from somatic to reproductive, meristmatic activity and development of floral primordial might have increased with Rhizobium inoculation methods resulting in more flowers and pods and ultimately the higher grain yield reported by Tripathi *et al*. (2021) [13].

Stover yield (t/ha) the data revealed that, significantly higher stover yield was observed with the Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed + Goat manure 7 t/ha., (4.07 t/ha). However, the treatments Rhizobium 20 g/kg seed + Goat manure 7 t/ha and PSB 20 g/kg Seed + Goat manure 7 t/ha, were found to be statistically at par with Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed + Goat manure 7 t/ha. PSB produces growth substances like IAA & GA and also helps for formation of growth hormones which promotes seed maturation. This could be reason for increased grain and straw yield of chickpea reported by Singh *et al*. (2023) [8]. The increase in straw yield with increasing rates of GM up to 20t/ha, was as a result of significant increases in almost all yield contributing characters especially number of ears/plant, number of grains/ear and weight of grains/ear. The increase in grain yield could also be due to the significant increases in number of leaves/plant and LAI which enhanced greater photosynthetic activity and translocation of assimilates. Therefore, the improved nutrient availability as a result of GM application, must have led to the significant enhancement of growth and yield. Similar results were reported by Uwah and Eyo *et al.* (2014) [14].

Economics Analysis

Gross return, Net return and benefit cost ratio of different treatments are depicted in (Table 3).

Gross return (INR/ha) Maximum gross return (INR 1,57,217.00/ha) was recorded in treatment-9 Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed + Goat manure 7 t/ha, Net returns (INR/ha) Maximum net return (INR 107071.80/ha) was found in treatment-9 Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed + Goat manure 7 t/ha, Benefit cost ratio (B:C) Benefit cost ratio (2.14) was found to be highest in the treatment-9 Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed + Goat manure 7 t/ha.

Table 1: Influence of biofertilizers and goat manure on growth attributes of Chickpea

S. No.	Treatment combinations	AT 100 DAS			During 80 - 100 DAS	
		Plant Height(cm)	Dry Weight (g/plant)	Number of Nodules/ plant	Crop growth rate (g/m2/day)	Relative growth rate (g/g/day)
1.	PSB 20 g/kg Seed + Goat manure 3 t/ha	44.49	28.69	6.60	11.83	0.077
2.	Rhizobium 20 g/kg seed + Goat manure 3 t/ha	46.77	29.22	7.53	12.29	0.087
3.	Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed + Goat manure 3 t/ha	47.70	29.33	7.60	12.10	0.077
4.	PSB 20 g/kg Seed + Goat manure 5 t/ha	49.23	31.29	7.93	12.62	0.083
5.	Rhizobium 20 g/kg seed + Goat manure 5 t/ha	50.36	32.13	8.00	13.15	0.086
6.	Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed + Goat manure 5 t/ha	51.84	32.78	8.40	12.36	0.082
7.	PSB 20 g/kg Seed + Goat manure 7 t/ha	51.91	33.63	9.27	12.59	0.092
8.	Rhizobium 20 g/kg seed + Goat manure 7 t/ha	53.18	34.28	9.73	12.64	0.083
9.	Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed + Goat manure 7 t/ha	54.57	35.35	10.51	12.23	0.084
10.	Control (Blanket application of farm yard manure 10 t/ha)	42.60	27.01	5.93	11.48	0.080
	F- test	S	S	S	NS	NS
	SEm(±)	1.08	1.13	0.52	1.14	0.001
	CD (p=0.05)	3.23	3.38	1.57	--	----

Table 2: Influence of biofertilizers and goat manure yield attributes of Chickpea

S. No.	Treatments	Number of Pods / plant	Number of Seeds/pod	Seed Index (g)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)
1.	PSB 20 g/kg Seed + Goat manure 3 t/ha	27.13	1.07	20.64	1.40	2.90	32.67
2.	Rhizobium 20 g/kg seed + Goat manure 3 t/ha	28.43	1.20	20.28	1.45	3.03	32.36
3.	Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed + Goat manure 3 t/ha	30.05	1.13	21.03	1.50	3.11	32.62
4.	PSB 20 g/kg Seed + Goat manure 5 t/ha	29.85	1.03	20.05	1.52	3.21	32.22
5.	Rhizobium 20 g/kg seed + Goat manure 5 t/ha	31.07	1.13	22.22	1.56	3.35	31.71
6.	Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed + Goat manure 5 t/ha	31.42	1.27	22.76	1.61	3.50	31.49
7.	PSB 20 g/kg Seed + Goat manure 7 t/ha	33.14	1.07	22.71	1.74	3.57	32.25
8.	Rhizobium 20 g/kg seed + Goat manure 7 t/ha	32.85	1.17	23.46	1.76	3.71	32.01
9.	Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed + Goat manure 7 t/ha	34.21	1.23	24.61	1.94	4.07	32.43
10.	Control (Blanket application of farm yard manure 10 t/ha)	25.54	1.00	19.63	1.06	2.72	32.20
	F – Test	S	NS	S	S	S	NS
	SE m (±)	1.40	0.14	0.92	0.07	0.13	0.84
	CD (p=0.05)	4.16	--	2.70	0.29	0.54	--

Table 3: Influence of biofertilizers and goat manure on Economics of chickpea

Treatments	Total cost of cultivation	Gross Return	Net Return	B:C ratio
PSB 20 g/kg Seed + Goat manure 3 t/ha	39,565.00	1,04,508.00	64943.06	1.64
Rhizobium 20 g/kg seed + Goat manure 3 t/ha	38,395.00	1,08,305.00	69909.50	1.82
Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed + Goat manure 3 t/ha	42145.00	1,11,885.00	69739.96	1.65
PSB 20 g/kg Seed + Goat manure 5 t/ha	43,565.00	1,13,908.90	70343.90	1.61
Rhizobium 20 g/kg seed + Goat manure 5 t/ha	42,395.00	1,16,989.55	74594.55	1.76
Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed + Goat manure 5 t/ha	46145.00	1,20,883.00	74737.90	1.62
PSB 20 g/kg Seed + Goat manure 7 t/ha	47,565.00	1,29,189.00	81623.76	1.72
Rhizobium 20 g/kg seed + Goat manure 7 t/ha	46,395.00	1,31,726.83	85331.83	1.84
Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed + Goat manure 7 t/ha	50,145.00	1,57,217.00	107071.80	2.14
Control (Blanket application of farm yard manure 10 t/ha)	29,815.00	70,420.00	40605.00	1.36

Conclusion

It is concluded that is chickpea with the combination of Rhizobium 20 g/kg Seed + PSB 20 g/kg Seed + Goat manure 7 t/ha in treatment-9 was observed higher growth, Yield and Benefit cost ratio.

Acknowledgement

I express my gratitude to my advisor Dr. Vikram Singh and all the faculty members of the Department of Agronomy, Naini Agricultural Institute, Prayagraj, Sam Higginbottom University of Agriculture Technology and sciences, (U.P) India for providing necessary facilities to undertaken the studies.

References

1. Dakshayini, Balakrishna Reddy, Kammar S. Evaluation of the efficient phosphate solubilizing bacteria on growth of chickpea under greenhouse condition. Adv Life Sci. 2016;5(2):662-666.
2. FAOSTAT. Food and Agriculture Organization of the United Nations statistical database; c2022.
3. Gomez KA, Gomez AA. Statistical procedure for agricultural research. New York: Wiley International Sciences Pub.; c1984.
4. Palla H, Dawson J. Effect of phosphorus, potassium and bio-fertilizer on growth and yield of chickpea (*Cicer arietinum* L.). The Pharma Innov. J. 2023;11(5):1429-1432.
5. Jakonia MWG, Septirosya T. Growth and yield of soybean (*Glycine max* L.) with fertilization of goat cage and bio-growth. Portal J Unimor. 2022;7(4):69-72.
6. Kandil AE, Özdamar Ünlü H. Effect of rhizobium inoculation on yield and some quality properties of fresh cowpea. Cogent Food Agric. 2023;9:2275410.
7. Katiyar D, Kumar S, Singh N. Effect of Rhizobium and PSB inoculation on growth, yield attributes, and yield of chickpea (*Cicer arietinum* L.). Int J Chem Stud. 2020;8(4):3729-3734.
8. Lalrinzuali, Singh R, Pradhan A. Effect of phosphorus and biofertilizers on growth and yield of chickpea (*Cicer arietinum* L.). Int. J Plant Soil Sci. 2023;35(17):273-279.
9. Puspasari R, Karywati AS, Sitompul SM. Establishment of pods and yield of soybean (*Glycine Max* L.). J Prod Tanaman. 2018;6:1096-1102.
10. Richards LA. Diagnosis and improvements of saline and alkaline soils. Agric Handbook No.60. USDA, Washington; c1954.
11. Singh A, Umesha C, Kiran VU. Effect of spacing and biofertilizers on growth and yield of chickpea. Int J Environ Clim Change. 2023;13(10):809-815.
12. Tagore GS, Namdeo SL, Sharma SK, Kumar N. Effect of Rhizobium and phosphate solubilizing bacterial inoculants on symbiotic traits, nodule leghemoglobin, and yield of chickpea genotypes. Int J Agron. 2013;2013:581627.
13. Tripathi S, Kumar S, Kumar M, Kumar A, Dhyani BP, Kumar Y, et al. Effect of Rhizobium inoculation methods on growth, nodulation and yield of black gram (*Vigna mungo* L.). Int. J Curr. Microbiol. Appl. Sci. 2021;10(1):1588-1598.
14. Uwah DF, Eyo VE. Effects of number and rate of goat manure application on soil properties, growth and yield of sweet maize (*Zea mays* L. saccharata Strut). Sustain Agric Res., 2014, 3(4). 1927-050X E-ISSN 1927-0518.
15. Yadav S, Kumar S, Kumar A, Singh N, Srivastava A. Studies on effect of different biofertilizer on yield and economics of chickpea. The Pharma Innov. J. 2021;10(4):541-545.