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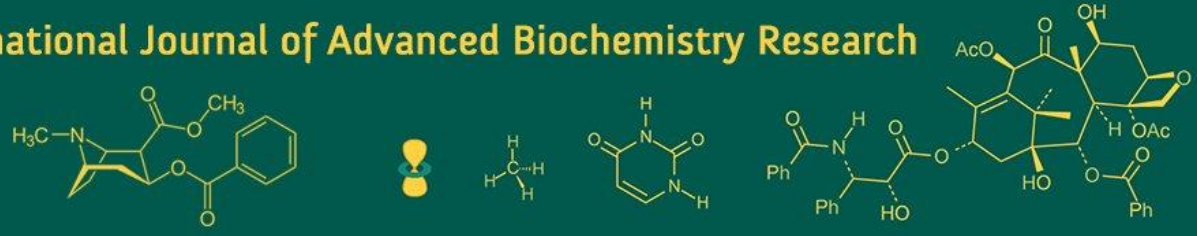

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Effect of farmyard manure and phosphorus levels on growth and yield of chickpea (*Cicer arietinum* L.)

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Abstract
During the *Rabi* season of 2024, the Crop Research Farm at the Naini Agriculture Institute, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology, and Sciences, Prayagraj, conducted a field experiment titled "Effect of Farmyard Manure and Phosphorus levels on growth and yield of Chickpea (Cicer arietinum L.)" The experimental field's soil had a sandy loam texture, a pH of 7.3, a low organic carbon content of 0.60 percent, and accessible nitrogen (178.48 kg/ha), phosphorus (41.3 kg/ha), and potassium (244.6 kg/ha). Randomized Block Design (RBD) was used to set up the experiment, and ten treatments—including control—were reproduced three times each. The treatment combinations are T_1- FYM 5t/ha + Phosphorus 20 kg/ha, T_2 - FYM 5t/ha + Phosphorus 40 kg/ha, T_3 - FYM 5t/ha + Phosphorus 60 kg/ha, T_4 - FYM 10t/ha + Phosphorus 20 kg/ha, T_5 - FYM 10t/ha + Phosphorus 40 kg/ha, T_6 - FYM 10t/ha + Phosphorus 60 kg/ha, T_7 - FYM 15t/ha + Phosphorus 20 kg/ha, T_8 - 15t/ha + Phosphorus 40 kg/ha, T_9 - 15t/ha + Phosphorus 60 kg/ha, T_{10} - Control 20:40:20 kg NPK/ha. The results indicated that T_8 with application of FYM 15 t/ha along with Phosphorus 40 kg/ha had significantly higher growth parameters, including plant height (46.2 cm), plant dry weight (45.75 g/plant), number of nodules per plant (9.3), and significantly maximum number of pods per plant (35.87), number of seeds per pod (2.5), test weight (35.68 g), seed yield (2.50 t/ha), and straw yield (4.32 t/ha). Grain production, stover yield, gross return, net return, and benefit cost ratio are all highest for chickpeas.

Keywords: Chickpea, farm yard manure, phosphorus, growth, yield, economics

Introduction
Chickpea (*Cicer arietinum* L.) is an annual legume belongs to genus Cicer, tribe *Cicereae* Family *Fabaceae*, sub family *Papilionaceae* (Anonymous). It is a crop farmed for food all over the world during the Rabi season. Chickpeas are a great source of calcium, iron, niacin, and vitamins B and C. Because of their high protein content, pulses are a significant group of food crops that hold a widespread use position in the agricultural industry. Energy (334-437 kcal in Desi and 357-446 kcal in Kabuli), fat (2.9-7.4% in Desi and 3.4-8.8% in Kabuli), carbohydrates (51-65%), protein (16.7-30.6%), and 3% ash are all found in 100 grams of dried chickpea kernels on average. Since pulses contribute far more to the Indian diet in terms of nutrient delivery than they do in Asia and the rest of the world, they are comparatively more important in our nation. Most people eat chickpeas as dal or as dal flour (besan), or as processed whole seeds (boiled, roasted, parched, fried, steamed, sprouted, etc.). A wide range of appetizers, desserts, and condiments are made using it. When preparing chapatis, it is used with wheat flour. As a green vegetable, fresh green seeds are eaten. Green leaves are a type of vegetable. Another usage for grain is as a vegetable (chhole). Animals are fed nutritious feed made from husk and a small amount of dal. Additionally, chickpeas can be utilized as green animal feed.

India produced 13.75 million tons of chickpeas in 2021-2022 (the fourth estimate), with a productivity of 12.6 q./ha on an acreage of 10.91 million ha (DES 2023, MOAF&W, GoI). Only chickpeas account for about half of India's pulse production. Major Indian states that produced chickpeas included Uttar Pradesh (5.64%), Maharashtra (25.97% of total production), Madhya Pradesh (18.59%), Rajasthan (20.65%), and Gujarat (10.10%). In the Indian market, chickpea consumption is varied.

The decomposition of farm animals, such as a mixture of dung and urine, litter, and leftover roughage or fodder material supplied to the cattle, is referred to as "farm yard manure." The

decomposed farmyard manure contains 0.5% MgO5, 0.2% P2O5, and 0.5% N. The crop's N-use productivity has increased as a result of FYM, as has the soil's organic carbon, accessible N, P, and trace element levels. Additionally, FYM improves the soil's physical condition (Laxmansinh *et al*., 2016) [14]. One of the main sources of organic manure for field crops is FYM. The nutrient need can be lowered to medium to high levels of available nutrient status because FYM converts inaccessible soil nutrients into useable form (Lakum *et al*., 2011) [13].

Growth that is slow, feeble, and stunted is the first general indication of phosphorus deficiency, which occurs during the early phases of cell division. Because phosphorus is comparatively mobile in plants, it can be transported to areas where new development is occurring. As a result, older leaves of certain plants may exhibit signs of dark to blue-green hue. Purpling of leaves and stems may occur in cases of severe shortage. A lack of phosphorus results in poor seed and fruit development, delayed maturity, and restricted plant growth, all of which lower output (Singh *et al*., 2020) [20]. The most important nutrient for pulse crops is phosphorus. The amount of accessible phosphorus in Indian soils ranges from low to medium. Just over 30% of the phosphorus that is applied is used by crops; the remainder is transformed into insoluble phosphorus. Continuous replacement of soluble P from inorganic and organic sources is required to meet the crop's phosphorous needs since the concentration of accessible P in the soil solution is typically insufficient to maintain plant growth. Phosphorus is supplied in excess of the permitted dosage, which increases nitrogen fixation and ultimately boosts chickpea yield.

Materials and Methods

The field experiment was carried out at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (U.P.) during the *Rabi* season of 2024. to investigate how phosphorus levels and farmyard manure affect Chickpea (*Cicer arietinum* L.) growth and yield. Sandy loam soil with a pH of 6.8, organic carbon (0.562%), neutral soil response (pH 6.8), available N (220.00 kg/ha), available P (28.2 kg/ha), and available K (240.7 kg/ha) made up the experimental plot. With ten treatments and three replications, the experiment was set up using a Randomized Block Design. The treatment combinations are., T_1FYM 5t/ha + Phosphorus 20 kg/ha, T_2 - FYM 5t/ha + Phosphorus 40 kg/ha, T_3 - FYM 5t/ha + Phosphorus 60 kg/ha, T_4 - FYM 10t/ha + Phosphorus 20 kg/ha, T_5 - FYM 10t/ha + Phosphorus 40 kg/ha, T_6 - FYM 10t/ha + Phosphorus 60 kg/ha, T_7 - FYM 15t/ha + Phosphorus 20 kg/ha, T_8 - 15t/ha + Phosphorus 40 kg/ha, T_9 - 15t/ha + Phosphorus 60 kg/ha, T_{10} - Control 20:40:20 kg NPK/ha. Chickpeas were planted 30 cm apart by 10 cm on November 14, 2023. A manual hoe was used to dig furrows along the seed rows that were 4-5 cm deep in order to apply organic manure as a spreading strategy. After germination, the gaps were closed by transplanting ten days after sowing. When needed, seedlings were removed to keep the distance between plants at 30 cm by 10 cm. Every 25 to 45 days, intercultural activities were conducted to lessen crop density and weed competition. The date of crop harvesting was April 12, 2024. Plant growth characteristics include height (cm), number of branches/plant, number of nodules/plant, dry weight (g), crop growth rate (g/m2/day), and relative growth rate (g/g/day) yield attributes and yield Number of pods/plant, Number of seeds/pod, Test weight (g), Seed yield (t/ha), Stover yield (t/ha), Harvest index (%)] were subjected to statistical analyzed by analysis of variance method as reported by Gomez and Gomez (1976) and Mohan *et al.*, (2024) [17]. Additionally, economics were computed. Benefit-cost ratio, net returns (INR/ha), gross returns (INR/ha), and cultivation cost (INR/ha). Prayagraj experiences both winter and Kharif temperatures, resulting in a semiarid and subtropical climate. It will be scorching, starting in February, and will cool off by the end of October. The Agro-meteorological Observatory of the Naini Agricultural Institute, SHUATS, records meteorological data, such as the weekly average of the highest and lowest temperatures, relative humidity, and rainfall.

Results and Discussion Growth Attributes

1. Plant height (cm)

At 120 DAS there was significant difference among the treatments. However, Treatment 8 [FYM 15t/ha + Phosphorus 40 kg/ha] had the highest plant height (46.2 cm), while Control (20-40-20) had the lowest (36.6 cm). In contrast, Treatment 9 [FYM 15t/ha + Phosphorus 60 kg/ha] (45.1 cm) was statistically comparable to T_8, and plant height, root plant-1 length and weight, and nodule plant-1 number and weight increased significantly with each increase in the rate of phosphorus application up to 40 kg P2O5 ha-1; after that, no discernible benefit was observed (Sahu *et al*. 2002) [18]. FYM while organic matter is breaking down. This sped up the formation of new tissues and shoots, which ultimately caused the plant to grow taller (Kumar and Gautam 2004) [11].

2. Plant Dry weight (g)

At 120 DAS there was significant difference among the treatments. Treatment 8 [FYM 15t/ha + Phosphorus 40 kg/ha] had the highest plant dry weight (45.75 g), whereas Control (20-40-20) had the lowest (41.73 g). In contrast, Treatment 9 [FYM 15t/ha + Phosphorus 60 kg/ha] had a statistically comparable plant dry weight (45.02 g) to T_8. Because it has been shown to promote growth, start nodule formation, and affect the effectiveness of rhizobium-legume symbiosis, phosphorus is essential for cowpea output. Large amounts of phosphorus are necessary for the growth and development of all growing plants [Haruna *et al*., 2013] [7]. The increase in easily available nutrients released from the organic sources may be the cause of the dry matter yield increase observed with increasing amounts of applied organic manures.

Number of nodules per plant

At 120 DAS there was no significant difference among the treatments. However, Treatment 8 [FYM 15t/ha + Phosphorus 40 kg/ha] had the most nodules per plant (9.3), while Control (20-40-20) had the fewest (4.4). According to some recent research, phosphorus needs for nodulation and maximal nodule activities are significantly higher than those for poor host plant development (Vishwa Karma *et al*., 2012) [21]. Rhizobium bacteria must be intercepted by root hair when phosphorus is applied sufficiently for infection to occur. Because of well-developed roots and a higher density of nodule bacteria, nodulation increased as a result of high bacterial interception. These findings are consistent with those of [Rudresh 2005], who found that the plot treated with FYM @ 15t/ha had the highest number of nodules per plant, whereas the control plots had the lowest number of nodules.

Yield Attributes

Number of pods per plant

The treatments differed significantly from one another. However, Treatment 8 [FYM 15t/ha + Phosphorus 40 kg/ha] had the most pods per plant (35.87), whereas Control (20-40-20) had the fewest (26.00). In contrast, Treatment 9 [FYM 15t/ha + Phosphorus 60 kg/ha] had a statistically comparable amount of pods per plant (34.80). Elevated phosphate caused the leaves to expand further, which in turn produced more carbohydrates in the productive areas and more pods (Elbeik *et al*., 2013).

Number of seeds per pod

The treatments differed significantly from one another. However, Treatment 8 [FYM 15t/ha + Phosphorus 40 kg/ha] had the most seeds per pod (2.5), whereas Control (20:40:20) had the fewest (1.4). In contrast, Treatment 9 [FYM 15t/ha + Phosphorus 60 kg/ha] (2.3) was statistically comparable to T_8. In contrast to Magani and Kuchinda [2009], who came to the conclusion that a larger amount of phosphorus results in a higher yield of cowpeas, the level of phosphorus had no discernible effect on the cowpea yield.

Test weight (g)

Maximum test weight (35.68 g) was recorded with the treatment in Treatment 8[FYM 15t/ha + Phosphorus 40 kg/ha], and minimum was reported in Control (20-40-20) (30.56 g), Whereas Treatment 9 [FYM 15t/ha + Phosphorus 60 kg/ha] (35.10 g) was statistically at par with T_8. This could be related to an increase in seed output that decreases when phosphorus levels rise. Jat *et al*. (2013) [9] and Serawat *et al*., have also reported an increase in net returns and B:C ratios as a result of increased phosphorus treatment.

Seed yield (t/ha)

Importantly Treatment 8 [FYM 15t/ha + Phosphorus 40 kg/ha] produced the highest seed yield (2.50 t/ha), while Control (20:40:20) produced the lowest (1.44 t/ha). Treatment 9 [FYM 15t/ha + Phosphorus 60 kg/ha] produced 2.48 t/ha, which was statistically equivalent to T_8. Grain and straw yields significantly increased as a result of the rise in nearly all growth and yield contributing characteristics brought about by biofertilizers. The current study's findings closely align with those of Sarna *et al*. (2008). A larger photosynthetic site and a redirection of photosynthates towards sinks (ear and grain) were the results of increased FYM growth.

Straw yield (t/ha)

The maximum stover yield (4.32 t/ha) was obtained from Treatment 9 [FYM 15 t/ha + Phosphorus 60 kg/ha], whereas the lowest was obtained from Control (20-40-20) (4.04 t/ha). The therapies did not differ in any noticeable way. Islam *et al*. (2011) [8] showed that seed yield varied with phosphorus levels and that P treatment greatly boosted seed production. In this study, there was no yield difference between 70 kg P ha-1 and the control dose. The increased soil fertility and health brought about by organic manures may lead to long-term yield gains. For optimal plant growth and yield, it was advised to mix organic manures with inorganic fertilizers.

Economics

Cost of cultivation (INR/ha)

Cost of cultivation (61,450 INR/ha) was found to be highest in the treatment 8 [FYM 15t/ha + Phosphorus 40 kg/ha], and minimum cost of cultivation (30,450 INR/ha) was found to be in control (20-40-20) as compared to other treatments.

Gross return (INR/ha)

Gross return (1,50,082.48 INR/ha) was found to be highest in the treatment 8 [FYM 15t/ha + Phosphorus 40 kg/ha], and minimum gross return (86,666.00 INR/ha) was found to be in control (20-40-20 kg/ha NPK) as compared to other treatments.

Net returns (INR/ha)

Net return (1,21,132.48 INR/ha) was found to be highest in the treatment 8 [FYM 15t/ha + Phosphorus 40 kg/ha], and minimum Net return (56,216.00 INR/ha) was found to be in control (20-40-20) as compared to other treatments.

Benefit cost ratio (B:C)

Benefit cost ratio (1.97) was found to be highest in the treatment 8 [FYM 15t/ha + Phosphorus 40 kg/ha], and minimum Benefit cost ratio (1.85) was found to be in control (20-40-20) as compared to other treatments.

Conclusion

It is concluded that application of farmyard manure 15 t/ha along with application of Phosphorus 40kg/ha produced higher yield as well as economic also.

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Table 1: Effect of Farmyard manure and Phosphorus levels on Growth Parameters of chickpea

S. No.	Treatment Combination	Plant Height (cm)	Plant Dry Weight	Number of Nodules per Plant
1	FYM 5 t/ha + Phosphorus 20 kg/ha	38.7	42.31	2.4
2	FYM 5 t/ha + Phosphorus 40 kg/ha	40.5	43.39	2.4
3	FYM 5 t/ha + Phosphorus 60 kg/ha	41.0	43.76	2.7
4	FYM 10 t/ha + Phosphorus 20 kg/ha	41.8	44.07	2.9
5	FYM 10 t/ha + Phosphorus 40 kg/ha	43.1	44.45	2.2
6	FYM 10 t/ha + Phosphorus 60 kg/ha	44.3	44.54	2.1
7	FYM 15 t/ha + Phosphorus 20 kg/ha	42.5	44.32	2.4
8	FYM 15 t/ha + Phosphorus 40 kg/ha	46.2	45.75	2.7
9	FYM 15 t/ha + Phosphorus 60 kg/ha	45.1	45.02	2.6
10	Control (20:40:20)	36.6	41.73	2.6
F - Test		S	S	NS
S.Em (±)		1.66	0.31	0.28
CD (p = 0.05)		4.91	0.92	-

Table 2: Effect of Farmyard manure and Phosphorus levels on Yield and Yield attributes of chickpea

S.no	Treatment combination	At harvest				
		Number of pods per plant	Number of seeds per pod	Test weight (g)	Seed yield (t/ha)	Straw yield (t/ha)
1.	FYM 5t/ha + Phosphorus 20 kg/ha	27.07	1.5	31.59	1.78	4.09
2.	FYM 5t/ha + Phosphorus 40 kg/ha	28.00	1.5	31.85	1.80	4.12
3.	FYM 5t/ha + Phosphorus 60 kg/ha	29.00	1.7	32.67	1.81	4.16
4.	FYM 10t/ha + Phosphorus 20 kg/ha	30.07	1.8	33.57	2.11	4.19
5.	FYM 10t/ha + Phosphorus 40 kg/ha	32.40	2.0	34.20	2.09	4.22
6.	FYM 10t/ha + Phosphorus 60 kg/ha	34.33	2.1	34.63	2.14	4.26
7.	FYM 15t/ha + Phosphorus 20 kg/ha	30.00	1.9	33.87	2.36	4.20
8.	FYM 15t/ha + Phosphorus 40 kg/ha	35.87	2.5	35.68	2.50	4.30
9.	FYM 15t/ha + Phosphorus 60 kg/ha	34.80	2.3	35.10	2.48	4.32
10.	Control (20:40:20)26.00		1.4	30.56	1.44	4.04
F test		S	S	S	S	NS
S. Em (±)		1.13	0.07	0.54	0.10	0.06
CD (p = 0.05)		3.35	0.21	1.62	0.30	-

Table 3: Effect of Farmyard manure and Phosphorus levels on economics of chickpea

Treatments	Total cost cultivation	Gross Return	Net Return	B:C ratio
FYM 5t/ha + Phosphorus 20 kg/ha	40,150	1,06,514.00	77,564.00	1.93
FYM 5t/ha + Phosphorus 40 kg/ha	41,350	1,08,212.00	79,262.00	1.92
FYM 5t/ha + Phosphorus 60 kg/ha	41,350	1,08,504.00	79,554.00	1.92
FYM 10t/ha + Phosphorus 20 kg/ha	50,150	1,26,448.00	97,498.00	1.94
FYM 10t/ha + Phosphorus 40 kg/ha	51,350	1,25,660.00	96,710.00	1.88
FYM 10t/ha + Phosphorus 60 kg/ha	51,350	1,28,696.68	99,746.68	1.94
FYM 15t/ha + Phosphorus 20 kg/ha	60,150	1,41,642.00	1,12,692.00	1.87
FYM 15t/ha + Phosphorus 40 kg/ha	61,450	1,50,082.48	1,21,132.48	1.97
FYM 15t/ha + Phosphorus 60 kg/ha	61,350	1,48,546.00	1,19,596.00	1.95
Control (20-40-20)	30,450	86,666.00	56,216.00	1.85

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