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Effect of bio fertilizers and phosphorus on growth and yield of chickpea

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Abstract
Field experiment was conducted during *Rabi* 2023 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The experiment was laid out in Randomized Block Design with ten treatments which are replicated thrice on the basis of one year experimentation. The treatments consisted of 3 levels of Bio-fertilizers (*Trichoderma viride* 5 gm/kg seeds, *Phosphorus Solubilizing Bacteria* 10ml/kg seed, *Rhizobium* 20gm/kg seeds) and levels of Phosphorus (20, 40, 60 kg/ha) and a control. The application of *Rhizobium* 20 gm/kg seed + Phosphorus 60 kg/ha recorded significantly higher Plant height (68.2 cm), Plant dry weight (36.69 g/plant), number of nodules per plant (31.0). Significantly maximum number of pods per plant (25.8), number of seeds per pod (2.5), It is concluded that seed treatment with *Rhizobium* @ 20gm/kg seed along with application of 60 kg P/ha produced higher growth and yield attributes.

Keywords: Chickpea, phosphorus, PSB, *Rhizobium*, *Trichoderma viride*

Introduction
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 tonnes and India is the major producer accounting for 64% of the total chickpea production (FAOSTAT, 2012) [3]. It is a major source of high quality protein in human diet and also provides high quality crop residues for animal feed.

Chickpea is grown in more than 55 countries across the globe, in India it is grown in an area of 14.56 m.ha and 9.54 m.ha yielding 14.77 m. tonnes and 9.1 m. tonnes with a productivity of 1014 kg haand 951 kg ha, respectively. India ranks first in terms of chickpea production and consumption in the world.

During 2021-22 (fourth estimate), chickpea production of India was 13.75 million tonnes from an acreage of 10.91 million ha, with a productivity of 12.6 q./ha (DES 2023, MOAF&W, GoI). Chickpea solely contributes nearly 50% of the Indian pulse production. States like Uttar Pradesh (5.64%), Maharashtra (25.97% contribution to national production), Madhya Pradesh (18.59%), Rajasthan (20.65%), and Gujarat (10.10%) were major chickpea producing states of India. Chickpea has a diverse consumption pattern in the Indian market.

Phosphorus uptake and transport is mediated by the presence of high- and low affinity transport systems that vary in their Michaelis-Menten constant (Km) values and operate at low and high P concentrations, respectively. Some specific growth factors that have been associated with P are: stimulated root development, increased stalk and stem strength, improved flower formation and seed production, more uniform and earlier crop maturity, increased nitrogen N-fixing capacity of legumes, improvements in crop quality, and increased resistance to plant diseases (Griffith, 2010). Phosphorus transformations and mobility in the soil-plant system are controlled by a combination of biological, chemical and physical processes. In natural ecosystems plant growth is often limited by P availability, while P is generally recycled and retained efficiently (Frossard *et. al*., 2000) [4].

Biofertilizers are carrier based preparations containing beneficial microorganisms in a viable state intended for seed or soil application to improve soil fertility and plant growth by increasing

the number and biological activity of beneficial microorganisms in the rhizosphere. They improve soil fertility level by fixing atmospheric nitrogen, solubilizing insoluble soil phosphates and releasing plant growth substances in the soil (Venkatashwarlu, 2008) [10]. Biofertilizers are cost effective, ecofriendly, and renewable sources of plant nutrition. These are also known as microbial inoculants. There are different types of microbial inoculants. Some important inoculants are Rhizobium inoculants, Trichoderma, blue green algae inoculants, azolla, phosphate solubilizing bacterial (PSB) inoculants etc. Rhizobium inoculants are widely used as biofertilizer to enhance Chickpea growth & yield as they fix atmospheric nitrogen symbiotically. Rhizobium inoculation increased nodulation and seed yields upto 35% (Bhuiyan *et al*., 1998; Gupta and Namdeo 1996) [2, 6] found that seed inoculation with Rhizobium increased chickpea seed yields by 9.6-27.9%.

Materials and Methods

The experiments on the effect of bio fertilizers and phosphorus with recommended dose of fertilizers (RDF) on the growth and yield enhancement of chickpea were conducted at *Rabi* season of 2023 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj which is located at 250 24 42 N latitude, 810 50 56 E longitude and 98 m altitude above the mean sea level. This area is situatedon the right side of the river Yamuna by the side of Prayagraj Rewa Road about 5 km away from Prayagraj city. A composite soil sample was collected at a depth of 0-30 cm. It was air dried, crushed, and tested for physical and chemical properties. The soil was sandy clay loam in texture with soil reaction of (pH 7.1), 0.58 organic matter (0.62%), available nitrogen (152.41kg/ha), phosphorus (33.7 kg/ha), potassium (217.3 kg/ha), sulphur (12.34 mg/kg), Zn (0.83 mg/kg), Mg (4.57 mg/kg), Cu (0.44 mg/kg) and available B (0.22 mg/kg). Chickpea variety Pusa 362 was selected for sowing. Seeds were sown in line manually on 2023. Seeds were covered with the soil immediately after sowing. The spacing adopted was plant to plant 10 cm and row to row 30 cm according to the treatment details and the seeds were drilled at 3-4 cm depth.

Seed treatment

Trichoderma viride: Mix 6–10 grams of Trichoderma powder per kilogram of seed before sowing. You can also mix 8–10 grams of a 1.5% Trichoderma viride formulation in 50 milliliters of water and apply it uniformly to 1 kilogram of seed. After applying the formulation, shade dry the seeds for 20–30 minutes before sowing. It's recommended to use a freshly prepared formulation, as storing it for a long time can make the spores lose their viability.

Phosphorus Solubilizing Bacteria

- Prepare the slurry of required quantity of inoculant in sufficient water (generally 400-500 ml of water for 200 g inoculant). To prepare the slurry, boil 50 g gur in one litre of water and cool it.
- Pour this slurry over the heap of seeds to be treated. Mix the seeds thoroughly with hands.

Rhizobium

- Mix 250 milliliters of powder Rhizobium biofertilizer with 2–3 liters of water
- Slowly mix the solution with 50–60 kilograms of seeds by hand until the seeds are evenly coated
- Roll the seeds to ensure even coating
- Shade dry the seeds Sow the treated seeds as soon as possible

Results and Discussion: Plant Height

Maximum plant height was increased with crop age and was observed at 80 DAS there was significant difference among the treatments. However, highest plant height (68.2 cm) was recorded with the application of *Rhizobium 20* gm/kg seed + Phosphorus 60 kg/ha, whereas treatment *PSB* 10 ml/kg seed + Phosphorus 60 kg/ha (67.5 cm) and *Trichoderma viride* 5 g*/kg* seed + Phosphorus 60 kg/ha (66.6 cm) were found to be statistically at par with T7, and minimum was reported in control (55.0 cm). Sahu *et al*. 2003, plant height, Length and weight of root plant- 1 and number and weight of nodules plant^{-1} was increased appreciably with every increase in the rate of phosphorus application upto 60 kg P_2O_5 ha^{-1}, beyond that no significant advantage was noticed.

Plant dry weight

At 80 DAS there was significant difference among the treatments. However, highest plant dry weight (36.69 g) was recorded with the application of *Rhizobium* 20 gm/kg seed + Phosphorus
60 kg/ha, whereas treatment *PSB* 10 ml/kg seed + Phosphorus 60 kg/ha (36.32 g) and *Trichoderma viride* 5 g*/kg* seed + Phosphorus 60 kg/ha (35.12 g) were found to be statistically at par with T_7, and minimum was reported in control (27.92 g). Phosphorus being an energy bond compound and its major role in transformation of energy essential for almost all metabolic processes *viz*., photosynthesis, respiration, cell elongation and cell division, activation of amino acids for synthesis of protein and carbohydrates metabolism which ultimately increase all the growth attributes and dry weight of plants. Similar results have also been reported.

Number of nodules per plant

there was significant difference among the treatments. However, highest number of nodules per plant (31.0) was recorded with the application of *Rhizobium 20* gm/kg seed + Phosphorus 60 kg/ha, whereas treatment *PSB* 10 ml/kg seed + Phosphorus 60 kg/ha (27.3) and *Trichoderma viride* 5 g*/kg* seed + Phosphorus 60 kg/ha (28.8) were found to be statistically at par with T7, and minimum was reported in control (19.6). Some recent evidences (Vishwa Karma *et al*. (2012) [9] suggest that phosphorus requirements for nodulation and maximum nodules activities are much greater than poor host plant growth. Infection of Rhizobium bacteria depends on their interception with root hair, under adequate phosphorus application. Nodulation increased due to high bacterial interception on account of properly developed roots and increased density of nodule bacteria.

Number of pods per plant

Significantly maximum number of pods per plant (25.8) was recorded with the treatment in application of *Rhizobium 20 gm/kg* seed + Phosphorus 60 kg/ha, whereas PSB 10 ml/kg seed + Phosphorus 60 kg/ha (25.1) was statistically at par with T9. and minimum was recorded in control (25:50:30) (19.00)., grain yield, number of seeds pod plant and 100 seed weight of chickpea were increased by phosphorus applications. Basir *et al*. (2008) [1] showed that, as compared to other phosphorus treatments 60 kg P ha^{-1}, significantly improved agronomic traits. Maximum plant height, number of pods plant^{-1}, 100 seed weight and grain yield were recorded for 60 kg P ha^{-1} as mentioned in Table 1.

Number of seeds per POD

it is clear absorved in table 1 that there was significant maximum number of pods per plant (2.5) was recorded with the treatment in application of *Rhizobium 20 gm/kg* seed + Phosphorus 60 kg/ha, whereas *PSB* 10 ml/kg seed + Phosphorus 60 kg/ha (2.3) was statistically at par with T9. and minimum was recorded in *PSB* 10 ml/kg seed + Phosphorus 20 kg/ha (1.2).

Conclusion

It is concluded that seed treatment with Rhizobium at 20gm/kg seed (T_9) along with application of 60 kg P/ha produced higher yield as well as economic also

Table 1: Effect of phosphorus and bio fertilizers on growth and yield attributes of chickpea

S. No.	Treatments	Plant height (80 DAS)	Plant dry weight (80 DAS)	Number of nodule per plant (80 DAS)	Number of pods per plant	Number of seeds per pod
1.	*Trichoderma viride* 5 g/kg seed + Phosphorus 20 kg/ha	59.5	31.80	21.9	21.1	1.3
2.	*Trichoderma viride* 5 g/kg seed + Phosphorus 40 kg/ha	62.0	33.45	25.5	23.1	1.9
3.	*Trichoderma viride* 5 g/kg seed + Phosphorus 60 kg/ha	66.6	35.12	28.8	24.7	1.9
4.	*PSB* 10 ml/kg seed+ Phosphorus 20 kg/ha	60.8	32.85	21.8	22.0	1.2
5.	*PSB* 10 ml/kg seed + Phosphorus 40 kg/ha	64.1	33.83	26.7	24.0	1.9
6.	*PSB* 10 ml/kg seed + Phosphorus 60 kg/ha	67.5	36.32	29.0	25.1	2.3
7.	*Rhizobium* 20 gm/kg seed+ Phosphorus 20 kg/ha	61.5	34.80	24.0	22.2	1.7
8.	*Rhizobium* 20 gm/kg seed + Phosphorus 40 kg/ha	65.6	34.58	27.3	24.1	2.2
9.	*Rhizobium* 20 gm/kg seed + Phosphorus 60 kg/ha	68.2	36.69	31.0	25.8	2.5
10.	Control (25:50:30)	55.0	27.92	19.6	19.0	1.6
	SEm±	2.60	1.28	2.15	1.18	0.10
	CD (p=0.05)	7.73	3.80	6.40	3.51	0.31

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