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Effect of PSB, VAM and phosphorus levels on plant height, shoot and root growth in chickpea (*Cicer arietinum* L.)

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Abstract
The field experiment was conducted in the year 2020 to evaluate the effect of PSB, VAM and phosphorus (P) levels on the growth of shoot and root of chickpea crop. The experiment was done in a Randomized Block Design comparing 12 treatments with 3 replications involving Biofertilizers (No innocuation, VAM, PSB, VAM+PSB) and 3 doses of Phosphorus (0%, 50%,100%)recommended fertilizer dose for study the growth of shoot and chickpea. Biofertilizer inoculation enhancing overall plant root and shoot parameter. Thus the combine inoculation with phosphorus progressively enhances the growth of chickpea.

Key words: VAM, PSB, phosphorus level, shoot growth, root growth

Introduction
Pulses play a key role as well as occupy a unique position in Indian agriculture. It has higher protein which makes available protein rich diet to vegetarian mass. It also help in maintaining the soil fertility by fixing nitrogen which ware help to succeeding crop Chickpea (*Cicer arietinum* L.) contain about 20-22% of protein. Phosphorus is one of the important macronutrient for growth and developments of the plants. The phosphorus is recognized as nutrient which is most important for plant (Dotaniya *et al*., 2014a) [4]. It stimulate the early growth of roots, plant height, flowering and early maturity of crop. The Phosphorus plays a role in the metabolism and certain nucleic acid like phospholipid, chromosome, nucleotide (NAD), adenosine triphosphate (ATP), adenosine diphosphate (ADP). Phosphorus fertilization is a chief input in crop production (Blackshaw *et al*. 2004) [2]. Concentration of phosphorus in soil is height but small portion of phosphorus is available for crops (Dotaniya *et al*., 2014b) [4]. Hence phosphorus is a critical nutrient limiting for plant growth. The reaction phosphorus in the soil has important for crop growth and fertilizers use efficiency. The proportion of phosphorus and fixation capacity of phosphorus is directly affect the availability of phosphorus. Pulses are strong feeders of phosphorus because it is a constituent of all living organisms and plays key role as energy transformation. In all nutrient phosphorus is called as mineral of life. Especially in the middle stage of plant development, adequate supply of phosphorus is required for development of root and the reproductive parts, early maturity and reduced disease incidence. In different soil types, phosphorus availability is different that's why it is limiting nutrient for the production of crops, particularly legume crops like chickpea. Chickpea have higher phosphorus requirement because lot of energy consumed for the process of symbiotic nitrogen fixation.

Arbasculer Micorrhiza is fungi which help to solubilize phosphorus and make available for the plants. Arbascular Micorrhiza is root formation of intracellular structure arbuscles during various phases of plant development. The Arabascular Mycorrhiza found in root system of most flower plants. The Arbascular Mycorrahizal Fungi increases uptake of phosphorus by plants in three ways (i) increase the absorption of phosphorus from soil by hyphae, (ii) translocation of phosphorus along with hyphae, and (iii) the transfer of phosphorus to cortical root cells, which is readily used by plant. The AM fungi also increased availability of micronutrients like zinc (Zn), copper (Cu), iron (Fe) and also macronutrients like K and N. The combination of Arbascular Mycorrhiza fungi and phosphorus greatly effect on the nodule population and nitrogen fixation in addition to phosphorus uptake and growth.

By suppling the adequate amount of phosphorus Arbuscular mycorrhiza stimulates the activity of rhizobium. Use of Arbascular Mycorrhiza increase the production of growth promoters, increases tolerance to diseases by plant and improves the synergistic interaction with Benefical N-fixer and P-solubilizes microorganism. The culture of Arbuscular Mycorrhza is limited because it is an obligate symbiotic and have to maintained and multiplied on live plants.

Phosphorus solubilizing bacteria (PSB) play important role in soil biochemical cycle. It have the cheapest source to increase availability of phosphorus. There are many bacteria's having the ability to bring insoluble inorganic or organic phosphates into soluble form by secreting organic acids. It increase the availability organic acid chelates like Ca, Al, Fe and phosphorus, also increase higher utilization by plants. Phosphorus solubilizing bacteria mostly available in soils have rich in organic matter and low in available phosphorus. It increases phosphorus availability is an important trait in sustainable farming for increasing plant yields. Phosphorus solubilizing bacteria is capable to increase availability of phosphorus by solubilization of inorganic phosphorus or by mineralization of organic phosphorus. It is considered to increase plant growth and yield. Keeping in view the importance of Arbascular Mycorrhiza and Phosphorus solubilizing bacteria on solubilization and added phosphorus the research was taken to evaluate the effect of PSB, VAM and phosphorus levels on plant height, number of branches, shoot fresh weight, shoot dry weight, root fresh weight, root dry weight of chickpea crop.

Materials and Methods

A field experiment were conducted during *rabi* season 2020-2021 at agricultural farm of Lovely Professional University located in the village Hardaspur of Kapurthala District under open condition. The details of the material and methods and the experimental techniques which are to be followed during the course of investigation are presented below.

Experimental site

The experimental site is located at field of lovely professional university, Jalandhar, at longitude 31^0 22' 31.81" N and altitude 75^0 23' 3.02" E of about 252 above mean sea level which fall under Transgenic Gangetic plain region of Punjab agro climatic region. The climate of the experimental area is hot and dry summer, wet and humid monsoons cold and wet in winter.

Experimental details

A total of 12 treatments were evaluated in a Randomized Block Design (RBD) with three replications, *viz*., 4 Levels of Biofetilizer and 3 Levels of Phosphorus. Combination of Factors treatment are as T1: No inoculation + No P, T2: Only PSB,T3: Only VAM T4: PSB + VAM T5: P-50%, T6: PSB + P-50%, T7: VAM +P-50%, T8: PSB+VAM+P-50%, T9: P-100%,T10: PSB+P-100%, T11: VAM +P-100%, T12: PSB+VAM+P-100%.

Field operations

The field used for cultivation of chickpea crops was cultivated plough one time and harrowed 2 times with a tractor and then, it was planked. After that field was divided into $15m^2$ size plots. Full doses of fertilizers was added as per treatment fixed also bio fertilizer added as per the treatment. The seeds of chickpea were sown by Kera method. The row to row and plant to plant distance maintained as recommended by PAU, Row to row was 30 cm, whereas plant to plant distance was 10 cm. In order to manage weeds 2 hand weeding done. Further, all relevant plant protection measures were followed.

Shoot Studies

Plant Height

The length of the main stem of five tagged plants was measured from the ground level to the tip and average height was expressed in cm/plant.

Number of branches/plant

The number of branches from five sampled plants was counted and averaged. Primary and secondary Branches were counted separately.

Shoot fresh Weight (g)

Freshly Collected five plant samples weight were recorded, averaged and expressed g/plant.

Shoot dry weight (g)

The Collected plant sample ware kept in oven at 60°C for 48 hours. The dry weight of the whole shoot was averaged and expressed g/ plant.

Root studies

Above studies were carried out at the 120 days of crop. The root samples were taken by "core break method" (Bohm, 1979) [3] to a depth of 0- 0.30 m. In the present study, metallic core of size 1532 cm3 was used. The soil samples with root biomass were kept in water to loss the soil and then, roots were gentle washing under a water bath. The roots were collected on sieves to remove water and observations on following parameters were made.

Root fresh weight (g)

Weight of the freshly collected root sample was recorded.

Root dry weight (g)

Collected root samples were dried in an hot air oven at 60oC for 72 hours, after which their weights were recorded.

Result and Discussion

Data generated out of field experiments during the course of investigation were statistically analyzed and results obtained are presented below.

Shoot Height

Data on mean shoot height (cm) recorded at maximum flowering stage (120 DAS) in Table no. 1. The plant height progressively increased with the application of VAM +PSB as compare with the sapretly inoculation of PSB and VAM. Plant height also increased with application of phosphorus as compare to no phosphorus. The application of VAM +PSB +100% phosphorus recorded higher growth, followed by VAM+PSB+50% phosphorus. Jain *et al*. (1999) reported that plant height positively increased with PSB inoculation. Allen *et al*. (1982) [1] concluded that increased of gibberellin-like substances and reduced of ABA in the leaves of VAM infected plants may substantially alter the physiology of the plant. Dixit *et al*. (1983) [5] and Saraf *et al*. (1997) [11] clearly indicated increase in plant height due to phosphorus application.

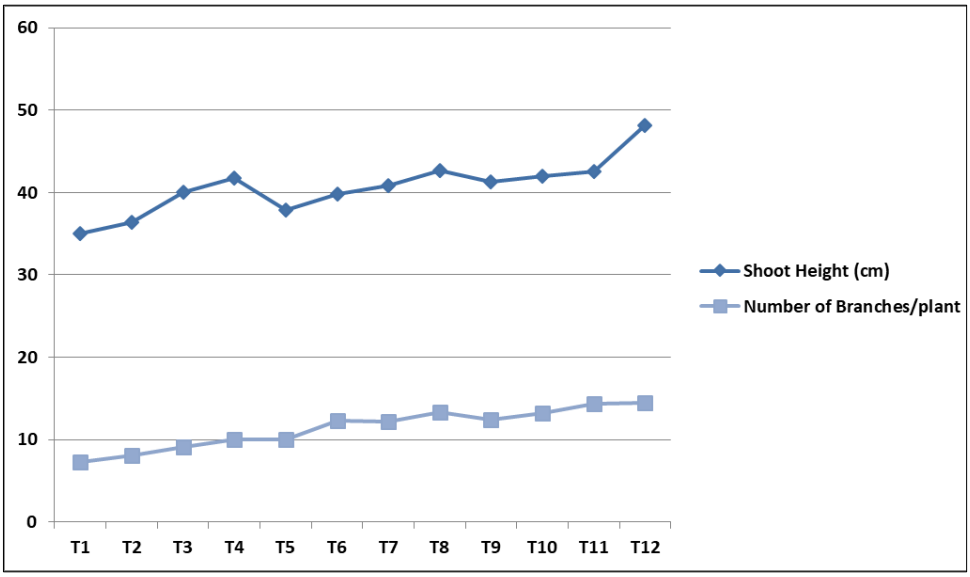

Fig 1: Effect of different treatments on Plant height and Branches at 120dyas.

Number of Branches/Plant

Data of number of branches /plant recorded in table no.1. The number of branches influenced with the inoculation with VAM + PSB, also 0%, 50%, 100% phosphorus application increases significantly. Difference between PSB and VAM was not as much significant. Application of VAM+PSB+100% phosphorus recorded highest branches followed by VAM+PSB+50% phosphorus. Jain *et al*. (1999) and Mukherjee and Rai (2000) also indicated significant increase· in number of branches/plant due to PSB and VAM inoculation.

Table 1: Effect of treatments on plant height and number of branches

Treatments	Shoot Height (cm)	Number of Branches/plant
T1	35.07	7.27
T2	36.37	8.03
T3	40.07	9.17
T4	41.80	9.97
T5	37.83	10.07
T6	39.80	12.30
T7	40.87	12.20
T8	42.67	13.30
T9	41.27	12.37
T10	42.00	13.23
T11	42.57	14.37
T12	48.13	14.50
CD	0.910	0.698

Shoot Fresh Weight

The data of fresh weight recorded at 120 days and showed in table no. 2. The significant increase in the PSB, VAM and PSB+VAM with 50% and 100% phosphorus level. The highest increase in fresh weight was recorded in VAM+PSB+100% phosphorus application, followed by inoculation with PSB, VAM with 100% phosphorus. Salahedin Morad *et al*. (2013) [10] reported the shoot weight increases with application of VAM and phosphorus.

Shoot Dry Weight

The data showed in Table no. 2. The Higher fresh weight was recorded in dual inoculation with 100% phosphorus application followed by separate inoculation with 100% phosphorus over the control. Salahedin Morad *et al*. (2013) [10] reported dry weight of shoot increased with VAM inoculation and phosphorus application.

Root Fresh Weight

The inoculation with VAM and PSB significantly increase in fresh weight of root compared to no inoculation. Also dry weight of root increased with 50% and 100% phosphorus application as compared to 0% phosphorus application. Salahedin morad *et al*. (2013) [10] reported reported fresh weight of root increased with VAM inoculation and phosphorus application.

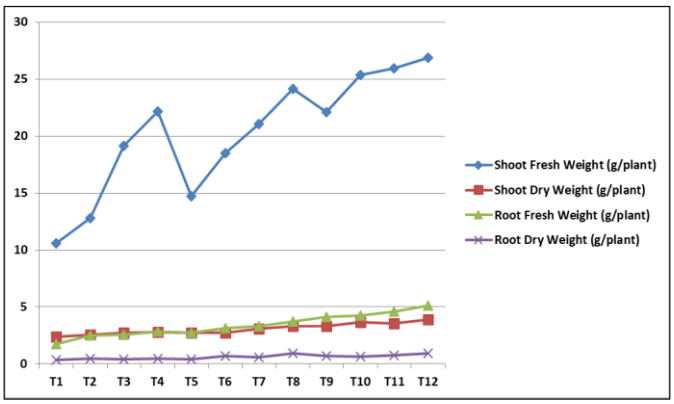

Fig 2: Effect of different treatments on Shoot fresh and dry weight, Root fresh and dry weight.

Root Dry Weight

The data showed in table no. 2, it apparent that the inoculation with VAM and PSB significantly increases the dry weigh of root, also on the phosphorus application dry weight of root increased as compared to no application. The application of PSB +VAM+100% Phosphorus recorded highest root dry weight followed by PSB and VAM inoculation with 100% phosphorus compared to No inoculation and No application of Phosphorus. Combined inoculation of PSB+VAM stimulated increase in root dry weight. It corroborated the finding of Piccini and Azcon (1987) [9]. Application of phosphorus significantly increased root dry weight. Sharma and Yadav (1976) [12] has been reported that phosphorus playa beneficial role in legume growth by promoting extensive root development and nodulation

Table 2: Effect of treatments on Shoot fresh and dry weight, root fresh and dry weight.

Treatments	Shoot Fresh Weight (g/plant)	Shoot Dry Weight (g/plant)	Root Fresh Weight (g/plant)	Root Dry Weight (g/plant)
T1	10.59	2.36	1.73	0.36
T2	12.81	2.54	2.47	0.46
T3	19.13	2.72	2.57	0.40
T4	22.18	2.79	2.82	0.45
T5	14.72	2.73	2.72	0.42
T6	18.49	2.75	3.12	0.67
T7	21.04	3.09	3.33	0.56
T8	24.13	3.33	3.71	0.94
T9	22.09	3.34	4.14	0.70
T10	25.33	3.69	4.25	0.63
T11	25.94	3.57	4.59	0.73
T12	26.85	3.88	5.13	0.93
CD	2.050	0.241	0.492	0.115

Conclusions

On the basis of above research data it may concluded that the application of 100% phosphorus as well as dual inoculation with bio fertilizer produced higher growth, no. branches, dry matter accumulation, root growth. Application of phosphorus increased growth and yield over control Also application of Arbasculer Micorrhiza and Phosphorus solubilizing bacteria increased plant growth and yield. Thus, application 100% as well as dual inoculation with bio fertilizer may be recommended to enhance the profitable cultivation of chickpea for the farmers.

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