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Effect of biofertilizers, *Rhizobium* & *Phosphatica* in combination of different level of Ca, Mg, & S on the productivity of chick pea (*Cicer arietinum* L.) cultivar avrodhi

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Abstract
A field experiment was conducted in Bareilly, Uttar Pradesh, India, during the Rabi season to study the effect of bio-fertilizer (*Rhizobium* & Phosphate) in combination of different level Ca, Mg, & S on productivity of Chickpea (Cicer arietinum) cultivar "Avrodhi". Experiment units were arranged in split-split plot based on randomized complete blocks with three replication. The treatment consisted of nitrogen, phosphorus, potassium (N:P:K 20:60:30 Kg/ha), Calcium, Magnesium and Sulphur (Ca:Mg:S 38kg/ha) and seed inoculation with *rhizobium* or phosphate solubilizing bacteria (PSB),both *Rhizobium* & PSB/on uninoculated control. The results revealed the application of N:P:K 20:60:30Kg/ha+ Ca, Mg, & S 38 Kg/ha+ dual inoculation with Brady*rhizobium* japonicum and Pseudomonas striata (200 gm/ha) significantly increased the growth characters (plant height, number of nodules, number of filled pods, total chlorophyll content, protein content of chickpea. The increase height of plant cm (45, 78) number of nodules per plant (35, 18), total chlorophyll content 2.13 (50.00%) & protein content 20.19 (32.04%).

Keywords: *Cicer arietinum*, *rhizobium*, PSB, productivity

Introduction

Chickpea (*Cicer arietinum* L.) is one of the important grain legume crops of India accounting for about 20.7 percent of the area under protein and carbohydrates about 41.6 percent of the total pulse production of the country. It is the third most widely grown grain legume in the world tolerating a arids range a climate condition. The seed protein content of these crops, which may be up to 30 percent, is superior, in quality to most other gram legumes, these characteristics therefore, make chickpea a potentially valuable crop. India is the largest produces, importer & consumer of pulses in the world, accounting for 25% of global production, 15% trade and 21% consumption in India more than a dozen of pulse crops including chickpea 40%, pigeonpea 18%, Urd bean 11%, many bean 9%, lentil 8%, field pea 5% and others are grown on 22-24 million hectares producing 13-15 million tons of grain with an average productivity of 600-650 Kg/ha.

Leguminous crops have nodules in their root where *Rhizobium* fix atmospheric nitrogen with the help of nitrogenase enzyme, number and size of nodules directly affect the amount of nitrogen fixed by *Rhizobium*. Phosphate solublizing bacteria (PSB) secrate organic and inorganic acids which content insoluble phosphate into soluble forms, which can be used by the plant chickpea requires relativity more phosphorus because of its high energy requirement for protein synthesis, the combined inoculation of *Rhizobium* and phosphate solubilizing bacteria has increased nodulation, growth parameter in chickpea.

Mineral nutrient are N, P, K, Ca, Mg, S, Nitrogen is a part of all living cells and is a necessary part of all protein, enzyme and metabolic process involved in the synthesis and transfer of energy. Proteins are complex substances of high molecular weight ranging up to several millions and content in addition to carbon, hydrogen and oxygen sometime elements like phosphorus, sulfur, iron, zinc and iodine may also be present, protein made up of several simple nitrogen containing organic molecules called amino acid i.e. protein are polymerized forms or polymers of amino acid. Thus amino acid is the basic unit of protein.

Nitrogen is a part of chlorophyll, the green pigment of the plants that is responsible for the photosynthesis like nitrogen, phosphorus is an essential part of the process of photosynthesis, involved in the formation of all oils, sugars, starch etc. Potassium (K) helps in the building of the protein, photosynthesis, fruits quality and reduction of disease. Calcium (Ca) an essential part of cell wall structure, provides for normal transport and retention of other element as well as strength is the plants. Magnesium (Mg) is part of the chlorophyll is all green plants and essential for photosynthesis, it is also helps activate many plants enzymes needed for growth. Sulfur (S) essential plant food for production of protein. Sulfur promotes activity and development of enzymes and vitamins.

Material and method

The experiment was conducted at the famer's field (Bilwa research form, Bareilly District) Uttar Pradesh, India during soil PH was recorded 6.8, biofertilizers [*Bradyrhizobium japonicum* and *Pseudomonas straita* (PSB)] inoculation and macronutrients were applied at the time of land in basal dose of all plots. Nitrogen, phosphorus, potassium (N:P:K 20:60:30 kg/ha) and Calcium, magnesium and sulfer 30 kg/ha. The experimental design was randomized complete block with 3 replication and 16 treatment included (T_1) uninoculated, (T_2) uninoculated + Nitrogen + Phosphorus +

Potassium, (T_3) *Rhizobium*, (T_4) *Rhizobium* + Nitrogen + phosphorus + Potassium (T_5), *Rhizobium* + PSB, (T_6) *Rhizobium* + PSB + Nitrogen + Phosphorus + Potassium, (T_7) *Rhizobium* + PSB + Calcium, (T_8) *Rhizobium* + PSB + Calcium + Nitrogen + Phosphorus + Potassium, (T_9) *Rhizobium* +PSB + Magnesium, (T_{10}) *Rhizobium* + PSB + Magnesium + Nitrogen + Phosphorus + Potassium,(T_{11}) *Rhizobium* + PSB + Sulfer, (T_{12}) *Rhizobium* + PSB + Sulfur + Nitrogen + Phosphorus + Potassium, (T_{13}) *Rhizobium* + Calcium + Magnessium + Sulfur, (T_{14}) *Rhizobium*+ Calcium+ Magnesium+Sulfur+Nitrogen+ Phosphorus+ Potassium+, (T_{15}) *Rhizobium*+PSB+calcium+ Magnissium+ Sulfur,(T_{16}) *Rhizobium*+PSB+ Calcium+Magnesium+Sulfur+Nitrogen+Phosphorus+ Potassium.

Collection of data

Data on plant height in Cm, No of nodules/plants, No of filled pod/plant, data were taken from randomly selected 3 plants from each plot and biochemical experiment total chlorophyll/, and protein content]

Height of plant in Cm

Observation on the effect of basal application of dual inoculation (*Rhizobium & PSB*) & macronutrient on height of plant (45.78) was recorded by (T_{16}) with *Bradyrhizobium japonicum & Pseudomonas striata* 200 gm/ha & 38Kg/ha Ca, Mg, & S, N:P:K 20:60:30 Kg/ha. The lowest rate (33:40) was shown by treatment (T_1) with uninoculated control.

Results

No. of nodules / plant

Data presented in table shows that no of nodules/plant of Cicer arietinum increase significantly in all treatments as compared to control. The no of nodules / plant was affect by treatment, So that the highest number of nodule (35.18) was produced by the treatment (T_{16}) and the lowest rate (20.16) no of nodules /plant was recorded by treatment (T_1) with uninoculated control.

Rahul *et a*l (2007) [10] studied the effect of biofertilizers and sulfur levels on the growth and yield of black gram (Vigna munga) cv type 9. The result revealed that application of sulfur at 20 Kg/ha + dual inoculation with *Rhizobium* &PSB significantly increased the growth characters (plant height, nodules and dry weight) of black gram.

No of filled pod/plant

The data on no of filled pods/plant as influenced by the dual inoculation of biofertilizer (Brady *Rhizobium* japonicum & Pseudomonas straita) & basal application of macronutrients (Ca, Mg & S, N, P, K). The hieghest number of filled pod /plant 36.00 was recorded at treatment(T_{15}) with dual inoculation of biofertilizers (Brady*rhizobium* japonicum 200gm La-1 &Pseudomonas striata 200 gm/ha^{-1}) basal application of macronutrients 38 Kg of Ca, Mg, & S ha^{-1} + NPK 20:60:30 Kg ha^{-1} kg of Ca, Mg & S ha^{-1}+NPK 20:60:30 kg ha^{-1} and the lowest rate 27.37 was show by treatment (T_{-1}) with an inoculated control.

Biochemcal composition

Protein content

The data on the protrin content (%) in the grain as influenced by the dual inoculation of biofertilizers (Brady *rhizobium* japonicum &Pseudomonas striata) and basal application of macronutrients (Ca, Mg & S.N.P.K.) are presented in table. The heighest protein contents 20-50 in the grain was recorded at treatment (T_{15}) with dual inoculation of biofertilizers (Brady*rhizobium* japonicum 200gm ha^{-1} & Pseudomonas striata 200gm/ha^{-1}) basal application of macronutrients (38Kgha^{-1} of Ca, Mg &S ha^{-1} NPK 20:60:30 Kg ha^{-1}) and lowest protein content 15.29 uninoculated control. Waggar and Menon (2003) studied the effects of various N levels (0, 10, 20, 30 and 40 Kg/ha) on the yield of Chickpea cultivars Cholla, Sanyasi and DG-89. Application on of 40 KgN/ha resulted in the tallest plant and highest grain N Content and protein content, straw n content, straw yield grain yield regardden of the cultivar used.

Total chlorophyll content

The data on total chlorophyll content (/mg/gm f.wt.) in the leaves as influenced by the dual inoculation of biofertilizers (Brady*rhizobium* japonicum &Pseudomonas striata) and basal application of macronutrients (Ca, Mg, S & N, P, K) are presented in table. The highest total chlorophyll content 2.13 in the leaves was recorded at treatment (T-$_{15}$) with dual inoculation of biofertilizers (Brady*rhizobium* japonicum and Pseudomonas striata 200gm ha^{-1}) and basal application of macronutrients (Ca, Mg, S ha^{-1}& N, P, K 20:60: 30 Kg ha^{-1}). Chlorophyll is an extremely important biomolecule, critical in photosynthesis which allows plants to be absorb energy from light, the total leaf area available for photosynthesis is an integrate of number of leaves and its area (fagade and De Dutta, 1971.)

Table 1

S.N	Treatment	Height of plant in cm.	No. of nodules/plant	No. of filled pod/plant	Protein content % in grain	Total chlorophyll content mg/gm. f.wt.
1	Uninoculated	33.40	20.16	23.66	15.29	1.42
2	Uninoculated N_{20}:P_{60}:K_{30}	38.57	23.11	26.11	16.51	1.57
3	*Rhizobium*	44.33	27.33	29.61	17.33	1.59
4	*Rhizobium* N_{20}:P_{60}:K_{30}	4567	29.67	31.45	18.51	1.68
5	*Rhizobium* + PSB	41.67	30.78	29.54	17.87	1.64
6	*Rhizobium* + PSB N_{20}:P_{60}:K_{30}	44.16	32.16	32.20	18.88	1.73
7	*Rhizobium* +PSB + Calcium	44.18	28.33	27.14	17.90	1.51
8	*Rhizobium* +PSB +Ca +N_{20}:P_{60}:K_{30}	44.21	30.21	32.49	18.95	1.62
9	*Rhizobium* +PSB+Magnessium	44.18	26.33	27.13	17.51	1.93
10	*Rhizobium* +PSB+Mg+ N_{20}:P_{60}:K_{30}	43.41	29.67	30.84	18.72	2.04
11	*Rhizobium* +PSB+ Sulfur	44.35	28.10	30.46	17.21	1.53
12	*Rhizobium* +PSB+ S + N_{20}:P_{60}:K_{30}	45.00	31.33	32.42	17.57	1.71

13	*Rhizobium* + Ca + Mg + S	43.21	26.33	32.81	18.90	1.67
14	*Rhizobium* + Ca +Mg + S + N_{20}:P_{60}:K_{30}	45.67	29.66	34.13	19.22	1.82
15	*Rhizobium* +PSB+ Ca +Mg +S	45.28	32.16	34.61	19.61	1.91
16	*Rhizobium* +PSB+ Ca +Mg + S +N_{20}:$P_{60}K_{30}$	45.78	35.18	36.00	20.50	2.13

Discussion

Desirable effects of dual inoculation Brady*rhizobium* japonicum & Pseudomonas striata in growth formation and macronutrient by plant had been reported to vary experiments, in the present study combined inoculation (Brady*rhizobium* japonicum & Pseudomonas striata) & macronutrients (N, P, K, Ca, Mg, S) covered a considerable experiment in growth, production of Chickpea, the highest plant heighest plant height (mean) recorded at the treatment (T_6) (05.700) with Brady*rhizobium* japonicum/ Pseudomonas striata & macronutrients (Ca, Mg, S, N, P, K).This is supported by many authors (Hussain *et al* 2008) they showed the application of phosphorus (S&P) single super phosphate &PSB inoculation recorded significantly increase, greater plant height, no of root nodules, dry matter accumulation and nodule dry weight.

No of nodules per plant was recrded at the treatment T_{16} (35.18) with *Bradyrhizobium japonicum*, *Pseudomonas striata* and macronutrient (N, P, K, Ca, Mg, S). This is supported by authors. Singh and Paresh (2003) studied the effect of Phosporus fertilizers (at 0.15, 30, 45 & 60 Kg P2O5/ha) and biofertilizers (*Rhizobium* sp. Phosphate solublizing bacteria, PSB, and combination of *Rhizobium*+ PSB) on the growth and yield of mung bean Cv RMG62, All biofertilizer treatments increased growth and yield characters, except pod length and test weight. The heighest value for all the parameters studied were obtained with *Rhizobium*+PSB; dry matter accumulation row at 50days after showing and harvest: branches/plant and seed yield/ha.

No of filled pod/plant of chickpea was significantly influenced due to different integrated plant nutrient protein such as dual inoculation of biofertilizer & basal application of macronutrients (Ca, Mg, &S, N, P, K) this is supported many authors. Bahr *et al* 2007 conducted a field experiment during the winter seasons of 2004-2005 and 2005-2006 in all Nagali provice. All Beheira Governorate, Egypt. To study the effect of plant density and area foliar application on yield and yield components of Chickpea (Cicer arietinum) the foliar application of 1.0% area at the pod filling stage recorded the highest values for yield and yield attributes. The interaction between high plant density and high foliar application for all characters.

Protein content in the grains of chick pea was significantly influenced due to different integrated plant nutrient practices such as due to inoculation of biofertilizers (*Brady rhizobium japonicum & Pseudomonas striata*) & basal application of macronutrients (Ca, Mg, & S, N, P, K). daual inoculation of biofertilizers and different macronutrients increased the protein content, thi is supported by many authors,

Waggeon and Menon (2003) studied the effects of various levels (0,10,20,30, and 40 Kg/hac.) on the yield of chickpea cultivars cholla. Application on of 40 Kg m/hac resulted in the tallest plant and highest grain with content and protein content, straw wit content, straw yield.

The total chlorophyll content in the leaves of chick pea was significantly influenced due to different integrated plant nutrient practices such as dual inoculation of biofertilizers and basal application of macronutrients. This is supported many authors. Rajendran *et al* (2003) reported that the amount of chlorophyll increased when the co- inoculation with *Rhizobium* and PSB.

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