Dissertation -I

(AGR-596)

"Role of Rhizobium in enhancing the yield and yield attributes of Chickpea. (*Cicer arietinum L.)"*

Submitted To

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Transforming Education Transforming India

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CERTIFICATE

This is to certified that this entitled "**Role of Rhizobium in enhancing the yield and yield attributes of chickpea (*Cicer arietinum* L.)**" submitted in partial fulfilment of requirements for degree- Master of Science in Agronomy by **Puyam Binita Devi, Registration no. 11719085** to Department of Agronomy, School of Agriculture, Lovely Professional University, has been formulated and finalized by the student himself on the subject.

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DECLARATION

I hereby declare that the project work entitled – "**Role of Rhizobium in enhancing the yield and yield attributes of chickpea (*Cicer arietinum* L.)**" is an authentic record of my work carried at **Lovely Professional University** as requirements of Project work for the award of degree – Master of Science in Agronomy, under the valuable guidance of **Mr. Ajeet Prakash,** Assistant Professor, School of Agriculture, Lovely Professional University, Phagwara, Punjab, India.

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1. INTRODUCTION

Chickpea,Gram or Bengal gram (*Cicer arietinum* L.) is the most important legume crop in the world on the basis of total production after soyabean, groundnouts, beans and peaes (Muzquiz and Wood, 2007). Gram is a main nutritive legume crop of rural and urban household of the poor in the developing world. It is an important source of cheap protein with high energy and nutritive value (EI-Karamany and Bahr, 1999). It is a rich source of protein, carbohydrate, vitamins and certain minerals, particularly to the populations of developing nations (Chaan et al., 1978). Chickpea is a rabi crop mainly sown in September- November and harvested in February. Crop duration is 90-120 days, depending on the variety. Desi varieties are short duration while Kabuli varieties take relatively longer period, to mature. Similarly cooler like northern India take longer period compared to relatively warm weather in southern parts of India. It is best suited to areas having low to moderate rainfall and a mid cold weather. Excessive rains soon after sowing or at flowering stage are harmful for the crop.

Chickpea is used for human consumption as well as for feeding to animals. It is eaten both whole fried or boiled and salted, or more generally in the form of the split pulse which is cooked and eaten. Both husks and bits of the 'dal' are valuable cattle feed. Straw of chickpea is an excellent fodder for cattle. Chickpea flour (besan) is used in the preparation of various types of sweets. Chickpea is considered to have medicinal effects and it is used for blood purification. Chickpea contains 21.1 per cent protein, 61.5 per cent carbohydrate, 4.5 per cent fat. It is also rich in calcium, iron and niacin.

In India, the total food production in 1999-2000 was about 209 million tonnes, out of this only 13.4 million tonnes was contributed by pulses. There is a shortage of pulses in the country. Thus the availability of pulse per capita per day has proportionately declined from 71g (1955) to 36.9g (1998) against the minimum requirement of 70g per capita per day. There is not much possibility of the import of pulses in the country.

Chickpea is one of the most important pulse crops of the world cultivated over an area of 12.0 million hectares with a production of about 9.2 million tonnes of grain (1999). The important gram growing countries are India, Pakistan, Ethopia, Burma and Turkery. India ranks first in the world in respect of production as well as acreage followed by Pakistan.

India occupying an area of 5.3 million hectares with production of 5.1 million tonnes. The average yield of chickpea is only 806 kg per hectare. The major chickpea producing areas are suitated in Madhya Pradesh, Rajasthan, Uttar Pradesh, Haryana, Maharashtra and Punjab.

G.S Tagore & S.L Namdeo reported that Pulses are the second most important group of crops after cereals. India, China, Brazil, Canada, Myanmar and Australia are the major pulse producing countries with relative share of 25 per cent, 10 per cent, 5 per cent, 5 per cent and 4 percent respectively. In 2009, the global pulses production was 61.5 million tonnes from an area of 70.6 million hectares with an average yield of 871kg/ha. Among this chickpea contributed about 15.9 percent to global pulse production. India is the largest producer and consumer of pulses in the world contributing around 25-28 % of the total global production. About 75 percent of the global chickpea (*Cicer arietinum* L.) area falls in India.

Production of chickpea is concentrated in central and southern parts of India. Production trends during the past 15 years indicated that except for a few years in the early 2000s, the output of chickpea fluctuated at around 6 million tonnes for over a decade till 2007-08.However, production has steady increased thereafter and largely in tune with the trends in yield levels and reached about 8.8 million tonnes in 2012-13. This increase in production is possible due to development of high yielding disease resistant varieties, matching production and production technologies in chickpea growing areas. Incidentally, the period the steep rise in production is in perfect line with the rise in minimum support prices (MSP) announced by the Govt. of India along with a significant expansion in the area under cultivation.

During 2012-13, highest production of chickpea (3551 thousand tonnes) was recorded in Madhya Pradesh with productivity of 1010 kg/ha. In Maharashtra, production of 1058 thousand tonnes was recorded with productivity of 844 kg/ha. Highest productivity of 1430 kg/ha was recorded in Bihar state. In Andhra Pradesh, 759 thousand tonnes of chickpea was produced with productivity of 1115 kg/ha.

Chickpea is grown on a wide range of soils in India. In the north, gram is generally grown on moderately heavy soils. Light soils, mostly sandy loams are preferred in Punjab, Uttar Pradesh, Haryana and Rajasthan. The best type of soil for chickpea is one that is well drained and not too heavy. However, chickpea is not suited to soils having a pH higher than

8.5. Chickpea is highly sensitive to soil aeration. So, very fine and compact seedbed is not suitable for chickpea it requires a loose and well aerated seedbed.

Chickpea being a leguminous crop fulfils the major part of its nitrogen requirement (about 75 %) through the process of symbiotic nitrogen fixation which work effectively from three to four weeks after sowing. However, if the soils have low organic matter and poor nitrogen supply may require 20-30 Kg per hectare of nitrogen as starter doses which can meet plant requirement before the formulation of nodules.

Rhizobium is small bacteria which fix the nitrogen through root nodules of legume crops. Fixation of nitrogen cannot be done independently. Rhizobium require a plant host. Nitrogen fixation helps in increasing productivity of low – N soil and soil fertility.

Nodulation of chickpea start at 10-12 days after planting. The active nodules are pink in colour due to the presence of leghaemolobin, and are capable of fixing atmospheric nitrogen. The nitrogen fixing process continue up to 40-50 days after sowing in warm climates. In cooler climates, it may continue more than 100 days depending on soil moisture and temperature (Dart 1947). Rhizobia fix atmospheric nitrogen and not only increase the production of inoculated crops but also leave a fair amount of nitrogen in the soil, which benefit the sequence crops (Agarwal 1998).

Albay rak *et. al* (2006) Rhizobium bacteria synthesized Phytohormones like auxin as sercondary metabolites in inoculated plants. Phytohormones are known to play a key role in plant growth regulation. They promotes seed germination, root elongation and stimulation of leaf expansion. In addition, great root development and proliferation of plants in response to rhizobium activities enhance water and nutrients uptakes (Werner, Newton 2005: Erman et al 2011).

2. OBJECTIVES

- To study the morphological and biochemical changes occurring in chickpea treated with Rhizobium.
- To study the morphological and biochemical changes occurring in chickpea treated with different doses of fertilizer.

2.1. SCOPE OF STUDY

Studying and evaluating role of rhizobium in enhancing the yield and yield attributes of chickpea (*Cicer arietinum* **L**.*).* In this field experiment we will evaluate role of rhizobium and the best doses of fertilizer that can enhance the yield of chickpea. Because only the best use of fertilizer doses will enhanced the yield of chickpea. Thus we have to find out the best fertilizer doses for the betterment of the yield of the crop and suggesting the farmers about the recommended dose and rhizobium treatment.

3. REVIEW OF LITERATURE

Chickpea (*Cicer arietinum* L.) is an important pulses crop of India and research work has been conducted on different aspects at various places in the country. In this chapter, the relevant literature on "Role of Rhizobium in enhancing the yield and yield attributes of chickpea (*Cicer arietinum*)".

R.Parveen, M.Sadiq & M. Saleem (1999) reported that performance of Rhizobium inoculation in Chickpea was better under normal than under stress

E.A.EI Hadi & E.A.E. Elsheikh (1999) observed that inoculation with Rhizobium strain TAL_{1148} showed a significant increment in most of the parameters studied compared to other strained and untreated control. Cultivar ILC_{1919} showed the best yielding cultivar, whereas cultivar Gabel marra showed the highest amount of protein due to inoculation or N fertilization in the two seasons.

Solaiman A. R. M.; Rabbani M.G. & Molla M. N. (2005) reported that dual inoculation of Rhizobium and arbuscular mycorrhiza along with poultry litter show the balance combination of nutrients for achieving the maximum output from cultivation of chickpea.

Albayrak *et.,al*. (2006) observed that great root development and proliferation of plants is response to Rhizobium activities and also enhance the water and nutrients uptakes.

M.Z. Alam and S.A. Haider (2006) reported that application of nitrogen fertilizer increased the total dry matter, leaf area index, crop growth ratio and net assimilation.

S.G. Khattak *et.al.,* (2006) study the effect of Rhizobial inoculation and nitrogen application on the performance of chickpea. He observed that inoculation with rhizobium improved nodulation on the root system of the crop. However, nitrogen application @ 30 kg ha^{-1} at sowing could not affect the nodulation status of crop

Erdal Elkoca, Faik Kantar & Fikrettin Sahin (2007) observed that seed inoculation with *Rhizobium, Bacillus subtilis* and *Bacillus megaterium,* especially dual and triple combination may substitute costly NP fertilizers in chickpea production even in cold highland areas.

Zarrin Fatima *et. al.,* (2007) reported that application of Rhizobium and mixed culture with phosphorus increased the yield and also improved soil fertility for sustainable agriculture system.

Erdal Elkoca *et.al.,* (2007) reported that combined seed treatment with the Rhizobium is better for nodulation than the use of Rhizobium alone and also increased in seed and total biomass yields were produced in dual and triple inoculation.

Prasad, D.K.Sharma and Satish Chandra (2008) reported that combination of Rhizobium culture + FYM is more effective over the FYM and Rhizobium culture alone.

Ali Namvar and Raouf Seyed Sharifi(2008) reported that applications of 75kg urea h^{-1} improve growth and final yield of inoculated chickpea.

Kedar M.A.H.Bhuiyan *et.al.,* (2008) found that plants inoculated with Rhizobium gave significantly higher nodule number, nodule weight, stover yield and seed yield compared to the un-inoculated plants.

S.R. Sing *et., al.* (2009) observed that Rhizobium along with 30 kg N show effective over the Rhizobium x 15 kg N ha^{-1}.

S.I Tolanur (2009) reported that highest grain yield and uptake of NPK of chickpea were obtained where 50% N through subabul/sunhemp.

R.S. Jat and I.P.S Ahlawat (2009) reported that inoculation of chickpea seed with rhizobium + PSB (Phosphate Solubilizing Bacteria) increased dry matter accumulation, grain yields and protein application content of Chickpea. Application of 26 kg P/ha improved dry matter accumulation, grain yield and protein content of chickpea, application of 13 and 26 kg P/ha increased soil N and P content over no phosphorus.

Muhammad aslam *et.al.,* (2010) reported that, fertilizer band placement + Bio-fertilizer inoculation was the best for higher yield and grain proteins content in chickpea

Giri, Nishita and Joshi N.C (2010) reported that inoculating the plant with Rhizobium is a promising fertilizer and it is easy to handle and improve plant growth and seed quality.

Ali Namvar *et.,al.*(2011) reported that application of N fertilizer (i,e between 50 and 75 kg urea ha^{-1}) as starter improve nodulation growth and final yield of inoculated chickpea plants.

. Murat Erman *et.,al.* (2011) observed that rhizobial inoculation increased root nodulation and the nitrogen content of seeds and shoots under irrigated conditions. Whey combined with Arbuscular mycorrhizal fungus (AMF) significantly increased root colonization while its combination with Rhizobium increased the number of nodule.

Ammar Salama *et.al.,(*2011) reported that nodules number, shoot dry weight, root dry weight, nodule dry weight, shoot nitrogen content and chickpea yield increased in the seed inoculation with root nodule bacteria. Whereas, use of chemical fertilizers also show increased shoot dry weight, root dry weight, nodule dry weight, shoot nitrogen and phosphorus content and yield.

Abraham *et.al.,* (2011) observed that band placement method show higher dry weight, pods plants, pods yield, seed weight plant and seed yield .

Muhammad Hamayum *et.al.,* (2011) reported that multiple application of both soil and foliar application of NPK show better result as compared to single application of nitrogen.

K. Pramika & A. K. Bera (2012) reported that combined inoculation of Rhizobium + PSB + VAM produced higher grain yield over no inoculation, rhizobium, phosphate solubilising bacteria, vesicular arbuscular mycorrhiza respectively.

N. Akhtar *et.al.,* (2013) reported that inoculation of Rhizobium and Bacillus sp. enhanced the availability of Phosphorus and exert positive effect on the growth and yield of crops.

G.S. Tagore *et.al.,* (2013) found that among the chickpea genotypes, IG- 593 performed better in respect of symbiotic parameters and leghemoglobin content (2.55mg g^{-1} of fresh nodules) was also higher. Among microbial inoculants, Rhizobium + PSB found effective and showed positive effect in enhancing all the yield attributing parameters, grain and straw yields.

Anis Siddiqui *et. al.,* (2014) observed that seed inoculation with an effective strain of Rhizobium species along with Azotobacter chroococcum is significant increase in nodulation, nitrogen content in the root and grain yield over un-inoculated control.

Dinesh Kumar *et.al.,* (2015) reported that the use of bio-fertilizers with reduced quantity of chemical fertilizers showed better yield of chickpea.

R.P. Ahirwar *et.al.,(* 2016) reported that dual bio-fertilizer (Rhizobium+ PUE) gave significantly higher physiological PUE over single bio-fertilizer. Whereas application of 90 kg P_2O_5/ha gave maximum grain yield.

Yogendra Singh *et.al.,* (2017) reported that application of 60 kg P_2O_5 ha^{-1} was significantly increased almost all the growth, yield attributes and seed yield of chickpea and combined seed inoculation (PSB + Rhizobium) increased the seed yield of chickpea over control.

4. Materials and Methods

4.1. Name of experimental "Role of rhizobium in enhancing the yield and yield attributes of chickpea (*Cicer arietnium* L.) ".

4.2. Experimental site:

The experiment was laid out in the Experimental field of Lovely Professional University, Punjab, Phagwara situated geographically at $31^0$14'48.0''N $75^0$41'45.0''E and 252m above the sea level. It falls under central plain zone of agro climatic zones of Punjab. The topography of the experimental area is uniform.

4.3. Climate:

The climate of the fields comes under

a) Agro ecological sub region (northern plain, hot sub humid eco-region Punjab)
b) Agro climatic zone (trans-gangetic plain region). The area comes under the semi arid and zone with annual rainfall 527.1mm/annually.

4.4 Soil Analysis

Collection of soil samples

Soil sample will be taken for analysis to check soil status (pH, N, P, K , EC and organic carbon) of experimental field before sowing of the crop.

Table 1. Analytical methods to be followed during investigation are as followed

Sr.no	Test Parameters	Method	References
Soil Parameter			
1	pH	Glass electrode	Sparks (1996)
2	EC	Conductivity meter	Sparks(1996)
3	Organic carbon	Wet digestion	Walkley and black (1934)
4	Available N	Alkaline potassium Permanganate method	Subbiah and Asija (1956)
5	Available P	Olsen's method	Olsen et .al (1954)
6	Available K	Flame photometer	Jackson (1973)

4.5. Statistical analysis

Data generated in the experiment will be analysed as per standard statistical procedure by Rangaswamy (2002)

4.6. Experimental detail

A. Plot treatments:

T_0 = Control

T_1 = C + Rhizobium + P_2O_5 + K_2O

T_2 = C + RDF(25% N) + P_2O_5 + K_2O

T_3 = C + RDF(50% N) + P_2O_5 + K_2O

T_4 = C + RDF (75% N) + P_2O_5 + K_2O

T_5 = C + RDF (100% N) + P_2O_5 + K_2O

T_6 = C + Rhizobium + RDF (100% N) + P_2O_5 + K_2O

4.7. Details of Layout:

i. Design = RBD (Randomized Block Design)

ii. Number of Treatments = 7

iii. Number of Replication = 3

iv. Total number of plots = 21

v. Gross plot size = 510 m^2

vi. Net plot size = 420 m^2

vii. Plot size = 20m^2 (5m x 4m)

viii. Main irrigation channel = 1

ix. Sub irrigation channel = 2

x. Seed rate = 80 kg/ha

xi. Spacing

P x P = 10cm

R x R = 30cm

Sowing depth = 8cm

4.8. Field Layout:

	R1	R2		R3
MAIN IRRIGATION CHANNEL				
SUB IRRIGATION CHANNEL	R_1T_0	R_2T_1	SUB IRRIGATION CHANNEL	R_3T_2
	R_1T_1	R_2T_2		R_3T_3
	R_1T_2	R_2T_3		R_3T_4
	R_1T_3	R_2T_4		R_3T_5
	R_1T_4	R_2T_5		R_3T_0
	R_1T_5	R_2T_0		R_3T_1
	R_1T_6	R_2T_6		R_3T_6

4. Observation to be recorded

4.1. Morphological observation

- Plant height
- Number of branches
- Number of pods
- Stem girth

4.2. Biochemical observation

- Total soluble sugar (TSS)
- Total soluble protein (TSP)
- Total carbohydrate
- Total chlorophyll content of leaves

4.3. Yield attributes

- Grain yield (kg/m^2)
- Straw yield
- Seed index (100 seed weight)
- Harvest index

5. EXPECTED OUTCOMES:

The experiment was conducted at the Lovely Professional University, School of Agriculture, near experimental farm of Phagwara, Punjab. The experiment was conducted by using seven treatment and three replication i.e. Rhizobium and different recommended doses of fertilizer, it is expected that they will enhanced the yield and yield attributes of chickpea (*Cicer arietinum* L.).

6. PROPOSED WORK WITH TIMELINE:

6.1.Material used:

- Measuring tape
- Rope
- Spade
- Khurpa

6.2. Planting material:

- Chickpea varieties which I used for my trial was PBG 5.

6.3.Time of sowing:

- Second fortnight of November

6.3. Spacing:

- R x R = 30 cm
- P x P = 15 cm
- Sowing depth = 8 cm

6.4. Irrigation:

- As per the soil condition

Reference:

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