

Original Research Article

Effect of fertility levels and biofertilizers on growth parameters, root architecture and quality of chickpea (*Cicer arietinum* L.)

Abstract:

The present field experiment was conducted during Rabi season of 2017–18 at the Student's Instructional Farm of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh to evaluate the effect of different fertility levels and biofertilizers on growth parameters, root architecture and quality of late sown chickpea (*Cicer arietinum* L.). The experiment comprised of 12 treatment combinations in split plot design which comprised 4 treatments [F₁ (control), F₂ (RDF 100%), F₃ (75% RDF), F₄ (50% RDF)] in main plot and 3 treatments [B₁ (*Rhizobium* + PSB), B₂ (*Rhizobium* + PGPR) and B₃ (*Rhizobium* + PSB + PGPR)] in sub plots with three replications. Results showed that among the different fertility levels, application of 100% RDF significantly enhanced growth parameters, root architecture and protein yield over the control. Among the different biofertilizers treatments application of *Rhizobium* + PSB + PGPR had significantly improved growth parameters, root architecture and protein yield as compared to *Rhizobium* + PGPR. The combined application of 100% RDF with *Rhizobium* + PSB + PGPR resulted in significantly higher growth parameters, root architecture and protein yield of late sown chickpea during winter (*Rabi*).

Key Words:- Biofertilizers, Chickpea, Fertility Levels, Root Architecture, Protein Yield

Introduction

The Pulses crops in India are grown under a wide range of agro-climatic condition. They are an excellent source of dietary protein for millions of people, nutritious feed for livestock and a mini nitrogen plant having profound ameliorative effect on soil. Pulses play an equally important role in rainfed and irrigated agriculture by improving physical, chemical and biological properties of soil and are considered excellent crop for natural resource management, environmental security, crop diversification and consequently for viable agriculture (Ali and Kumar, 2006). Globally, India is recognized as, a major player in pulses contributing 25% global production, (4-6 mt.) and consumer (26-27mt). Import duty on chickpea has been fixed at 60%. The year 2017-2018 had, witnessed record production in pulses (25.23mt). In India, Madhya Pradesh is the largest pulse producing state, which

accounts for 23% of total pulse production. It covers 32.97% area of chickpea in country. Chickpea is the King of pulses consist of more than 1/3 of area and 40% total pulse production. In Asian region chickpea is the premier pulse crop of Indian sub-continent. India is the largest producer as well as consumer of chickpea in the world. It is grown in area of 6.3million hectare with production of 5.1 mt. The average yield of chickpea is 806kg/hect. (FAOSTAT 2017-18).It is an important source of energy, protein, soluble and insoluble fibre. Mature chickpea grains contain 60-65% Carbohydrates, 6% Fat and 12-25% Protein higher than any other pulse crop. Through symbiotic Nitrogen fixation, the crop meet up to 80% of soil nitrogen needs, so farmers have to apply less N fertilizers. (Daset *al.*, 2012). Phosphorous is the second i.e. next to nitrogen. Due to deficiency of single element Phosphorous, plant cannot complete their life cycle. Hence, P is called 'Key to life'. It governs the root growth. P is essential constituent of nucleic acid, phytin, phospholipid, ATP stimulates early root growth, enhances the activity of rhizobia and root nodules. Biofertilizers promote plant growth and development also reduce the cost of production as they tend to decrease the doses of chemical fertilizers used. These can be used for fodder, food, vegetables and leguminous crops. Commonly used microorganisms as biofertilizers are Rhizobia, Phosphate Solubilizing Bacteria (PSB) and Plant Growth Promoting Rhizobacteria (PGPR). Seed inoculation with *Rhizobium* increases the nodulation through better root development and improves nutrient availability which is beneficial in improving the grain yield (Aliet *al.*, 2004). Inoculation of chickpea with *Rhizobium* significantly increased the nodulation and its dry weight, plant height, pods plant⁻¹, 1000-grain weight, root length, root dry weight and grain yield (Akhtaret *al.*, 2009). *Rhizobium* and phosphate solubilizing bacteria (PSB) assume a great importance on account of their vital role in N₂ fixation and P solubilizations. Use of *Rhizobium* and PSB had shown advantage in enhancing chickpea productivity (Rudresh *et al.* 2005).

Materials and Methods

The experiment was laid out in at the SIF Farm of CSAU&T, Kanpur, Uttar Pradesh. It is located on 25°18' N latitude, 83°03' E longitude and at an altitude of 80.71 meters above mean sea level. Experimental site area, Kanpur is situated in the central part of U.P. and have sub-tropical climate, characterized by hot summer and cool winters. Total rainfall received during the crop growing period was 15.90 mm. The experimental field is sandy clay loam in texture, neutral in reaction (pH 7.6), EC (0.11 dSm⁻¹), low in organic carbon (0.30%), available N (188 kgha⁻¹), medium in available P (13.4 kg ha⁻¹) and available K (173.3 kgha⁻¹).

The experiment was consists of 12 treatment combinations and laid out in split plot design assigning four treatments in main plot viz. F1- Control, F2- RDF 100%, F3- RDF 75%, F4- RDF 50% and three treatments in sub plot viz. B1- Rhizobium+PSB, B2- Rhizobium+ PGPR, B3- Rhizobium+PSB+PGPR with three replications. Each treatment was randomly allocated with in them. The crop was fertilized with a recommended dose of @ 20-60-20-20 kg nitrogen, phosphorus potassium and sulphur/ha, respectively. Urea DAP, MOP and gandhak powder were used as the source of nitrogen, phosphorus, potassium and Sulphur respectively. Culture of biofertilizers i.e. Rhizobium, PGPR and PSB, each packet has 200g weight and used for seed treatment at the rate of 20g/kg seed. Seeds were treated with *biofertilizers* (20 g per kg of seed) as per standard procedure and were sown after drying for six hours under shade. Chickpea seeds were sown at 75 kg ha⁻¹ in the furrows opened by the kudal by manual labours at 40 cm row to row spacing and 10 cm plant to plant spacing. The observations were recorded growth characters such as plant population, plant height and dry matter accumulation.

Protein content in grain was obtained by multiplying the nitrogen content in grain with factor 6.25 (AOAC, Washington 1995).

$$\text{Protein (\%)} = \text{N (\%)} \times \text{factor 6.25}$$

The protein yield (kg ha⁻¹) was obtained by the following formula:

$$\text{Protein yield (kg ha}^{-1}\text{)} = \text{Protein content (\%)} \times \text{Yield (kg ha}^{-1}\text{)} / 100$$

The data recorded during the course of investigation was subjected to statistical analysis by “Analysis of variance technique”. The significant and non-significant treatment effects were judged with the help of ‘F’ (variance ratio) table. The significant differences between the means were tested against the critical difference at 5% probability level (Chandel, 1998).

Result and Discussion

The data revealed that maximum plant height at 60 DAS was found with the application of 100% RDF which was statistically at par with 75% RDF and significantly higher than 50% RDF and control treatment. The results of present investigation are also in agreement with the findings of (Fatima *et al.*, 2008). At 60 DAS and at 90 DAS found maximum plant dry matter accumulation with the application of 100% RDF which was significantly higher than 50% RDF and control treatment. (Jat and Ahalawat, 2004)

Table 1. Effect of fertility levels and Biofertilizers on plant population, plant height and dry matter accumulation

Where F1-Control, F2- RDF 100% , F3- RDF 75% , F4- RDF 50% ,B1- Rhizobium +

Treatments	Plant population (running meter)		Plant height(cm)			Dry matter accumulation (gram/plant)		
	Initial	Harvest	30DAS	60DAS	Harvest	30DAS	60DAS	90DAS
Fertility levels								
F1	16.26	16.01	8.50	47.91	50.92	2.40	14.04	20.22
F2	16.76	16.55	10.49	58.36	61.99	3.01	17.57	25.31
F3	16.63	16.48	9.95	55.94	58.92	2.86	16.68	24.02
F4	16.58	16.41	9.41	52.83	55.93	2.70	15.76	22.71
SEm±	0.28	0.29	0.19	0.69	1.09	0.07	0.27	0.38
CD (P= 0.05)	NS	NS	0.68	2.39	3.77	0.25	0.96	1.31
Biofertilizers								
B1	16.57	16.45	9.59	53.87	56.99	2.75	16.08	23.16
B2	16.38	16.13	9.10	50.84	53.96	2.58	15.07	21.71
B3	16.72	16.51	10.07	56.56	59.86	2.89	16.88	24.32
SEm±	0.27	0.26	0.18	0.89	0.95	0.07	0.25	0.32
CD (P= 0.05)	NS	NS	0.53	2.69	2.85	0.25	0.75	0.96
FXB	NS	NS	NS	NS	NS	NS	NS	NS

PSB,B2- Rhizobium + PGPR ,B3 – Rhizobium + PSB + PGPR

All the root parameters i.e. root dry weight/plant, number of nodules per plant and nodule dry weight/plant influenced significantly due to different Fertility levels at all the stages of crop growth except root dry weight/plant at 30 DAS. However, higher values of root parameters i.e. root dry weight/plant, number of nodules per plant and nodule dry weight/plant with the application of 100% RDF which was statistically at par with 75 % and 50% RDF and significantly higher than control treatment. Favourable effect on plant growth with different nutrient levels over control treatment may be attributed to better nutrient availability and number of metabolic processes taking place in the plant body, which in turn are affected by a variety of inherent and environmental factors to which plant is exposed that results more root dry weight, number of nodules per plant and nodule dry weight/plant (**Gray and Bahar,**

2013; Egamberdieva *et al.*, 2015). Biofertilizers found significant effect on all the root parameters at all the stages of crop growth except root dry weight/plant at 30 DAS. Biofertilizers treatments resulted higher values of root parameters in chickpea with the application of Rhizobium + PSB + PGPR (B₃) followed by 75% RDF (F₃) treatment. The probable reasons for such results could be the growth promoting substances secreted by the microbial inoculants, which in turn might have led to better root development, better transpiration of water and enhanced uptake of nutrients that results more root dry weight/plant, number of nodules per plant and nodule dry weight/plant. These results were in accordance with works of (Triphati *et al.*, 2015; Singh and Prasad, 2008 and Gupta, 2004).

Table 2. Effect of fertility levels and biofertilizers on Root parameters of chickpea

Treatments	Root dry weight (gram/plant)			Number of nodules /plant			Nodules dry weight (mg/plant)		
	30DA S	60 DAS	Harvest	30 DAS	60 DAS	90 DAS	30 DAS	60DA S	90 DAS
Fertility levels									
F1	0.17	0.56	0.63	12.26	15.43	17.50	15.71	38.86	40.73
F2	0.21	0.70	0.78	15.16	19.08	21.65	19.07	47.19	49.46
F3	0.20	0.65	0.73	14.13	17.77	20.16	17.77	43.95	46.07
F4	0.19	0.62	0.69	13.42	16.89	19.16	16.88	41.76	43.77
SEm±	0.01	0.01	0.02	0.30	0.39	0.39	0.36	0.75	0.91
CD (P= 0.05)	NS	0.05	0.06	1.06	1.35	1.36	1.24	2.60	3.16
Biofertilizers									
B1	0.19	0.63	0.71	13.79	17.35	19.69	17.35	42.92	44.99
B2	0.18	0.59	0.66	12.95	16.26	18.45	16.46	40.72	42.69
B3	0.20	0.67	0.75	14.52	18.27	20.18	18.26	45.18	47.35
SEm±	0.008	0.02	0.02	0.25	0.34	0.33	0.32	0.64	0.84
CD (P= 0.05)	NS	0.05	0.06	0.77	1.02	1.02	0.94	1.94	2.51
FXB	0.19	0.63	0.71	13.79	17.35	19.69	17.35	42.92	44.99

Where F1-Control, F2- RDF 100%, F3- RDF 75%, F4- RDF 50%, B1- Rhizobium + PSB, B2- Rhizobium + PGPR, B3 – Rhizobium + PSB + PGPR

However, maximum protein content was observed with the application of control treatment and lowest protein content was found with the application of 100% RDF. The increase in fertility levels that results higher nitrogen content in 100% fertilized plot which ultimately results low protein content in seeds (Singh *et al.*, 2004).Maximum protein content in seed was recorded with the application of B3 treatment and lowest protein content was found B2 treatment.Application of biofertilizers increase the protein content in seeds because biofertilizers enhance the nutrient uptake and plant use nutrients rapidly and efficiently that results more protein content in seeds (Singh and Prasad 2008).Protein yield influenced significantly by different fertility levels.Maximum protein yield was recorded with the application of 100% RDF which was statistically at par with 75% RDF and 50% RDF but significantly higher than control treatment. Increasing the seed yield increased the protein yield. These results are in tune with (Meena *et al.*, 2005).Protein yield influenced significantly by different biofertilizers treatments. However, maximum protein yield was recorded with the application of B3 treatment which was significantly higher than other treatments. Increasing the seed yield increased the protein yield.

Table 3. Effect of fertility levels and biofertilizers on quality of chickpea

Quality parameter		
Treatment	Protein Content (%)	Protein yield (q/ha)
Fertility levels		
F₁	21.22	427.63
F₂	23.11	572.31
F₃	22.10	523.34
F₄	21.87	485.17
SE_m ±	0.051	11.71
CD (P = 0.05)	0.17	40.42
Biofertilizers		
B₁	21.81	500.68
B₂	21.67	462.74
B₃	22.70	542.91
SE± m	0.039	8.98

CD (P = 0.05)	0.117	26.94
FXB	NS	NS

Where F1-Control, F2- RDF 100%, F3- RDF 75%, F4- RDF 50%, B1- Rhizobium + PSB, B2- Rhizobium + PGPR, B3 – Rhizobium + PSB + PGPR

Conclusion

Based on the finding of the present study, it can be inferred that application of 100% RDF (F₂) with Rhizobium + PSB + PGPR (B₃) resulted maximum growth and root parameters which results ultimate more protein yield of late sown chickpea crop during rabi season in central zone of Uttar Pradesh.

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