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Impact of organic, inorganic and biofertilizers on yield attributing parameters and quality of chickpea (*Cicer arietinum* L.)

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Abstract
A field experiment was conducted at Students' Instructional Farm, Chandra Shekhar Azad University of Agriculture and Technology Kanpur, Uttar Pradesh to study the impact of organic, inorganic and biofertilizers on yield attributes and quality of chickpea (*Cicer arietinum* L) during *Rabi* season for two consecutive years (2018-19 and 2019-20). The experiment comprised of 14 treatments combinations *viz,* T_1(Control), T_2 (100% RDF), T_3 (75% RDF), T_4 (50% RDF), T_5 (100% RDF+ FYM @ 5 t ha^{-1}), T_6 (100% RDF + VC @ 3 t ha^{-1}), T_7 (100% RDF + *Rhizobium* + PSB), T_8 (75% RDF+ FYM @ 5 t ha^{-1}), T_9 (75% RDF + VC @ 3 t ha^{-1}), T_{10} (75% RDF + *Rhizobium* + PSB), T_{11} (50% RDF +FYM @ 5 t ha^{-1}), T_{12} (50% RDF+VC @ 3t ha^{-1}), T_{13} (50% RDF + Rhizobium +PSB), T_{14} (FYM @ 5 t ha^{-1}+ VC @ 3 t ha^{-1}+ *Rhizobium* +PSB) in randomized block design with three replications. Chickpea variety *KGD-1168* was grown with the recommended agronomic practices. Results showed that among the different treatments combination, application of 100% RDF with *Rhizobium* and PSB significantly higher yield attributes, *viz*. number of pods/plants, numbers of seeds/pod except test weight and higher protein content in grain of chickpea.

Keywords: Biofertilizers, chickpea, organic, protein, yield attributes

Introduction
Chickpea (*Cicer arietinum* L.) is an ancient self-pollinated, leguminous and very nutritious crop grown worldwide and one of the most widely consumed pulses in the world. Chickpea as an affordable source of protein (18-22%), carbohydrates, minerals and vitamins, dietary fiber, folate, beta-carotene, significant amounts of all the essential amino acids except the sulfur-containing types and health-promoting fatty acids. Jukanti *et al*. (2012) [10].
In India chickpea occupies 10.17 million ha area, with a production of 11.35 million tonnes registering the productivity of 1116 kg/ha (Anonymous, 2021) [2]. In Uttar Pradesh, chickpea crop occupied 0.62 million hectares area, 0.85 million tonnes production and 1371 kg/ha productivity (Anonymous, 2021) [2].
Pulses can be grown on variety of soil and climatic conditions, play important role in crop rotation, mixed and inter-cropping, maintaining soil fertility through nitrogen fixation, release of soil-bound phosphorus, and thus contribute significantly to sustainability of the farming systems. Nitrogen plays a vital role in increasing the crop production and as a constituent of chlorophyll, protoplasm, nucleic acids and protein which are the building blocks of all proteins including the enzymes which control effectively all biological processes. The role of phosphorus in pulse in energy storage and transfer. An adequate supply of phosphorus early in plant life is important for the reproductive parts of the plants. Phosphorus enhances the activity of rhizobia and increases the formation of root nodules thereby helps in fixing more of atmospheric nitrogen in root nodules Potassium is an essential macro nutrient for plant that enhances root growth and makes plant vigor, helps prevent lodging and enhances crop resistance to pests and diseases.
Biofertilizers, a type of organic fertilizers, are developing as an environmentally safe means of fertilization. It is defined as a substance which contains living micro-organisms which, when applied to seed, plant surfaces, or soil, colonizes the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of nutrients to the host plant (Vessey, 2003) [16]. Nitrogen fixers and phosphate soluble microorganisms play an important role in supplementing nitrogen and phosphorus to the plant, allowing sustainable use of nitrogen and

phosphate fertilizers (Tambekar *et al.*, 2009) [15]. Vermicompost stimulates to influence the microbial activity of soil, increases the availability of oxygen, maintains normal soil temperature, increases soil porosity and infiltration of water, improves nutrient content and increases growth, yield and quality of the plant (Arora *et al*. 2011) [3].

Materials and Methods

Research Site

The experiment was conducted in field number 07 at Students' Instructional Farm, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, which is situated in the alluvial tract of Indo - Gangetic plains in central part of Uttar Pradesh between 25º 26' to 26º 58' North latitude and 79º 31' to 80º34'East longitude at an elevation of 125.9 meters from the sea level. This region falls under agro-climatic zone V (Central Plain Zone) of Uttar Pradesh. The irrigation facilities are adequately available on this farm.

Climate

This zone has semi-arid climatic conditions having alluvial fertile soil. The normal rainfall of the area is about 890 mm per annum. Most of the rains are received from mid-June to the end of the September. The winter months are cooler with occasional rain and frost during last week of December to mid-January. The temperature in the month of May and June may go up to 44-47ºC or beyond and during winter go down to 2-3ºC. Mean relative humidity (7AM) remains nearly constant at about 80-90% from July to end of the March and after March slowly decline to about 40-50% by the end of April and remains 80% up to May.

Properties of the experimental area soil

The soil of the experimental field was originated from alluvial deposits. The soil type and fertility status were determined by the mechanical and chemical analysis of the soil. In order to ascertain physio-chemical properties of the experimental soil, primary soil samples were drawn randomly up to 15cm depth from different spots of the entire experimental area. The soil of the experimental field was sandy loam in texture, well drained, plane topography, alkaline in nature having initial values pH (7.80), EC (0.387 dsm^{-1}), medium in organic carbon (0.455%), low in available nitrogen (215.05 kg ha^{-1}), medium in phosphorus (11.09 kg ha^{-1}) and Potash (149.75 kg ha^{-1}).

Experimental Details

The experiment comprised of 14 treatment combinations *viz*, T_1(Control), T_2 (100% RDF), T_3 (75% RDF), T_4 (50% RDF), T_5 (100% RDF+ FYM @ 5 t ha^{-1}), T_6 (100% RDF + Vermicompost @ 3 t ha^{-1}), T_7 (100% RDF + *Rhizobium* + PSB), T_8 (75% RDF+ FYM @ 5 t ha^{-1}), T_9 (75% RDF + Vermicompost @ 3 t ha^{-1}), T_{10} (75% RDF + *Rhizobium* + PSB), T_{11} (50% RDF +FYM @ 5 t ha^{-1}), T_{12} (50% RDF+ Vermicompost @ 3t ha^{-1}), T_{13} (50% RDF + Rhizobium +PSB), T_{14} (FYM @ 5 t ha^{-1}+ Vermicompost @ 3 t ha^{-1}+ *Rhizobium* +PSB) in randomized block design(RBD) with three replications. Recommended dose of fertilizer at 20:60:20 kg N, P_2O_5 and K_2O ha^{-1} respectively were supplied through urea, single superphosphate (SSP) and muriate of potash (MOP). Starter dose of nitrogen and full dose of phosphorus and potassium as per treatment were applied as basal. Vermicompost applied @ 3 t ha^{-1} at the time of sowing and FYM @ 5 t ha^{-1} applied 15 days before sowing as per treatment. Before sowing, seed was treated with biofertilizers (*Rhizobium* and PSB) (20 g kg^{-1} seed) as per standard procedure after drying of 6 hours under shade. Chickpea cultivar *Alok* (KGD-1168) was sown at row to row spacing 40 cm and plant to plant spacing of 10 cm apart during first week of November with a seed rate of 80 kg ha^{-1}.

The observations were recorded on yield attributes such as pods/plants, seeds/pod, test weight and yield. Protein content of chickpea seed was determined by multiplying the N content of chickpea seed with factor 6.25 (N % × 6.25). Nitrogen uptake and protein yield of chickpea seed was computed from the following formulae (Rhee, 2001) [14]. Protein yield of chickpea (kg/ha) was calculated through protein content (%) multiplied by seed yield (kg/ha) and divided by 100. The information was analyzed statistically with standard procedure of ANOVA technique. The standard errors of mean were calculated in each item of investigation and critical differences (CD) at 5% level were worked out for comparing the treatment mean wherever 'F' test was found significant Chandel (1998) [4].

Result and Discussion

Yields and yield attributes

Seed and stover yield were influenced significantly due to organic, inorganic and biofertilizers application. It is evident from the pooled data given in Table 1 that the maximum grain and stover yield was observed with application of *Rhizobium* + PSB along with 100% RDF (T_7) gave the highest seed yield (22.85 q ha^{-1}) and stover yield (31.50 q ha^{-1}) which was statistically at par with vermicompost @ 3 t ha^{-1} along with 100% RDF (T_6) but significantly higher than rest of the treatments. The surge in seed and stover yields under adequate nutrients supply might be attributed to mainly to the collective effect of a greater number of pods/plants, seeds/pod and higher test weight, which was the result of improved translocation of photosynthates from source to sink ultimately yield is increased. The increase in seed yield under adequate nutrients supply mainly due to more yield attributes ultimately resulted more seed yield. These results also confirm findings of Prasad *et al*., (2005) [13] and Gupta (2006) [7].

Organic, inorganic and biofertilizers treatments have significantly influenced the yield attributes, *viz*. number of pods/plant and numbers of seeds/pod except test weight (Table 1). Number of pod plant^{-1} increased significantly in all the treatments over control during both the years. Maximum no. of pod plant^{-1} 67.78 was noted with (T_7) *Rhizobium* + PSB along with 100% RDF which was statistically at par with 100% RDF+ Vermicompost @ 3 t ha^{-1} (T_6) and but significantly higher than rest of the treatments. The number of seeds pod^{-1} significantly influenced by in all the treatments over control during both the years. Maximum number of seed pod^{-1} (1.70) was noted with T_7 (100% RDF + *Rhizobium* + PSB) followed by (1.64) with T_6 (100% RDF + VC @ 3 t ha^{-1}) which was significantly higher than rest of the treatments but both the treatments are statistically at par with each other. The minimum number of seeds pod^{-1} observed at control (T_1). The results reveled that test weight in grain was non-significantly influenced by the different treatments during both the years. Maximum increases in test weight were recorded 185.80 gm with T_7 (100% RDF + *Rhizobium* + PSB) and minimum 176.27 gm at control (T_1). Enhanced yield attributes with the combined application of organic, inorganic and biofertilizers, which contributed favorable condition for plant growth by increasing the availability of nutrients to plant and enhancing the branching and leaf area for photosynthesis. These findings are on the line with those reported by Prasad *et al.* (2005) [13], Mustafa *et al.* (2008) [11], Islam *et al*. (2010) [8], and Gangwar and Dubey (2012) [6].

Protein content (%) and protein yield (kg/ha) in grain

The data pertaining to protein content and protein yield in chickpea grain are given in Table -1. The protein content was significantly affected by organic, inorganic and biofertilizers management practices. Maximum protein content (21.71%) and protein yield (496.24 kg/ ha) with T_7 (100% RDF + *Rhizobium* + PSB) which is significantly higher over control and minimum at control (T_1). The higher protein content in grain might be due to greater accumulation of nitrogen in chickpea grain as it is major constitute of protein. The higher nitrogen content in chickpea grain may be achieved due to availability of nitrogen in adequate amount because of better root nodulation and root growth under T_7 treatment. Result of the present study are in conformity with the results of other investigators, Ahmed *et al.* (2003) [1], Elsheikh *et al.* (2001) [5], and Patel *et al.* (2013) [12].

Table 1: Effect of organic, inorganic and biofertilizers on yield attributes, yields, protein content and protein yield of chickpea (pooled data of 2 years)

Treatment	No of pods/plant	No of seeds/pod	Test weight (g)	Grain yield (q/ha)	Stover yield (q/ha)	Protein content (%)	Protein yield (kg/ha)
T_1: Control	29.81	1.06	176.27	10.05	14.30	19.25	193.54
T_2: 100% RDF	56.19	1.45	181.94	18.94	26.34	20.06	380.05
T_3: 75% RDF	43.53	1.16	179.96	14.69	20.33	19.50	286.18
T_4: 50% RDF	39.86	1.10	179.16	13.44	18.49	19.38	260.44
T_5: 100% RDF+ FYM @5 t ha^{-1}	61.32	1.60	183.07	20.67	28.80	21.25	439.49
T_6: 100% RDF + Vermicompost @ 3 t ha^{-1}	65.40	1.64	183.44	22.05	30.61	21.56	475.44
T_7: 100% RDF + *Rhizobium* + PSB	67.78	1.70	185.80	22.85	31.50	21.71	496.24
T_8: 75% RDF+ FYM@ 5 t ha^{-1}	56.34	1.45	180.94	18.99	27.00	20.06	381.05
T_9: 75% RDF + Vermicompost @ 3 t ha^{-1}	61.45	1.56	181.20	20.55	28.53	21.00	431.60
T_{10}: 75% RDF +*Rhizobium*+ PSB	62.70	1.62	181.93	21.14	29.45	21.38	451.92
T_{11}: 50% RDF +FYM@ 5 t ha^{-1}	47.09	1.28	179.69	15.87	21.94	19.56	310.56
T_{12}: 50% RDF+ Vermicompost @ 3t ha^{-1}	50.45	1.36	179.48	17.01	23.59	19.68	334.89
T_{13}: 50% RDF + *Rhizobium* +PSB	53.79	1.47	179.77	18.19	25.21	19.81	352.54
T_{14}: FYM @ 5 t ha^{-1}+ Vermicompost @ 3t ha^{-1}+ *Rhizobium* +PSB	55.23	1.50	180.83	18.62	25.60	20.49	381.67
S.Em ±	1.13	0.03	2.00	0.57	0.69	0.23	4.36
CD (P= 0.05)	3.20	0.09	N. S	1.62	1.98	0.64	12.38

Conclusion

On the basis of present investigation, it may conclude that with the application of *Rhizobium* + PSB along with 100% recommended dose of fertilize (RDF) is good option for achieving higher yield attributes, yield and better grain quality of chickpea crop.

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