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# Study the effect of organic, inorganic and biofertilizers on nutrients content and uptake of chickpea (*Cicer arietinum* L.)

**Anshul Singh, Devendra Singh, Ravindra Kumar, Sudhir Pal, Ravindra Sachan and Ankit Yadav**

**Abstract**
A field experiment was conducted at Students' Instructional Farm, Chandra Shekhar Azad University of Agriculture and Technology Kanpur, Uttar Pradesh to study the effect of organic, inorganic and biofertilizers on nutrients content, and uptake of chickpea (*Cicer arietinum* L.) during *Rabi* season for two consecutive years (2018-19 and 2019-20). The experiment comprised of 14 treatment $T_1$(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 $tha^{-1}$+ *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 recorded maximum nutrients content and uptake in grain and stover of chickpea crop.

**Keywords:** Biofertilizers, chickpea, inorganic, organic, Rhizobium, vermicompost

## 1. Introduction
Chickpea is an ancient crop grown worldwide and one of the most widely consumed pulses in the world. Chickpea is a very nutritious crop and also has many medicinal properties provide nutritionally balanced food. Chickpea as an affordable source of protein (17-22%), 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) [11]. India is the largest producer (25% of global production), consumer (27% of world consumption) and importer (14%) of pulses in the world. India ranks first in the world in terms of pulse production (25% of total worlds production) (FAOSTAT 2017) [4]. 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 is accountable for the growth and development of plant. It 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.
*Rhizobium* and phosphate solubilizing bacteria (PSB) assume a countless importance on account of their dynamic role in $N_2$-fixation and P solubilizations. Use of Rhizobium and PSB had shown advantage in improving chickpea productivity (Rudresh *et al*. 2005) [20]. Vermicompost is a finely divided peat-like material with excellent structure, porosity, aeration, drainage and moisture-holding capacity (Ismail 2005) [6]. Vermicompost plays a vital role in dictating the biochemical cycles as it supports the growth and activities of soil micro flora. It enhances the colonization of *Mycorrhizae*, *Rhizobium*, *Azotobacter* and *Azospirillum* which in

turn improve the nitrogen (N) as well as phosphorus ($P_2O_5$) supply and other micronutrients (Zn, Fe, Cu, Mn) besides imparting the resistance to plant against various soil borne diseases and insect pest attack. Vasanthi and Subramanian. (2004) [24]. observed that the highest crude protein N, P and K concentration and uptake were recorded with the application of vermicompost @ 2 t $ha^{-1}$ along with 100 percent recommended levels of N, P and K. Mahetele *et al.* (2011) [15] reported that FYM addition @ 10 t $ha^{-1}$ to soil improved the supply of plant available nutrient and brought about favorable soil environment which ultimately increased nutrient and water holding capacity of soil for longer period.

Indiscriminate use of chemical fertilizers has brought loss of vital soil fauna and flora. Organic manures modify the soil physical behavior and increase the efficiency of applied nutrients (Pandey *et al*. 2007) [18]. Organic manures not only supply a higher amount of different nutrient elements but also contains beneficial microbes like nitrogen fixing bacteria, mycorrhizae and growth promoting substances for betterment of crops (Barik *et al*., 2006) [1].

This study was commenced to determine the effect of organic, inorganic and biofertilizers on nutrient content, and uptake of chickpea crop.

## 2. Materials and Methods

### 2.1 Research Site

The experiment was conducted 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.

**2.2 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.

### 2.3 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 (7.81 and 7.80), EC (0.381 and 0.393$dsm^{-1}$), medium in organic carbon (0.452% and 0.459%), low in available nitrogen (215.20 and 214.90 kg $ha^{-1}$), medium in phosphorus (11.07 and 11.12 kg $ha^{-1}$) and Potash (150.00 and 149.50 kg $ha^{-1}$).

### 2.4 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 chemical analysis of plants for the nutrient content was done when grain and straw samples were collected from each treatment at harvest to analyse nitrogen, phosphorous and potassium concentration (%) and their uptake (kg $ha^{-1}$). The plant material was oven dried (70± $5^0$C for 72 hours) and ground separately and then subjected to analysis.Plant analysis for the determination of nutrient content in grain and stover were done with the standard procedures viz., nitrogen concentration in plant (both grain and straw) was determined by micro-kjeldahl's method (Jackson, 1973) [7], phosphorus by vanado-molybdo phosphoric acid yellow colour method (Jackson, 1973) [7], potassium by flame photometer (Jackson, 1973) [7]. The uptake of nitrogen, phosphorus, potassium and were done by the following formula

$$\text{Nutrient uptake by grain or stover (kg ha}^{-1}) = \frac{\text{Nutrient content in grain or stover (\%)} \times \text{grain or stover yield (kg ha}^{-1})}{100}$$

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) [2].

## 3. Result and Discussion

**3.1 Nitrogen content and uptake:** The significantly higher value of nitrogen content in grain and stover (Table 1 & 2) was noticed with the application of *Rhizobium* + PSB along with 100% recommended dose of fertilizer (RDF) which was statistically at par with 100% RDF+ Vermicompost @ 3 t $ha^{-1}$ ($T_6$) and 75% RDF + *Rhizobium* + PSB($T_{10}$) but significantly higher than rest of the treatments during both the years of study and on pooled basis. The lowest values of nitrogen content in grain and stover were observed in control ($T_1$) where no fertilizer was given to chickpea crop during both the

years and on pooled basis. The higher concentration of N to be attributed to higher availability and synergetic effects of the nutrients each other in grain and stover during both the years. These findings are in close conformity with the results of Jain *et al*. (2005) [8].

The nitrogen uptake in grain and stover of chickpea (Table 3 & 4) was significantly influenced in all the treatments over control by organic, inorganic and biofertilizers management practices during both the years. *Rhizobium* + PSB along with 100% recommended dose of fertilizer ($T_7$) showed the highest uptake of N in grain and stover which was statistically at par with 100% RDF+ Vermicompost @ 3 t $ha^{-1}$ ($T_6$) but significantly higher than rest of the treatments, however minimum N uptake in grain and stover was observed in control ($T_1$) during both the years of study. Increased in uptake of nitrogen was observed due to higher nitrogen fixing capacity of plant roots. Kharche *et al*. (2006) [14].

### 3.2 Phosphorus content and uptake

The data related to phosphorus content in grain and stover of chickpea are presented in Table 1 and 2. The phosphorus content in grain and straw was significantly influenced during both the years. Maximum P content in grain and straw was recorded with $T_7$ (100% RDF + *Rhizobium* + PSB) which was statistically at par with 100% RDF+ Vermicompost @ 3 t $ha^{-1}$ ($T_6$) and 75% RDF + *Rhizobium* + PSB($T_{10}$) but significantly higher than rest of the treatment's during both the years of study. The lowest values of phosphorus content in grain and stover were observed with control ($T_1$) during both the years of study and on pooled basis. The increase in nutrient content after the addition of biofertilizers especially phosphorus solubilizing bacteria and *Rhizobium* may be because of the mobilization of nutrients. These findings corroborate the results of Jain and Singh (2003) [9] and Dadgale *et al*. (2011) [3].

The significantly higher phosphorus uptake (Table 2&4) by grain and stover was noticed with the application of $T_7$ (100% RDF + *Rhizobium* + PSB) followed by 100% RDF + VC @ 3 t $ha^{-1}$ ($T_6$) and minimum at control $T_1$ during first year and second year. Treatments $T_6$, and $T_7$ were found at par with each other and significantly superior to rest of the treatments. Inoculation of biofertilizers increasing the availability of phosphorus through the mobilizing the unavailable phosphorus present in the soil. Similar findings have also been reported by Kalipada and Singh (2003) [12], Thenua *et al*. (2010) [23].

### 3.3 Potassium content and uptake

The data pertaining to potassium content in grain and stover (Table 1 and 2) of chickpea showed significant influence in K content in all the treatments over control. Maximum K content was noted with $T_7$ (100% RDF + *Rhizobium* + PSB) followed by $T_6$ (100% RDF + Vermicompost @ 3 t $ha^{-1}$) and minimum at control ($T_1$) during first and second year. Treatments $T_6$, $T_7$ and $T_{10}$ were found at par with each other and significantly superior to rest of the treatments. These results also confirm with findings of Singh and Prasad (2008) [22] and Murari *et al*. (2013) [17].

The uptake of K in grain and stover of chickpea was also influenced with application of organic, inorganic and biofertilizer during both the years of study. The highest uptake of K in grain and stover of chickpea was recorded with treatment $T_7$ (100% RDF + *Rhizobium* + PSB) followed $T_6$ (100% RDF + VC @ 3 t $ha^{-1}$) and minimum at control $T_1$ during first year and second year respectively. *Rhizobium* + PSB and organic fertilizer application with inorganic might be increased nutrient availability, influences rhizosphere bacteria and microorganisms to increase mineral nutrition of plants by changing root-uptake characteristics, modification of root morphology or alteration of uptake mechanism, relative growth rate or internal composition of chickpea plant These findings are in close conformity with the results of Sahu *et al*. (2008) [21], Meena and Sharma (2010) [16], and Jangir *et al*. (2017) [10].

**Table 1:** Effect of organic, inorganic and biofertilizers on nutrient content (%) in grain of chickpea

| Treatment | Nutrient content in grain (%) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | N | | | P | | | K | | |
| | 2018-19 | 2019-20 | Pooled | 2018-19 | 2019-20 | Pooled | 2018-19 | 2019-20 | pooled |
| $T_1$: Control | 3.07 | 3.09 | 3.08 | 1.18 | 1.20 | 1.19 | 0.53 | 0.54 | 0.53 |
| $T_2$: 100% RDF | 3.20 | 3.22 | 3.21 | 1.25 | 1.27 | 1.26 | 0.58 | 0.60 | 0.59 |
| $T_3$: 75% RDF | 3.11 | 3.13 | 3.12 | 1.22 | 1.24 | 1.23 | 0.57 | 0.58 | 0.57 |
| $T_4$: 50% RDF | 3.09 | 3.11 | 3.10 | 1.20 | 1.26 | 1.23 | 0.56 | 0.57 | 0.56 |
| $T_5$: 100% RDF+ FYM @5 t $ha^{-1}$ | 3.39 | 3.41 | 3.40 | 1.34 | 1.37 | 1.35 | 0.63 | 0.64 | 0.63 |
| $T_6$: 100% RDF + VC @ 3 t $ha^{-1}$ | 3.44 | 3.46 | 3.45 | 1.42 | 1.44 | 1.43 | 0.66 | 0.67 | 0.66 |
| $T_7$: 100% RDF + RC + PSB | 3.46 | 3.49 | 3.47 | 1.43 | 1.45 | 1.44 | 0.67 | 0.69 | 0.68 |
| $T_8$: 75% RDF+ FYM@ 5 t $ha^{-1}$ | 3.20 | 3.22 | 3.21 | 1.25 | 1.27 | 1.26 | 0.58 | 0.59 | 0.58 |
| $T_9$: 75% RDF + VC @ 3 t $ha^{-1}$ | 3.35 | 3.37 | 3.36 | 1.28 | 1.30 | 1.29 | 0.59 | 0.61 | 0.60 |
| $T_{10}$: 75% RDF +RC+ PSB | 3.41 | 3.43 | 3.42 | 1.38 | 1.40 | 1.39 | 0.64 | 0.65 | 0.64 |
| $T_{11}$: 50% RDF +FYM@ 5 t $ha^{-1}$ | 3.12 | 3.14 | 3.13 | 1.24 | 1.26 | 1.25 | 0.58 | 0.60 | 0.59 |
| $T_{12}$: 50% RDF+VC @ 3t $ha^{-1}$ | 3.14 | 3.16 | 3.15 | 1.25 | 1.27 | 1.26 | 0.57 | 0.58 | 0.57 |
| $T_{13}$: 50% RDF + RC +PSB | 3.16 | 3.18 | 3.17 | 1.26 | 1.28 | 1.27 | 0.58 | 0.59 | 0.58 |
| $T_{14}$: FYM @ 5 t $ha^{-1}$+ VC @ 3t $ha^{-1}$+RC +PSB | 3.27 | 3.29 | 3.28 | 1.27 | 1.28 | 1.28 | 0.59 | 0.60 | 0.59 |
| S.Em ± | 0.05 | 0.05 | 0.04 | 0.02 | 0.03 | 0.02 | 0.01 | 0.01 | 0.07 |
| CD at 5% | 0.15 | 0.15 | 0.10 | 0.08 | 0.09 | 0.06 | 0.03 | 0.03 | 0.02 |

**Table 2:** Effect of organic, inorganic and biofertilizers on nutrient content (%) in stover of chickpea.

| Treatment | Nutrient content in Stover (%) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | N | | | P | | | K | | |
| | 2018-19 | 2019-20 | Pooled | 2018-19 | 2019-20 | Pooled | 2018-19 | 2019-20 | pooled |
| $T_1$: Control | 1.95 | 1.97 | 1.96 | 0.22 | 0.23 | 0.22 | 1.66 | 1.68 | 1.67 |
| $T_2$: 100% RDF | 2.06 | 2.08 | 2.07 | 0.25 | 0.26 | 0.25 | 1.73 | 1.75 | 1.74 |
| $T_3$: 75% RDF | 2.02 | 2.05 | 2.03 | 0.23 | 0.24 | 0.24 | 1.69 | 1.71 | 1.70 |
| $T_4$: 50% RDF | 1.99 | 2.02 | 2.00 | 0.24 | 0.25 | 0.24 | 1.68 | 1.70 | 1.69 |
| $T_5$: 100% RDF+ FYM @5 t $ha^{-1}$ | 2.22 | 2.24 | 2.23 | 0.27 | 0.28 | 0.27 | 1.78 | 1.80 | 1.79 |
| $T_6$: 100% RDF + VC @ 3 t $ha^{-1}$ | 2.29 | 2.33 | 2.31 | 0.29 | 0.30 | 0.29 | 1.81 | 1.83 | 1.82 |
| $T_7$: 100% RDF + RC + PSB | 2.37 | 2.39 | 2.38 | 0.30 | 0.32 | 0.31 | 1.85 | 1.87 | 1.86 |
| $T_8$: 75% RDF+ FYM@ 5 t $ha^{-1}$ | 2.06 | 2.08 | 2.07 | 0.25 | 0.26 | 0.25 | 1.75 | 1.77 | 1.76 |
| $T_9$: 75% RDF + VC @ 3 t $ha^{-1}$ | 2.11 | 2.14 | 2.12 | 0.26 | 0.27 | 0.26 | 1.67 | 1.69 | 1.68 |
| $T_{10}$: 75% RDF +RC+ PSB | 2.35 | 2.37 | 2.36 | 0.28 | 0.29 | 0.28 | 1.80 | 1.82 | 1.81 |
| $T_{11}$: 50% RDF +FYM@ 5 t $ha^{-1}$ | 2.05 | 2.07 | 2.06 | 0.25 | 0.26 | 0.25 | 1.71 | 1.73 | 1.72 |
| $T_{12}$: 50% RDF+VC @ 3t $ha^{-1}$ | 2.06 | 2.08 | 2.07 | 0.26 | 0.27 | 0.26 | 1.74 | 1.76 | 1.75 |
| $T_{13}$: 50% RDF + RC +PSB | 2.07 | 2.10 | 2.08 | 0.26 | 0.27 | 0.26 | 1.76 | 1.78 | 1.77 |
| $T_{14}$: FYM @ 5 t $ha^{-1}$+ VC @ 3t $ha^{-1}$+RC +PSB | 2.08 | 2.11 | 2.09 | 0.27 | 0.28 | 0.27 | 1.78 | 1.79 | 1.79 |
| S.Em ± | 0.03 | 0.03 | 0.02 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.01 |
| CD at 5% | 0.10 | 0.10 | 0.07 | 0.02 | 0.03 | 0.02 | 0.05 | 0.06 | 0.04 |

**Table 3:** Effect of organic, inorganic and biofertilizers on nutrient uptake (kg $ha^{-1}$) in grain of chickpea.

| Treatment | Nutrient Uptake in Grain (kg $ha^{-1}$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | N | | | P | | | K | | |
| | 2018-19 | 2019-20 | Pooled | 2018-19 | 2019-20 | Pooled | 2018-19 | 2019-20 | pooled |
| $T_1$: Control | 29.10 | 32.82 | 30.96 | 11.19 | 12.14 | 11.66 | 5.02 | 5.73 | 5.37 |
| $T_2$: 100% RDF | 58.08 | 63.56 | 60.82 | 22.69 | 25.07 | 23.88 | 10.53 | 11.84 | 11.18 |
| $T_3$: 75% RDF | 44.78 | 46.79 | 45.78 | 17.57 | 18.54 | 18.05 | 8.21 | 8.67 | 8.44 |
| $T_4$: 50% RDF | 39.55 | 43.79 | 41.67 | 15.36 | 17.74 | 16.55 | 7.17 | 8.03 | 7.60 |
| $T_5$: 100% RDF+ FYM @5 t $ha^{-1}$ | 67.80 | 72.80 | 70.30 | 26.80 | 29.25 | 28.02 | 12.60 | 13.66 | 13.13 |
| $T_6$: 100% RDF + VC @ 3 t $ha^{-1}$ | 73.27 | 78.89 | 76.08 | 30.25 | 32.83 | 31.54 | 14.05 | 15.28 | 14.66 |
| $T_7$: 100% RDF + RC + PSB | 76.67 | 82.15 | 79.41 | 31.69 | 34.13 | 32.91 | 14.85 | 16.24 | 15.54 |
| $T_8$: 75% RDF+ FYM@ 5 t $ha^{-1}$ | 58.24 | 63.72 | 60.98 | 22.75 | 25.13 | 23.94 | 10.56 | 11.67 | 11.11 |
| $T_9$: 75% RDF + VC @ 3 t $ha^{-1}$ | 65.69 | 72.42 | 69.05 | 25.10 | 27.94 | 26.52 | 11.57 | 13.10 | 11.62 |
| $T_{10}$: 75% RDF +RC+ PSB | 69.29 | 72.92 | 71.10 | 28.04 | 30.74 | 29.39 | 13.00 | 14.27 | 13.63 |
| $T_{11}$: 50% RDF +FYM@ 5 t $ha^{-1}$ | 47.11 | 52.28 | 49.69 | 18.72 | 20.98 | 19.85 | 8.78 | 9.99 | 9.38 |
| $T_{12}$: 50% RDF+VC @ 3t $ha^{-1}$ | 50.93 | 56.24 | 53.58 | 20.27 | 22.61 | 21.44 | 9.25 | 10.32 | 9.78 |
| $T_{13}$: 50% RDF + RC +PSB | 54.98 | 60.36 | 57.67 | 21.92 | 24.29 | 23.10 | 10.09 | 11.19 | 10.64 |
| $T_{14}$: FYM @ 5 t $ha^{-1}$+ VC @ 3t $ha^{-1}$+RC +PSB | 58.14 | 64.02 | 61.08 | 22.58 | 25.10 | 23.84 | 10.49 | 11.68 | 11.08 |
| S.Em ± | 0.95 | 1.03 | 0.70 | 0.92 | 1.08 | 0.70 | 0.06 | 0.49 | 0.33 |
| CD at 5% | 2.76 | 2.99 | 1.99 | 2.69 | 3.14 | 1.98 | 1.35 | 1.43 | 0.94 |

**Table 4:** Effect of organic, inorganic and biofertilizers on nutrient uptake (kg $ha^{-1}$) in stover of chickpea.

| Treatment | Nutrient uptake in Stover (kg $ha^{-1}$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | N | | | P | | | K | | |
| | 2018-19 | 2019-20 | Pooled | 2018-19 | 2019-20 | Pooled | 2018-19 | 2019-20 | pooled |
| $T_1$: Control | 26.61 | 29.45 | 28.03 | 3.00 | 3.44 | 3.22 | 22.65 | 25.11 | 23.88 |
| $T_2$: 100% RDF | 51.97 | 57.12 | 54.54 | 6.30 | 7.14 | 6.72 | 43.65 | 48.06 | 45.85 |
| $T_3$: 75% RDF | 40.30 | 42.48 | 41.39 | 4.90 | 4.97 | 4.93 | 33.72 | 35.43 | 34.57 |
| $T_4$: 50% RDF | 35.14 | 39.03 | 37.08 | 4.24 | 4.83 | 4.53 | 29.67 | 32.84 | 31.25 |
| $T_5$: 100% RDF+ FYM @5 t $ha^{-1}$ | 61.83 | 66.64 | 64.23 | 7.52 | 8.33 | 7.92 | 49.57 | 53.55 | 51.56 |
| $T_6$: 100% RDF + VC @ 3 t $ha^{-1}$ | 68.03 | 73.44 | 70.73 | 8.61 | 9.45 | 9.03 | 53.77 | 57.68 | 55.72 |
| $T_7$: 100% RDF + RC + PSB | 73.23 | 76.72 | 74.95 | 9.27 | 10.27 | 9.77 | 56.86 | 60.03 | 58.44 |
| $T_8$: 75% RDF+ FYM@ 5 t $ha^{-1}$ | 52.12 | 59.70 | 55.91 | 6.33 | 7.45 | 6.89 | 44.27 | 50.80 | 47.53 |
| $T_9$: 75% RDF + VC @ 3 t $ha^{-1}$ | 57.52 | 63.77 | 60.64 | 7.09 | 8.05 | 7.57 | 45.52 | 50.36 | 47.94 |
| $T_{10}$: 75% RDF +RC+ PSB | 66.50 | 72.54 | 69.52 | 7.92 | 8.88 | 8.40 | 50.94 | 55.71 | 53.32 |
| $T_{11}$: 50% RDF +FYM@ 5 t $ha^{-1}$ | 42.80 | 47.63 | 45.21 | 5.22 | 5.98 | 5.60 | 35.77 | 39.81 | 37.75 |
| $T_{12}$: 50% RDF+VC @ 3t $ha^{-1}$ | 46.31 | 51.40 | 48.85 | 5.84 | 6.67 | 6.25 | 39.12 | 43.43 | 41.27 |
| $T_{13}$: 50% RDF + RC +PSB | 49.89 | 55.27 | 52.58 | 6.27 | 7.11 | 6.69 | 42.42 | 46.85 | 44.63 |
| $T_{14}$: FYM @ 5 t $ha^{-1}$+ VC @ 3t $ha^{-1}$+RC +PSB | 50.86 | 56.46 | 53.66 | 6.60 | 7.49 | 7.04 | 43.52 | 47.90 | 45.71 |
| S.Em ± | 2.314 | 3.086 | 1.89 | 0.35 | 0.415 | 0.27 | 1.543 | 1.85 | 1.18 |
| CD at 5% | 6.73 | 8.97 | 5.37 | 1.03 | 1.206 | 0.76 | 4.48 | 5.38 | 3.35 |

*FYM- Farm yard manure, PSB- phosphorus solubilizing bacteria, RDF-recommended dose of fertilizer, RC-Rhizobium, VC- vermicompost

### 3.4 Grain and stover yield

Application of organic, inorganic and biofertilizers significantly influenced the grain and straw yield of chickpea during both the years. It is evident from the data given in

Table 5 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 increase in grain and straw yield due to adequate supply of available nutrients to crop resulting in better growth and development eventually reflected into better grain and stover yields. The increase in yields with biofertilizers was mainly due to the increase in almost all growth and yield contributing characters, which eventually lead to a significant increase in grain and straw yields. These results also confirm with findings of Kantar *et al*., (2003) [13], Prasad *et al*., (2005) [19], Gupta (2006) [5].

**Table 5:** Effect of organic, inorganic and biofertilizers on grain and stover yield (q $ha^{-1}$) of chickpea.

| Treatment | Grain Yield (q $ha^{-1}$) | | | Stover Yield (q $ha^{-1}$) | | |
|---|---|---|---|---|---|---|
| | 2018-19 | 2019-20 | Pooled | 2018-19 | 2019-20 | Pooled |
| $T_1$: Control | 9.48 | 10.62 | 10.05 | 13.65 | 14.95 | 14.30 |
| $T_2$: 100% RDF | 18.15 | 19.74 | 18.94 | 25.23 | 27.46 | 26.34 |
| $T_3$: 75% RDF | 14.40 | 14.95 | 14.69 | 19.95 | 20.72 | 20.33 |
| $T_4$: 50% RDF | 12.80 | 14.08 | 13.44 | 17.66 | 19.32 | 18.49 |
| $T_5$: 100% RDF+ FYM @5 t $ha^{-1}$ | 20.00 | 21.35 | 20.67 | 27.85 | 29.75 | 28.80 |
| $T_6$: 100% RDF + VC @ 3 t $ha^{-1}$ | 21.30 | 22.80 | 22.05 | 29.71 | 31.52 | 30.61 |
| $T_7$: 100% RDF + RC + PSB | 22.16 | 23.54 | 22.85 | 30.90 | 32.10 | 31.50 |
| $T_8$: 75% RDF+ FYM@ 5 t $ha^{-1}$ | 18.20 | 19.79 | 18.99 | 25.30 | 28.70 | 27.00 |
| $T_9$: 75% RDF + VC @ 3 t $ha^{-1}$ | 19.61 | 21.49 | 20.55 | 27.26 | 29.80 | 28.53 |
| $T_{10}$: 75% RDF +RC+ PSB | 20.32 | 21.96 | 21.14 | 28.30 | 30.61 | 29.45 |
| $T_{11}$: 50% RDF +FYM@ 5 t $ha^{-1}$ | 15.10 | 16.65 | 15.87 | 20.88 | 23.01 | 21.94 |
| $T_{12}$: 50% RDF+VC @ 3t $ha^{-1}$ | 16.22 | 17.80 | 17.01 | 22.48 | 24.71 | 23.59 |
| $T_{13}$: 50% RDF + RC +PSB | 17.40 | 18.98 | 18.19 | 24.10 | 26.32 | 25.21 |
| $T_{14}$: FYM @ 5 t $ha^{-1}$+ VC @ 3t $ha^{-1}$+RC +PSB | 17.78 | 19.46 | 18.62 | 24.45 | 26.76 | 25.60 |
| S.Em ± | 0.76 | 0.85 | 0.57 | 0.92 | 1.08 | 0.69 |
| CD at 5% | 2.19 | 2.47 | 1.62 | 2.69 | 3.14 | 1.98 |

*FYM- Farm yard manure, PSB- phosphorus solubilizing bacteria, RDF-recommended dose of fertilizer, RC-Rhizobium, VC- vermicompost

## 4. Conclusion

The overall results obtained from the present study facilitated to draw the following conclusions.

Biofertilizers and inorganic fertilizers played an important role on content of plant nutrients and uptake of nutrients in chickpea. The combination of *Rhizobium* + PSB along with 100% recommended dose of fertilize (RDF) recorded highest plant nutrients status as well as nutrients uptake in chickpea crop as compared to application of inorganic fertilizers alone.

Thus, it may be concluded that *Rhizobium* and Phosphorus solubilizing bacteria (PSB) along with 100% recommended dose of fertilizer applied is good option for achieving higher nutrients content and uptake of chickpea crop.

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