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Different Fertilizer Dose And Bio-Fertilizer Inoculation's Effect On N, P And K Content And Uptake Of Chickpea (Cicer Arietinum L.)

SALCHAME A. SANGMA[1], NITIN M. CHANGADE[2]

[1,2]School of Agriculture, Lovely Professional University, Phagwara Punjab-14411, India
E-mail: ernitin1181@gmail.com[2]

Abstract: A field experiment was carried out to study the effect of different fertilizer doses and bio-fertilizer inoculation on nutrient content and uptake of chickpea (Cicer arietinum L.). Complete Randomized Block Design with 3 replications and 7 treatments was used for the study and the experiment was conducted during rabi season of 2017-2018 in the experimental farm of Lovely Professional University, Phagwara, Punjab. Application of 100 % RDF (T1) and 75% RDF + PSB as soil application + Rhizobium as seed treatment (T2) showed remarkable results on seed and stover yield; nutrient content and uptake by seed and stover; and protein content of the seed. Significantly higher seed yield (1348.75 kg ha-1) and stover yield (2370.37 kg ha-1) of chickpea was observed on application of 75% RDF + PSB as soil application + Rhizobium as seed treatment (T2) and 100% RDF (T1) respectively. Higher nutrient content in seed and stover, higher nutrient uptake by stover and higher protein content in seed was recorded with the application of 100% RDF which remained at par with T2. Interestingly, higher nutrient uptake by chickpea seed was revealed with the application of 75% RDF + PSB as soil application + Rhizobium as seed treatment and it remained at par with T1.

Keywords: Chickpea, PSB, Rhizobium, RDF, Protein content, Nutrient content, Nutrient uptake.

1. INTRODUCTION

Pulses contribute 16-18% of total protein of Indian average diet. It also contains essential nutrients such as Calcium, Iron, Vitamins namely carotene, thiamine, riboflavin, niacin, etc. (Kumar, 2014). Besides, the stover of pulses possesses good forage value which can be used as an animal feed. In addition, their contribution in maintaining soil fertility and health through natural nitrogen fixation is significant and thus play a crucial role in sustainable agriculture (ChitraMani & Kumar, P. (2020); Sharma, M., & Kumar, P. (2020); Chand, J., & Kumar, P. (2020); Naik, M., & Kumar, P. (2020); Kumar, P., & Naik, M. (2020); Kumar, P., & Dwivedi, P. (2020). "India is the world's biggest producer of the pulses and occupies an area of 23.89 million hectares with the production of 15.12 million tons" (Anon, 2009), which is comparatively very low to the average pulse yield (857 kg ha-1) of the world (Patel, 2011). In 2014, the area and the production were increased to 26.40 million hectares and 18.24 million tons respectively with the productivity of 690 kg ha-1 (Anon, 2013). Chickpea is a leguminous crop commonly known as Bengal gram and the largest produced leguminous food crop in South Asia securing third rank production wise globally after common bean *(Phaseolus vulgaris* L.*)* and field pea *(Pisum sativum* L.*)*. Among all the other countries, India accounts for producing the largest amount of chickpea contributing 64% of the chickpea production worldwide. (Gaur et.al. 2010). Whereas in 2013, it's production in India has increased to 67% and became the major chickpea growing country in the world accounting 76% of total area. The total area employed is about 9.18 million hectares with total production of 8.22 million tons and an average productivity of 900 kg ha-1 (Anon, 2013). In India, the states like Madhya Pradesh, Rajasthan, Maharashtra, Uttar Pradesh, Karnataka and Andhra Pradesh are the major producers of this crop which contributes to 92% of the production and 95% of the area in the country altogether (FAOSTAT, 2014). Although chickpea is very important pulse crop in our daily diet and also in agricultural production, its productivity is very low. The low production of this crop is because of improper utilization of fertilizers, weed competition, ill-advised time of sowing and seed rate, pest and disease management and no utilization of bio-fertilizers. The increasing demand of the population calls for proper nutrient management which ensures adequate combination of chemical fertilizers with organic fertilizers to increase the production as well as sustain the soil health. Nitrogen increases the growth and development, dry matter production and yield of crops even under dry land conditions. *(*Kumar, 2014*)* whereas, phosphorus has central role in energy transfer and protein metabolism and also associated with increased root growth and early maturity of crops. (Siag, 1995). Biofertilizers helps to generate solubilized essential nutrients of plants like nitrogen, and phosphorus through their activities in the soil or rhizosphere and make it available to the growing plants gradually. (Prajapati, 2014). The inoculation of seeds with proper strains of *Rhizobium* bacteria enhances the atmospheric nitrogen fixation resulting in better growth and increase in the crop yield. The phosphorus solubilizing bacteria (PSB) aids in converting the insoluble phosphate which is chemically fixed into available form which eventually results in higher crop yields (Gull *et al.*, 2004). It also contains good amount nitrogen-fixing and P-solubilizing beneficial microorganisms (Sultan, 1997; Devi, P., & Kumar, P. (2020); Kumari, P., & Kumar, P. (2020); Kaur, S., & Kumar, P. (2020); Devi, P., & Kumar, P. (2020); Sharma, K., & Kumar, P. (2020); Kumar, S. B. P. (2020); Devi, P., & Kumar, P. (2020); Chand, J., & Kumar, P. (2020). The application of vermicompost has positive influence on the physical and biological properties of the soil. It increases the macro pore space and thus improves air water relationship. Its application showed positive impact on the pH of the soil, population of soil microorganisms and enzyme activities in soil as well (Maneswarippa *et al*., 1999).

2. MATERIALS AND METHODS

The study was carried out during *rabi* season of 2017-2018 in the experimental farm of Lovely Professional University, Phagwara, Punjab. The soil was found to be sandy loam with neutral pH (7.3) and non-saline electrical conductivity (0.415 dSm-1). It showed low organic carbon (0.36%) and available nitrogen (212.45 kg ha-1), medium in available phosphorus (13.11 kg ha-1) and high range of available potassium (138.16 kg ha-1). The study was laid out in Randomized complete block design with seven treatments and 3 replications. Fertilizers and bio-fertilizers were applied as recommended by PAU, Ludhiana (N:P:K 15:20:00), PSB 4 kg ha-1, Rhizobium 50ml kg-1 seed and vermicompost 5 t ha-1. The treatments are To (Control), T1 (100% RDF), T2 (75% RDF + PSB as soil application + Rhizobium as seed treatment), T3 (50% RDF + PSB as soil application + Rhizobium as seed treatment), T4 (5 t ha-1 Vermicompost), T5 (3 t ha-1 Vermicompost + PSB as soil application + Rhizobium as seed treatment) and T6 (2 t ha-1 Vermicompost + PSB as soil application + Rhizobium as seed treatment). A chickpea variety Pusa-362 was sown at the rate of 80 kg ha-1 and a spacing of 40 cm X 10 cm was maintained. Kjeldahl method

(Subbiah and Asija (1956), Spectrophotometer method (Olsen *et. al* 1982) and Flame photometric method (Jackson, 1973). was used to estimate total nitrogen, phosphorus and potassium respectively.
The nutrient uptake of chickpea seed and stover was calculated by using the formula:
Nutrient uptake by seed (kg ha-1)= Nutrient content of seed (%) x seed yield (kg ha-1)/100
Nutrient uptake by stover (kg ha-1) = Nutrient content of stover (%) x stover yield (kg ha-1)/100
The protein content of the chickpea seed was determined by multiplying Nitrogen content of seed (%) with the conversion factor of 6.25 as given by (Gupta *et al.*, 1972).

Statistical Analysis
Experimental data were analyzed by using Randomized Complete Block Design (RCBD). The significant difference of the experimental data was tested by 'F' test. The standard error mean (S.Em) and critical difference (CD) were analyzed at 5% ($p \leq 0.05$) level of significance. The mean value of the collected data from each individual plot was subjected to analysis of variance (ANOVA) and the data were analyzed with the help of SPSS statistical software. The differences among the treatments which were non-significant are denoted as NS.

3. RESULT AND DISCUSSION

Effect on seed yield, stover yield and protein content
The data obtained from the study as presented in Table 1 revealed that fertilizing chickpea with different doses of inorganic and organic fertilizers and bio-fertilizers had significant effect of seed yield, stover yield and protein content of the chickpea seed.

Table 1: Influence of fertilizer levels and bio-fertilizers on seed yield, stover yield and protein content.

Treatments	**Seed yield (kg ha-1)**	**Stover yield (kg ha-1)**	**Protein content (%)**
T0	966.04c	1916.66d	17.62d
T1	1287.03a	2370.37a	19.62a
T2	1348.75a	2324.07ab	19.28ab
T3	1256.16a	2222.22c	18.66bc
T4	1240.73a	2250bc	18.71bc
T5	1228.39ab	2194.44c	18.08cd
T6	1120.36b	2157.40c	17.87d
S.Em±	39.723	24.544	0.131
C.D.	123.753	76.466	0.407
C.V.	5.701	1.926	1.221

The highest seed yield (1348.75 kg ha-1) was recorded in T2 (75% RDF + PSB as soil application + Rhizobium as seed treatment) which remained at par with T1 (100% RDF) (1287.03 kg ha-1). Similar findings were reported by Kumar,2014 where he stated that higher yield can be achieved by fertilizing chickpea crop @ 75% RDF along with *Rhizobium* and PSB both as seed treatment or *Rhizobium* as seed treatment + PSB as soil application or *Rhizobium* as seed treatment + VAM

as soil application. Better growth performance of the crop gives higher values of yield attributing characters which results into higher seed yield enhancing the development of sink under higher level of fertilizers. Seed yield is the combined effect of all the yield attributing characters such as pods plant-1 and seeds pod-1 etc. and increase of all these factors will directly increase the seed yield (Patidar, 2016). A reversed result was observed in case of stover yield and protein content where T1 showed slightly higher numbers than T2. The highest stover yield recorded in the study was 2370.37 kg ha-1 which stood superior to T2 whose value was 2324.07 kg ha-1. It is clear that T1 was at par with T2. Application of inorganic fertilizer and bio-fertilizers helps provide the plant with necessary N and P component that helps in the process of better photosynthetic efficiency per unit chlorophyll enhancing the metabolic rate, cell division and cell elongation, root elongation, leaf expansion for a faster plant growth which increase in the growth and yield attributing features of the plant increasing the stover yield as well (Tisdale *et al.*, 1993). Similar results were also reported by (Singh *et al.*, 2007) on *kharif* cowpea. Similarly higher percentage of protein content was recorded in T1 (19.62%) against T2 (19.28%) and the lowest was recorded in T0.The higher protein content with these level of fertilizers could be due to more availability of N and P to crop which enhances the content and uptake of NPK both in seed and stover and this eventually increases the protein content of the seed (Kumar *et al.*, 2014; Kumar, P. (2019); Kumar, D., Rameshwar, S. D., & Kumar, P. (2019); Dey, S. R., & Kumar, P. (2019); Kumar et al. (2019); Dey, S. R., & Kumar, P. (2019); Kumar, P., & Pathak, S. (2018); Kumar, P., & Dwivedi, P. (2018); Kumar, P., & Pathak, S. (2018)).

Effect on nutrient content of chickpea seed and stover (%)

The nutrient content of chickpea seeds and stover showed significant results on various fertilizer levels and bio-fertilizer inoculation. The study revealed that application of 100% RDF (T1) significantly gave higher values of nutrient content in both seed and stover : N (3.13%) (1.21%), P (0.68%) (0.19), K (0.69%) (1.34%). However, there was not much difference between the values obtained from T1 and T2 (75% RDF + PSB as soil application + Rhizobium as seed treatment) as they remained at par and gave results very close to each other. The control receiving no treatment revealed the lowest values in terms of nutrient content both in seed and stover. Similar result was reported by Gangwar and Dubey (2012) where highest values in nutrient content was observed with application of 100 % RDF and inoculation with bio-fertilizers and he has concluded that the application of Rhizobium and soil application of PSB might have increased the nitrogen fixation resulting in better availability phosphorus which have increased their productivity (Kumar et al.,2018; Kumar, P., & Hemantaranjan, A. (2017); Dwivedi, P., & Prasann, K. (2016). Kumar, P. (2014); Kumar, P. (2013); Kumar et al. (2013); Prasann, K. (2012); Kumar et al. (2011); Kumar et al. (2014).

Table 2: Effect of fertilizer levels and bio-fertilizers on N,P,K content by chickpea seeds and stover.

Treatments	**N content (%)**	**P2O5 content (%)**	**K2O content (%)**

Seed	Stover		Seed	Stover	Seed	Stover
T0	2.81d	0.74c	0.49e	0.14c	0.57d	1.17d
T1	3.13a	1.21a	0.68a	0.19a	0.69a	1.34a
T2	3.08ab	1.16ab	0.66a	0.18ab	0.67a	1.32ab
T3	2.98bc	1.10bc	0.59bc	0.17bc	0.61bc	1.27bc
T4	2.99bc	1.12bc	0.63b	0.16cd	0.62b	1.27bc
T5	2.89cd	1.06c	0.56cd	0.17bc	0.60bcd	1.26c
T6	2.85d	0.85d	0.53de	0.15de	0.58cd	1.18d
S.Em±	0.020	0.009	0.008	0.000	0.002	0.002
C.D.	0.063	0.027	0.025	0.000	0.006	0.006
C.V.	1.189	1.449	2.340	0.089	0.496	0.277

Effect on nutrient uptake of chickpea seed and stover (kg ha-1)

As per the results obtained from this study, it is observed that various dose of fertilizers and bio-fertilizer inoculation greatly influence the nutrient uptake by the chickpea seed and stover. Significantly maximum values for nutrient (N,P,K: 41.55, 8.97, 9.05 kg ha-1) uptake by seeds were recorded in 75% RDF + PSB as soil application + Rhizobium as seed treatment which was closely followed by 100% RDF with N,P,K uptake of 40.36, 8.75 and 8.96 respectively. The results of the study pertaining to nutrient uptake by chickpea stover were opposite to the nutrient uptake by chickpea seeds. The maximum N, P, K uptake was observed to be 28.73 kg ha-1, 4.65 kg ha-1, and 31.91 kg ha-1 respectively which was obtained from T1 and it remained at par with

T2 with 27.15, 4.34 and 36.90 kg ha-1 N,P,K uptake. The lowest nutrient uptake was recorded in T0 plot receiving no fertilization. Significantly higher values in these treatments being higher than control could be because of the addition of these fertilizers causing the accumulation of NPK in the soil (Patel, 2013) and application of organic fertilizer that provides a favorable environment for microbial activity which might have reflected in the nutrient increase in soil (Patel *et al.*, 2016).The increased in nutrient uptake could be the result of inoculation Rhizobium (Alagawadi and Gaur, 1998). Increase in NPK content and uptake could also be due to dual application of bio-fertilizers (Rhizobium and PSB) that might have increase due to higher mobilization of these nutrients (Patel *et al.*, 2016). These results were in agreement with the findings of (Reddy *et al*., 2007), (Sahay *et al*., 2011), and (Tanwar *et al.,* 2010)

Table 3. Effect of fertilizer levels and bio-fertilizers on N, P, K uptake by chickpea seeds and stover.

Treatments	**N uptake (kg ha-1)**		**P2O5 uptake (kg ha-1)**			**K2O uptake (kg ha-1)**
Seed	**Stover**	**Seed**	**Stover**		**Seed**	**Stover**
T0	27.18e	14.11f	`4.74c	2.81e	5.51d	25.55d
T1	40.36ab	28.73a	8.75a	4.65a	8.96a	31.91a
T2	41.55a	27.15b	8.97a	4.34b	9.05a	30.90a
T3	37.40bc	24.43d	7.44bc	3.91c	7.69b	28.36b
T4	37.08bc	25.22c	7.85b	3.74c	7.77b	28.60b
T5	35.51c	23.26d	6.87c	3.87c	7.36b	27.64b
T6	31.99d	18.43e	5.96d	3.36d	6.49c	25.56c
S.Em±	1.127	0.280	0.205	0.046	0.220	0.316
C.D.	3.511	0.873	0.638	0.143	0.685	0.985
C.V.	5.441	2.104	4.907	2.089	5.044	1.960

4. CONCLUSION :

The present findings of this research revealed that application of various fertilizers and bio-fertilizers showed positive influence on seed and stover yield, protein content of the seed, and also N,P,K content and uptake by seed and stover. Since the application of 75% RDF + PSB as soil application + Rhizobium as seed treatment showed at par results with 100% RDF it is advisable to use the first treatment so as to reduce the excessive use of inorganic fertilizers. The application of bio-fertilizers has beneficial effects on maintaining nutrient status of the soil as it increases the available nitrogen and phosphorus of the soil.

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