www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; SP-10(12): 437-443

www.thepharmajournal.com
Received: 22-10-2021
Accepted: 24-11-2021

Swetha Dhegavath
M. Sc Research Scholar in Department of SS& AC, PJTSAU, Hyderabad, Telangana, India

Dr. Anjaiah T
Senior Scientist, AICRP on Micronutrients, ARI, PJTSAU, Hyderabad, Telangana, India

Dr. Sharma SHK
Professor, Soil Science and Agricultural chemistry, PJTSAU, Hyderabad, Telangana, India

Dr. Sreedhar Chauhan
Principal Scientist, AICRP on Soybean, Agronomy, ARS, Adilabad, Telangana, India

Corresponding Author
Swetha Dhegavath
M. Sc Research Scholar in Department of SS& AC, PJTSAU, Hyderabad, Telangana, India

Effect of soybean residue incorporation along with inorganic fertilizer and biofertilizer on growth parameters and yield of chickpea

Swetha Dhegavath, Dr. Anjaiah T, Dr. Sharma SHK and Dr. Sreedhar Chauhan

Abstract
A field experiment was carried out during *rabi*, 2020 at Agricultural Research Station, Adilabad, under Professor Jayashankar Telangana State Agricultural University (PJTSAU). The experiment comprises of 6 treatmental combinations and laid out in split plot design. The main plots are without soybean residue incorporation and with soybean residue incorporation. Each main plot is sub divided into 6 subplots *viz*., Control (0% RDF) (T1), 100% RDF (20: 50: 20 kg ha-1 NPK)(T2), *Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha- 1(T3), *Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1 + 75% RDN and 75% RDP(T4), *Rhizobium* seed treatment @ 25 g kg -1 seed + PSB soil application @ 5 kg ha-1 + 50% RDN and 75% RDP(T5) and *Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1 + 50% RDN and 50% RDP(T6).
Results revealed that all the growth parameters*i.e.* Plant population, plant height, dry matter production, total number of pods, test weight, seed yield, stover yield and harvest index of chickpea significantly highest under residue incorporation of soybean. Among all treatments application of 100% RDF recorded highest parameters. However, that was on par with 75% RD of P along with biofertilizers and 75% N along with biofertilizers. Saving of 25 percent cost on inorganic fertilizers without decreeing the optimum economic yields is possible by adopting 75% N and 75% P fertilizers in combination with biofertilizers.

Keywords: chickpea, dry matter production, growth parameters, seed yield and stover yield

Introduction
Pulses are one of the major food items to be involved in a vegetarian diet and are the cheapest source of protein and they are regarded as poor man's meat. In a country like India where majority of the population comes under vegetarian, the significance of these pulses raises. Pulses contribute 16-18 percent of total protein of Indian diet in general. In leguminous crops, symbiosis is an additional factor which effects the internal physiological processes, leading to self-sufficiency in N-supply and in turn enhances the yield. Nitrogen fixing root nodule bacteria (*Rhizobia*) are of special interest because nitrogen is being constantly released in the atmosphere in the form of gas. The return process of N-fixation is a vital link in the nature without which life on earth would ultimately fade away (Hussen *et al.*, 2015) [7].
Chickpea (*Cicer arientinum* L.) is one of the major *rabi* pulse crops and it has digestible dietary protein (17-21%). It is an extensive legume crop. It plays an important role in enhancing fertility status of soils due to nitrogen fixation by *Rhizobium* bacteria found in it's root nodules. It is also called low input crop as it needs less fertilizer cost due to its nitrogen fixation property. Due to the rising population, chemical fertilizers are excessively utilized in order to achieve maximum production which has led to degradation of the agricultural lands (Mondal *et al.*, 2001) [9]. Therefore, to restore the health and quality of the soil, simple practices like judicious utilization of recommended chemical fertilizers can be effectively employed to combat these problems along with organic manures, biofertilizers and fertilizers.
Next to nitrogen, phosphorus is a vital nutrient recommended for plant growth. Phosphorus is a very frequently present in the soil in an unavailable form. It plays important role in root development, nodulation, flowering and fruiting. Need of phosphorus fertilization to legume crops is acknowledge well and offers a fruitful mean of adding nitrogen to the soil in proportion of crop growth. Application of phosphorus to chickpea enhances growth and harvest yield of finer quality valuable protein (Singh *et al*., 2018) [14]. Phosphorus can be made

soluble in soil by phosphorus solubilizing bacteria. They have the potential to bring insoluble phosphate into soluble form by secreting the organic acid. Inoculation of PSB produced higher seed and straw yield in gram (Pawar, 1998) [11]. The synergetic effect of, phosphorus application and PSB inoculation outstandingly given additional grain yield in gram (Namdeo *et al.*, 1991) [10].

Although, the use of inorganic fertilizers is the quickest and surest way of boosting crop production but the recent energy crisis and consequent price hike of fertilizers and environmental affairs have again revived and fascinate in organic recycling for sustainable productivity. Continuous use of inorganic fertilizer led to reduction in yield and reported in imbalance of nutrients in soil, which has adverse influence on soil health (Doran and Zeiss, 2000) [5]. Hence a field experiment was conducted to study the effect of soybean residue incorporation along with inorganic fertilizers and biofertilizer on plant parameters and yield of chickpea.

Material And Methods

Experiment conducted during 2020-21 at Agricultural Research Station, Adilabad, Telangana. During *rabi* season, Chickpea crop was laid out in split plot design with two main factors *i.e.,*without soybean residue incorporation (M1) and with soybean residue incorporation (M2) were taken as main plots and in sub plots six nutrient management practices *viz*. T1: Absolute Control , T2: 100% RDF (20: 50: 20 kg ha1 NPK), T3: *Rhizobium* seed treatment @ 25 g kg-1 seed + PSB Soil application @ 5kg ha-1, T4: *Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1 + 75% RDN and 75% RDP, T5: *Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5kg ha-1 + 50% RDN and 75% RDP and T6 : *Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5kg ha-1 + 50% RDN and 50% RDP were accommodated in chickpea during the experimentation and these replicated thrice. Plant growth parameters such as plant population (m-2) was noticed with quadrate in one square mts. area fixed randomly at different places during 30,60 DAS and at harvest. Randomly 5 plants were selected from each plot and plant height at various periods was recorded with scale. Plant dry matter accumulated was noted at 30,60 and at harvest in kg ha-1. Similarly, seed yield and stover yields were also expressed in kg ha-1.

Results And Discussion

Plant population

The data pertaining to plant population (m-2) of chickpea at 30, 60 DAS and at harvest stage as influenced by various treatments was presented in table1. Incorporation of soybean residue has not significantly improved chickpea plant population. Among main treatments mean plant population at 30,60 DAS and at harvest stage are 28.28 m-2, 28.06 m-2 and 28.06 m-2, respectively with residue incorporation. Application of inorganic and biofertilizers had also not shown any significant improvement in enhancing plant population. Highest mean value observed at with (T2) 100% RDF (20: 50: 20 kg ha1 NPK) (28.17 m-2) and lowest mean value registered at control (T1) (25.83 m-2). However, it was found on par and with T4,*Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5kg ha-1 + 75% RDN and 75% RDP (28.17 m-2) and with the application of *Rhizobium* seed treatment @ 25 g kg-1 + PSB soil application @ 5kg ha-1 + 50% RDN and 75% RDP (T5) (28.00 m-2).Interaction effect of residue incorporation and application of inorganic fertilizers at different graded levels of N and P plus biofertilizers had not shown any significant effect at any stage of crop growth.

Plant height

The data pertaining to plant height (cm) at 30, 60 DAS and harvest stage of chickpea plants presented in table 2. Perusal of data at various stages *i.e.,* 30, 60 DAS and at harvest stage of chickpea crop revealed that statistically significant effect was noticed in soybean residue incorporated treatments when compared to without incorporation. Plant height (cm) one of the growth characters was influenced significantly with application of graded levels of N P fertilizers along with biofertilizers. It was found that, significantly mean higher plant height at 30 DAS was recorded with the treatment received (T2) 100% RDF (20: 50: 20 kg ha1 NPK) (18.05 cm). However, it was found on par with *Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5kg ha-1 + 75% RDN and 75% RDP (T4) (17.97 cm) and with the application of *Rhizobium* seed treatment @ 25 g kg-1 + PSB soil application @ 5kg ha-1 + 50% RDN and 75% RDP (T5) (17.84 cm). While lowest plant height was noticed in control (T1) (12.70 cm).Similarly, the same trend was observed in plant height at 60 DAS and at harvest stage of chickpea crop.

However, interaction effect was non significant. The increase in plant height of chickpea might be due to the availability of plant required nutrients in balanced amounts through mineralisation of soybean residue and application of inorganic fertilizers, in addition to that nitrogen fixed by *Rhizobium* through biological nitrogen fixation and phosphorus availability from insoluble or fixed form by PSB. Synergistic effect of PSB + *Rhizobium* may produce growth hormones like cytokinin's, gibberellins which responsible for cell division and stem elongation. Similar results were registered by Amal kumar *et al*. (2014) [1].

Dry matter production

The data on dry matter (kg ha-1) produced at different stages of crop growth *viz*., 30, 60 and at 90 DAS are presented in table 3. Chickpea dry matter increased with increase in age of crop from 30 to 90 DAS with application of inorganic and biofertilizers. Perusal of data on dry matter production (kg ha-1) at 30 DAS with incorporation of soybean residue significantly affected when compared to without residue incorporation. The mean higher values 246.44 kg ha-1, 225.11kg ha-1 were registered with and without incorporation. This might be due to better nourishment derived from the soil as a result of balanced fertilization. The residue of soybean has a greater decomposition rate and there by release of nutrients into the soil might be the probable reason for higher dry matter recorded in residue incorporated plots than non incorporated plots.

Significantly higher dry matter (kg ha-1) was observed in (T2) 100% RDF (20: 50: 20 kg ha1 NPK) among fertilizers and biofertilizers applied treatments (sub treatments) (264.50 kg ha-1). However, it was found on par with T4 (*Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1 + 75% RDN and 75% RDP) (253.67 kg ha-1) and with (T5) (252.50 kg ha-1). Significantly, lowest dry matter recorded at control (T1) (195.17 kg ha-1). Increase in dry matter, due to better nourishment derived from the soil as a result of balanced fertilization which improves soil nutrient status. Similar results have also been reported by Yagoub *et* *al.*, (2015) [18]. Interaction effect at 30 DAS of chickpea on dry matter was found to be non significant.

Dry matter produced at 60 and 90 DAS of chickpea was significantly affected by residue incorporation (1961.11 kg ha-1 and 2995.56 kg ha-1) when compared to without residue incorporation (1768.89 kg ha-1 and 2638.89 kg ha-1) (table 3.3). This might be due to *Rhizobium* inoculation, when applied in combination with PSB, improves the number and dry weight of nodules, branches per plant, root length, shoot length, dry matter production of chickpea was noticed when compared to control as reported by Singh *et al*. (2011) [13]. Significantly, higher dry matter was recorded at T2 during 60 and 90 DAS due to 100% RDF (20: 50: 20 kg ha1 NPK) (2148.33 kg ha-1 and 3140.83 kg ha-1) when compared to control (T1) (1420 kg ha-1 and 2306.67

kg ha-1). However, it was found on par with *Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1 + 75% RDN and 75% RDP (2100 kg ha-1, 3106.67 kg ha-1) and with (T4) (2045 kg ha-1, 2993.33 kg ha-1). A higher amount of dry matter accumulation in *Rhizobium* inoculated plants is attributable to more N availability to plants *Rhizobium* have a positive effect on biomass production. Effect of biofertilizers inoculation in conjugation with different doses of chemical fertilizers increased the plant dry weight. Similar results are found with Bai *et al.* (2014) [2].

Data pertaining to interaction affect between soybean residue incorporation and graded level of fertilizers along with biofertilizers on dry matter was significant at 60 and 90 DAS of chickpea. Mean highest dry matter at 60 DAS was noticed in soybean residue incorporation and application of inorganic fertilizers and biofertilizers M2T2 (2186.67 kg ha-1). However, it was on par with M2T4 (2166.67 kg ha-1) and with M2T5 (2045 kg ha-1). Significantly, lowest values of dry matter noticed at control M2T1 (1543.33 kg ha-1). Similar trend was noticed at 90 DAS. This might be due to incorporation of soybean residue has a greater decomposition rate and there by release of nutrients into the soil and also due to *Rhizobium* inoculation, when applied in combination with PSB, improves the branches per plant, number and dry weight of nodules, and also increase in dry matter production of chickpea. Similar results have also been reported by Yagoub *et al*. (2015) [18].

Total number of pods per plant

Total number of pods plant-1 of chickpea crop as influenced by various treatments were presented in table 4. Perusal of data on total number of pods plant-1with incorporation of soybean residue significantly affected when compared to without residue incorporation. The mean higher values 51.33, 46. 44were registered with and without incorporation respectively. Significantly higher number of filled pods with residue incorporation might be due to influence of nitrogen, the chief constituent of protein, essential for protoplasm which leads to cell division and cell enlargement exerted a profound influence on seed filling and relatively high number of filled pods. The result obtained are in close prominently with the findings of Sioj *et al.* (2014) [15]. Among treatments, higher number of pods plant-1recorded with (T2) 100% RDF (20: 50: 20 kg ha1 NPK) (55.57). However, it was found on par with T4 (*Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1 + 75% RDN and 75% RDP) (54.83) and with the application of *Rhizobium* seed treatment @ 25 g kg-1 + PSB soil application @ 5 kg ha-1 + 50% RDN and 75% RDP (T5) (53.50). Lowest total number of pods plant-1recorded at control (T1) (39.50) among various fertilizer levels along with biofertilizers. Increase in number of filled pods might be due to the fact that phosphobacteria dissolved insoluble ‘P’ in the soil, making it available to the crop plants. Phosphorus fertilization encouraged formation of new cells, promoted plant vigour and hastened leaf, nodule development and which helped in harvesting more solar energy and better utilization of nitrogen resulting in more number of pods and plant spread. These findings have also been reported by Yadhav *et al.* (2004) [17].

Data pertaining to interaction effect between soybean residue incorporation and graded levels of N P fertilizer along with biofertilizers on total number of pods plant-1 shows significant impact during the experimentation. Maximum number of pods plant-1 were noticed in M2T2 (59). However, it was on par with M2T4 (57.67) with M2T5 (56.67). Significantly, lowest number of pods plant-1 noticed at control M2T1 (41). This might be due to *Rhizobium* inoculation, when applied alone or in combination with PSB, improves the number and dry weight of nodules, branches per plant, total number of pods per plant of chickpea was noticed when compared to control. Similar results have also been reported by Singh *et al*. (2011) [13].

Seed yield

The data pertaining to seed yield (kg ha-1) of chickpea crop as influenced by soybean residue incorporation and graded levels of fertilizers along with biofertilizers recorded and subjected to statistical analysis is presented in table 5.The data on seed yield (kg ha-1) with incorporation of soybean residue significantly enhanced when compared to without soybean residue incorporation. The mean values of 2209.31 kg ha-1 and 1819.31 kg ha-1 were registered with and without incorporation of soybean residue. The mean lowest chickpea seed yield recorded at control (T1) (1011.45 kg ha-1). However, higher seed yield procured with T2 (100% RDF (20: 50: 20 kg ha1 NPK) (2558.33 kg ha-1) but it was found on par with T4 (*Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1 + 75% RDN and 75% RDP) (2537.50 kg ha-1) and T5 (application of *Rhizobium* seed treatment @ 25 g kg-1 + PSB soil application @ 5 kg ha-1 + 50% RDN and 75% RDP) (2517.50 kg ha-1). An increase in the yield was observed with application of recommended dose of fertilizers along with biofertilizers. Application of Nitrogen enhanced nodulation by increasing the supply of nitrogen containing proteins which are essential for multiplication and growth of *Rhizobia* and inoculated phosphobacteria. Similar results are found with Dey and Basu, 2004 [4] and Kumari *et al*. (2015) [8].

The interaction between residue incorporation and fertilizer levels along with biofertilizers on seed yield was found to be significant. Among all treatments mean higher seed yield was observed in M2T2 (2558.33 kg ha-1) but it was on par with M2T4 (2746.43 kg ha-1) and M2T5 (2737.76 kg ha-1). Lowest seed yield recorded at control M2T1 (1188.20 kg ha-1). The higher seed yield may be attributed to release of sufficient plant nutrients from inorganic sources required for better crop growth and yield and also due to *Rhizobium* inoculation, when applied alone or in combination with PSB, improves the number and dry weight of nodules, branches per plant, pods per plant and seed yiled of chickpea. The findings are in agreement with the results of Chauhan and Raghav (2017) [3].

Stover yield

The data pertaining to stover yield (kg ha-1) of chickpea crop as influenced by soybean residue incorporation and graded levels of fertilizers along with biofertilizers was presented in table 5.Stover yield (kg ha-1) with incorporation of soybean residue significantly enhanced when compared to without incorporation. The mean values 2882.25 kg ha-1 and 2544.37 kg ha-1 were registered with and without incorporation of soybean residue.

The mean lowest stover yield recorded at control (T1) (1675.19 kg ha-1). However, higher stover yield procured with T2 (100% RDF (20: 50: 20 kg ha1 NPK) (3255.33 kg ha-1). But,it was found on par with T4 (*Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1 + 75% RDN and 75% RDP) (3241.50 kg ha-1) and T5 (application of *Rhizobium* seed treatment @ 25 g kg-1 + PSB soil application @ 5 kg ha-1 + 50% RDN and 75% RDP) (3231.29 kg ha-1). The increased availability of nitrogen, phosphorus and their synergistic effect might have increased root growth and nodulation there by increased nitrogen fixation and enhanced yield and yield parameters and higher absorption and utilization of nutrients. Similar results are found with Kumari *et al.* (2019).

Significant effect due to residue incorporation and fertilizers treatments was found on stover yield. Mean higher stover yiled among all treatments was recorded at M2T2 (3405.67 kg ha-1). This was on par with M2T4 (3405 kg ha-1) and M2T5 (3401.33 kg ha-1). Lowest seed yield was recorded at control M2T1 (1846.38 kg ha-1). It may be due to higher nutrient uptake by plants increase the growth of plant which ultimately increase stover yield and also due to, application of 100% RDP + PSB affected positively on seed yield, content of N, P, K and S & also their uptake by chickpea seeds as well as stover yield. These findings are in line with the results of Gangawar and Dubey (2012) [6].

Test weight

The data regarding to test weight (g) of chickpea crop was presented in table 6. Test weight (g) was significantly influenced with soybean residue addition as compared to without incorporation. Mean higher value among major treatments recorded at M2 (22.81 g) and lower value recorded at M1 (21.67 g). Among the treatments (sub treatments) that received graded levels of fertilizers and biofertilizers, significantly lower value was found at control (T1) (20.18 g). The test weight was increased with increase in levels of fertilizers from 50 to 100% along with biofertilizers combination. T2 (100% RDF (20: 50: 20 kg ha1 NPK) recorded highest test weight (23.50 g) followed by T4*Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1 + 75% RDN and 75% RDP) (23.23 g) and T5 (application of *Rhizobium* seed treatment @ 25 g kg-1 + PSB soil application @ 5 kg ha-1 + 50% RDN and 75% RDP) (23.18 g kg ha-1). These treatments were performed equally well and on par with T2. This is due to *Rhizobium* inoculation, when applied in combination with PSB, improves the number and dry weight of nodules, branches per plant, total number of pods per plants along with seed yiled of chickpea crop. Similar results have also been reported by Tagore *et al*. (2013) [16].

The interaction effect between soybean crop residue incorporation and graded levels of fertilizers along with biofertilizers on test weight (g) had shown non significant impact during the experimentation and in their mean.

Harvest index

The harvest index is a useful index in evaluating treatment effects on partition photo assimilates to grain within a given environment. The data regarding to harvest index (%) of chickpea crop as influenced by with soybean crop residue incorporation and without soybean crop residual incorporation is presented in table 5.

Soybean residue incorporation influenced the harvest index significantly (37.4%) than non incorporation. The crop at the no fertilizer and no biofertilizers inoculation recorded lowest value (30.82%). HI was increased with increase in levels of N and from 50 to 75 and upto 100%. Mean higher HI was recorded at T2 (100% RDF (20: 50: 20 kg ha1 NPK) (40.21%). It was found on par with T4 (*Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5kg ha-1 + 75% RDN and 75% RDP) (39.35%) and T5 (application of *Rhizobium* seed treatment @ 25 g kg-1 + PSB soil application @ 5kg ha-1 + 50% RDN and 75% RDP) (37.98%). The increased availability of nitrogen, phosphorus and their synergistic effect might have increased root growth and nodulation there by increased nitrogen fixation and dry weight of nodules, total number of pods per plant, test weight, seed and stover yiled along with harvest index of chickpea crop. Similar results are found with Prajapati (2017). The interaction effect between residual effect of soybean crop and graded levels of fertilizers along with biofertilizers of soybean crop on harvest index (%) turned to be non – significant.

Table 1: Effect of treatments on plant population (m-2) at various growth periods (30, 60 DAS and at harvest) of chickpea during *rabi* season.

Main Plots			
Treatments	**30 DAS**	**60 DAS**	**At harvest**
M1: Without soybean residue incorporation	26.56	26.69	26.69
M2: With soybean crop residue incorporation	28.28	28.06	28.06
Mean	27.42	27.38	27.38
SEm ±	0.78	0.19	0.19
CD (P=0.05)	NS	NS	NS
Subplots			
Treatments	30 DAS	60 DAS	At harvest
T1: Control (0% RDF)	25.83	25.83	25.83
T2: 100% RDF (20: 50: 20 kgha-1 NPK)	28.17	28.17	28.17
T3: Rhizobium seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1	26.83	26.50	26.50
T4: Rhizobium seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1 + 75% RDN and 75% RDP	28.17	28.17	28.17
T5: Rhizobium seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1 + 50% RDN and 75% RDP	28.00	28.17	28.17
T6: Rhizobium seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1 + 50% RDN and 50% RDP	27.50	27.42	27.42
Mean	27.42	27.38	27.38
SEm ±	1.26	0.22	0.22

CD (P=0.05)	NS	NS	NS

M1= Without soybean crop residue incorporation, M2= With soybean crop residue incorporation.
T1 = Control (0% RDF), T2 = 100% RDF (20: 50: 20 kg ha-1 NPK), T3 = *Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1, T4= *Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1 + 75% RDN and 75% RDP, T5= *Rhizobium* seed treatment @ 25 g kg -1 seed + PSB soil application @ 5 kg ha-1 + 50% RDN and 75% RDP, T6= *Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1 + 50% RDN and 50% RDP

Table 2: Effect of treatments on plant height (cm) at various growth periods (30, 60 DAS and at harvest) of chickpea during *rabi* season.

Treatments					**Plant height (cm)**				
		30 DAS			**60 DAS**			**At harves**	**t**
	M1	**M2**	**Mean**	**M1**	**M2**	**Mean**	**M1**	**M2**	**Mean**
T1	12.57	12.83	12.70	34.53	36.13	35.33	42.77	44.33	43.55
T2	18.00	18.11	18.05	41.40	42.10	41.75	48.17	50.00	49.08
T3	14.17	14.27	14.22	36.33	38.37	37.35	44.23	46.10	45.17
T4	17.83	18.10	17.97	41.07	42.04	41.56	47.73	49.70	48.72
T5	17.60	18.09	17.84	40.00	42.00	41.00	47.07	49.50	48.28
T6	15.17	15.43	15.30	38.07	40.33	39.20	46.10	47.50	46.80
Mean	15.89	16.14		38.57	40.16		46.01	47.86	
	SEm ±	CD (P=0.05)		SEm ±	CD (P=0.05)		SEm ±	CD (P=0.05)	
Main (A)	0.04	0.23		0.09	0.53		0.30	1.82	
Sub (B)	0.06	0.18		0.60	1.78		0.49	1.43	
Interactions									
Factor (B) at same level of A	0.08	NS		0.85	NS		0.69	NS	
Factor (A) at same level of B	0.09	NS		0.78	NS		0.68	NS	

M1= Without soybean crop residue incorporation, M2= With soybean crop residue incorporation.
T1 = Control (0% RDF), T2 = 100% RDF (20: 50: 20 kg ha-1 NPK), T3 = *Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1, T4= *Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1 + 75% RDN and 75% RDP, T5= *Rhizobium* seed treatment @ 25 g kg -1 seed + PSB soil application @ 5 kg ha-1 + 50% RDN and 75% RDP, T6= *Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1 + 50% RDN and 50% RDP

Table 3: Effect of treatments on dry matter (kg ha-1) at various growth periods (30, 60 DAS and 90DAS) of chickpea during *rabi* season

Treatments	**Dry matter (kg ha-1)**								
	30 DAS			**60 DAS**			**90 DAS**		
	M1	**M2**	**Mean**	**M1**	**M2**	**Mean**	**M1**	**M2**	**Mean**
T1	186.33	204.00	195.17	1296.67	1543.33	1420.00	2126.67	2486.67	2306.67
T2	251.67	277.33	264.50	2110.00	2186.67	2148.33	3008.33	3273.33	3140.83
T3	205.33	224.67	215.00	1506.67	1736.67	1621.67	2360.00	2780.00	2570.00
T4	243.00	264.33	253.67	2033.33	2166.67	2100.00	2966.67	3246.67	3106.67
T5	241.00	264.00	252.50	1926.67	2163.33	2045.00	2793.33	3193.33	2993.33
T6	223.33	244.33	233.83	1740.00	1970.00	1855.00	2578.33	2993.33	2785.83
Mean	225.11	246.44		1768.89	1961.11		2638.89	2995.56	
	SEm ±	CD (P=0.05)		SEm ±	CD (P=0.05)		SEm ±	CD (P=0.05)	
Main (A)	2.72	16.56		25.77	156.80		47.89	291.39	
Sub (B)	5.83	17.19		156.80	126.24		47.71	140.75	
Interactions	SEm ±	CD (P=0.05)		SEm ±	CD (P=0.05)		SEm ±	CD (P=0.05)	
Factor (B) at same level of A	8.24	NS		60.52	178.53		67.47	199.05	
Factor (A) at same level of B	8.00	NS		60.96	213.98		78.02	322.30	

M1= Without soybean crop residue incorporation, M2= With soybean crop residue incorporation.
T1 = Control (0% RDF), T2 = 100% RDF (20: 50: 20 kg ha-1 NPK), T3 = *Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1, T4= *Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1 + 75% RDN and 75% RDP, T5= *Rhizobium* seed treatment @ 25 g kg -1 seed + PSB soil application @ 5 kg ha-1 + 50% RDN and 75% RDP, T6= *Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1 + 50% RDN and 50% RDP

Table 4: Effect of treatments on Total number of pods per plant of chickpea during *rabi* season.

Treatments		**Total number of pods per plant**	
	M1	**M2**	**Mean**
T1	38.00	41.00	39.50
T2	52.14	59.00	55.57
T3	41.00	44.67	42.83
T4	52.00	57.67	54.83
T5	50.33	56.67	53.50
T6	45.17	49.00	47.08
Mean	46.44	51.33	

	SEm ±	CD (P=0.05)	
Main (A)	0.43	2.63	
Sub (B)	0.46	1.37	
Interactions	SEm ±	CD (P=0.05)	
Factor (B) at same level of A	0.66	1.94	
Factor (A) at same level of B	0.74	2.98	

M1= Without soybean crop residue incorporation, M2= With soybean crop residue incorporation.
T1 = Control (0% RDF), T2 = 100% RDF (20: 50: 20 kg ha-1 NPK), T3 = *Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1, T4= *Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1 + 75% RDN and 75% RDP, T5= *Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1 +50% RDN and 75% RDP, T6= *Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1 + 50% RDN and 50% RDP

Table 5: Effect of treatments on seed yield (kg ha-1), stover yield (kg ha-1) and harvest index (%) of chickpea crop during *rabi* season.

Treatments	Seed yield (kg ha-1)			Stover yield (kg ha-1)			Harvest Index (%)		
	M1	M2	Mean	M1	M2	Mean	M1	M2	Mean
T1	834	1188	1011	1504	1846	1675	29.30	32.33	30.82
T2	2347	2769	2558	3105	3405	3255	39.50	40.92	40.21
T3	1344	1587	1466	2014	2376	2195	31.67	34.93	33.30
T4	2328	2746	2537	3078	3405	3241	38.83	39.87	39.35
T5	2297	2737	2517	3061	3401	3231	36.63	39.33	37.98
T6	1763	2226	1995	2504	2858	2681	34.00	37.07	35.53
Mean	1819	2209		2544	2882		34.99	37.41	
	SEm±	CD (P=0.05)		SEm±	CD (P=0.05)		SEm ±	CD (P=0.05)	
Main	27.28	165.98		50.94	309.97		0.37	2.27	
Sub	22.59	66.63		47.06	138.82		0.68	1.99	
Interactions	SEm±	CD (P=0.05)		SEm±	CD (P=0.05)		SEm ±	CD (P=0.05)	
Factor (B) at same level of A	31.94	94.22		66.55	196.32		0.96	NS	
Factor (A) at same level of B	39.93	176.21		79.28	336.49		0.95	NS	

M1= Without soybean crop residue incorporation, M2= With soybean crop residue incorporation.
T1 = Control (0% RDF), T2 = 100% RDF (20: 50: 20 kg ha-1 NPK), T3 = *Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1, T4= *Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1 + 75% RDN and 75% RDP, T5= *Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1 +50% RDN and 75% RDP, T6= *Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1 + 50% RDN and 50% RDP

Table 6: Effect of treatments on test weight (g) of chickpea during *rabi* season.

Treatments		**Test weight (g)**	
	M1	**M2**	**Mean**
T1	20.07	20.30	20.18
T2	22.97	24.03	23.50
T3	20.67	21.70	21.18
T4	22.53	23.93	23.23
T5	22.50	23.87	23.18
T6	21.30	23.05	22.18
Mean	21.67	22.81	
	SEm ±	CD (P=0.05)	
Main	0.15	0.91	
Sub	0.34	0.99	
Interactions	SEm ±	CD (P=0.05)	
Factor (B) at same level of A	0.47	NS	
Factor (A) at same level of B	0.46	NS	

M1= Without soybean crop residue incorporation, M2= With soybean crop residue incorporation.
T1 = Control (0% RDF), T2 = 100% RDF (20: 50: 20 kg ha-1 NPK), T3 = *Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1, T4= *Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1 + 75% RDN and 75% RDP, T5= *Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1 +50% RDN and 75% RDP, T6= *Rhizobium* seed treatment @ 25 g kg-1 seed + PSB soil application @ 5 kg ha-1 + 50% RDN and 50% RDP.

Conclusion

All the growth parameters *i.e.*, plant population, plant height, dry matter production, total number of pods, test weight, seed yield, stover yield and harvest index significantly highest under soybean residue incorporation with the treatment that received 100% RDF. However, it was found on par to treatment of 75% RD of N plus biofertilizers and 75% RD of P plus biofertilizers along with 50% RD of N plus biofertilizers and 75% RD of P plus biofertilizers. Saving of 25 to 50 percent cost on inorganic nitrogen fertilizers without decreeing the optimum economic yields is possible by adopting the above mentioned treatments.

Reference

1. Amal Kumar V, Rai B, Jat RK. Yield and yield attributes of chickpea as influenced by various row spacing and weed control. Indian Journal of Weed Sciences 2014;41(4):222-224.
2. Bai MH, Khadam D, Khan KR, Hassan GS. Effect of phosphorus, iron and rhizobium on nodulation, growth and yield of chickpea. Annals of Agricultural Research 2014;11(4):11- 17.

3. Chauhan SVS, Bhoopendra Singh Raghav. Effect of phosphorus and phosphate solubilizing bacteria on growth, yield and quality of chickpea (*Cicer arietinum* L.). Annals of Plant and Soil Research. 2017;19(3):303-306.
4. Dey, Basu. Effect of seed rate, phosphorus and FYM application on growth and yield of chickpea. Indian Journal of Pulse Research 2004;21:4-10.
5. Doran JW, Zeiss MR. Soil health and sustainability: managing the biotic component of soil quality. Applied Soil Ecology 2000;15:3-11.
6. Gangwar S, Dubey M. Effect on N and P uptake by chickpea (*Cicer ariethinum* L.) as influenced by micronutrients and biofertilizers. Legume Research 2012;35(2):164-168.
7. Hussen S, Yirga F, Tibebu F. Effect of phosphorus fertilizer on yield and yield components of chickpea (*Cicer arietinum* L.) at Kelemeda, South Wollo, Ethiopia. International Journal of Soil Crop Science 2015;1(1):1-4.
8. Kumari MSDN, Kumari KU. Effect of vermicompost enriched with rock phosphate on the yield and uptake of nutrients in chickpea. Journal of Tropical Agriculture, 2015;40:27-30.
9. Mondal. Effect of potassium and Sulphur on chickpea in relation of growth and productivity under irrigation and non-irrigated condition. Procedure of national seminar on frontiers crop management 2001, 111-112.
10. Namdeo P, Lakshmi K, Srilatha Y. Tillage and residue management effect on soil properties, crop performance and energy relations in greengram (*Vigna radiata* L.) under maize-based cropping systems. International Soil and Water Conservation Research 1991;3(4):61-72.
11. Pawar NK. Effect of phosphate solubilizing microorganism (PSM) on the growth and yield of Pigion pea (*Cajan cajan* L.) M. Sc. Thesis (Unpub.) Dr. PDKV, Akola 1998.
12. Prajapathi B, Yadhav SP, Shrivastava UK. Integrated phosphorus management in chickpea (*Cicer arietinum* L.). (Doctoral dissertation, Agronomy Department, NM college of Agriculture, Navsari Agricultural University, Navsari) 2014.
13. Singh S, Rathore SS, Pawar T. Microbial phytases in phosphorus acquisition and plant growth promotion. Molecular Biology of Plants, 2011;7(2):9-10.
14. Singh S, Saini SS, Junk T. Microbial phytases in phosphorus acquisition and plant growth promotion. Physiology and Molecular Biology of Plants 2018;17(2):93-103.
15. Sioj S, Pawar VS. Integrated nutrient management in sorghum (*Sorghum bicolor*)– chickpea (*Cicer arietinum* L.) cropping sequence under irrigated conditions. Indian Journal of Agronomy 2014;51(1):17-20.
16. Tagore GS, Namdeo SL, Sharma SK, Kumar N. Effect of rhizobium and phosphate solubilizing bacterial inoculants on symbiotic traits, nodule leghemoglobin and yield of genotypes. International Journal of Agronomy 2013;8:23-27.
17. Yadhav SP, Shrivastava UK. Responce of chickpea (*Cicer arietinum* L.) to phosphate solubilizing bacteria to phosphorus and biofertilizers. Legume Research 2004;20(2):137-140.
18. Yagoub SO, Salam AK, Hassan MM, Hassan MA. Effects of organic and mineral fertilizers on growth and yield of soybean (*Glycine max* L.). International Journal of Agronomy and Agricultural Research 2015;7(1):45-52.