The Pharma Innovation Journal 2021; 10(4): 364-369

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(4): 364-369

www.thepharmajournal.com
Received: 01-02-2021
Accepted: 03-03-2021

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Effect of phosphorus, sulphur and bio-fertilizers with various treatment combination on the yield attributing characters and economic feasibilities of chickpea (*Cicer arietinum* L.)

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Abstract
A field experiment was conducted at Agronomy Research Farm of Narendra Deva University of Agriculture & Technology, Faizabad (U.P.) during rabi season of two consecutive years to assess the effect of phosphorus, sulphur and biofertilizers on the yield attribute and economic feasibilities of chickpea (Cicer *arietinum* L.) The experiment was layout in SPD having twenty-four treatment combinations consisted of three phosphorus levels (0, 30, 60 kg $P_2 O_5$ ha^{-1}), two sulphur levels (0, 20 kg ha^{-1}) and four seed inoculation with biofertilizers (un-inoculated, PSB, Rhizobium and PSB + Rhizobium). The application of phosphorus at 60 kg ha^{-1}, sulphur at 20 kg ha^{-1} and seed inoculation with PSB + Rhizobium significantly increased the yield attributing characters and economic feasibilities of chickpea over the control /un-inoculated. So, inoculation of biofertilizers with optimum level of fertilizers could able to improve the performance of chickpea (Cicer *arietinum* L.).

Keywords: phosphorus, sulphur, bio-fertilizers, yield attributing characters, *Cicer arietinum* L.

Introduction

The world area of chickpea is estimated to be about 135.40 lakh ha^{-1}, with production and productivity of 131.02 lakh tones and 968 kg ha^{-1}, respectively. In India, the area, production and productivity is 23.63 lakh ha, 141.76 lakh tones and 810 kg ha^{-1}, respectively (Anonymous, 2016) [2]. India primarily produces Bengal gram (chickpea), red gram (tur), lentil (masur), green gram (mung) and black gram (urad). For majority of vegetarian in India, pulses are the major source of protein.

Pulses crop residues are also major source of high quality and nutritive value of livestock feed in India. In India, Madhya Pradesh (39%), Rajasthan (14%), Uttar Pradesh (7%), Maharashtra (14%), Karnataka (6%), and Gujarat (5%) are the major chickpea growing states which together account for more than 85 per cent of the production. In Uttar Pradesh, chickpea is cultivated on an area of 4.5 lakh hectares with annual production a 2.98 lakh tones. The average productivity of this crop in Uttar Pradesh is only 669 kg ha^{-1} (Anonymous, 2016) [2]. Production is limited by lack of plant nutrients available in the soil. Plant nutrients suitable cultivars and correct fertilizer have significant effect on yield and yield components (Khan *et al*. 2005) [7].

Majority of our farmers hardly use any manure or fertilizer for legume cultivation. However, there is a possibility to enhance the productivity through optimum fertilization and management, as there is a wide gap between the average yield and yield potential of this crop.

Biofertilizer has been proved as the cheapest source of N and P for better crop yields, particularly in legumes. Indian soils, in general, are lacking in effective and specific strains of *Rhizobium* which are responsible for symbiotic nitrogen fixation. Information regarding its effect on some other aspects, particularly quality characteristics under varied soil types and fertility is sporadic. Phosphorus is regarded as the pioneer plant nutrient needed by the leguminous crops for rapid and proper root development, which later on becomes helpful for better nodulation by *Rhizobium* bacteria. Sufficient supply of phosphorus to plant hastens the maturity and increases the rate of nodulation and pod development. It is also an important constituent of vital substances like phospholipids and phosphoprotein.

Phosphatic fertilizers which are routinely applied in soil to promote crop yields readily react with calcium and become progressively less available to plants.

Only about 15-20 per cent of the applied phosphorus is utilized by first crop. Hence, the current trend throughout the world is to explore the possibility of using alternate nutrients sources for increasing the efficiency of chemical fertilizers. Since phosphorus availability from reserve phosphate *i.e*. rock phosphate in neutral and alkaline soil is very low or negligiblene. Therefore, the phosphate solubulizing organisms dissolved interlocked phosphate appear to have an important implication in Indian agriculture.

Phosphate solubilizing microorganisms (PSB) are available in all soils but their number varies with climate and soil types. The potentiality of different PSB strains varies with different phosphorus sources. Multi-location trials indicated that inoculation of seed with phospho-bacteria increased the yield of rice by 10-20 per cent, wheat by 10-40 per cent, bengal gram by 10-30 per cent, and potato by 30-35 per cent over control (Gaur, 1985) [4].

Sulphur a key element of higher pulse production, is required in the formation of proteins, vitamins and enzymes. Besides, it is involved in biological nitrogen fixation. Deficiency of sulphur in Indian soil is widespread due to extensive use of sulphur free fertilizer coupled with extensive cultivation of high sulphur demanding crops Moreover, sulphur requirement of crop plants is quite high; high yielding varieties and increase cropping intensity large amounts of nutrients from the soil gradually. Pulse crops have been reported to deplete the soil S relatively to a greater extent. The importance of S for pulses cannot be overlooked since it plays a vital role in biological nitrogen fixation.

Materials and Methods

The experiment was conducted at Agronomy Research Farm, Acharya Narendra Deva University of Agriculture &Technology, Narendra Nagar (Kumarganj), Ayodhya (U.P.) during *rabi* season of 2014-15 and 2015-16. The farm is situated in the main campus of University on left side of Ayodhya-Raebarelly road at a distance of 42 km from Faizabad district headquarter. The experimental site falls under sub-tropical climate zone of Indo-Gangetic plains and situated at 26.47^{0}N latitude and 82.12^{0}E longitude at an altitude of 113 m from mean sea level. The region receives mean annual rainfall of about 1200 mm, out of which about 80% is concentrate from mid June to end of September. The winter months are very cold, whereas summer months are hot and dry. Westerly hot winds start from the month of April and continue till the onset of monsoon. The soil of the experimental field was silty loam in texture with low organic carbon (0.31%) and nitrogen (175.40 kg ha-1) and medium in phosphorus (16.30 kg ha-1) and potassium (238 kg ha-1). In this experiment there was twenty-four treatment combinations involved in which, three phosphorus levels (0, 30 & 60 kg P_2O_5 ha^{-1}), two Sulphur levels (0 & 20 kg ha^{-1}) and four seed inoculation with biofertilizers (un-inoculated, PSB, Rhizobium and PSB + Rhizobium), The chickpea variety 'Avrodhi' was treated with biofertilizers and sown at the rate of 80 kg seed ha^{-1} in split plot design with three replications. To evaluate the effects of different treatments observation were taken in stipulated time.

Results and Discussion

Yield and yield attributes

The data on yield and yield contributing characters are given in Table

Dry weight plant^{-1} (g)

The biomass of the ground part which is the resultant of all growth parameters *viz.,* plant height, number of branches plant^{-1} and number of leaves plant^{-1} is represented in terms of dry matter accumulation at different stages of crop growth. The data pertaining to the dry weight plant^{-1} are given in Table 1. The application of 60 kg P_2O_5 ha^{-1} recorded significantly higher dry weight over rest of the doses of phosphorus. However, it was at par with the application of 30 kg P_2O_5 ha^{-1} at all the stages of crop growth during both the years. The lowest dry weight plant^{-1} was recorded in the control treatment. Singh *et al.* (2010) [13] observed that the application of 20 and 40 kg P_2O_5 ha^{-1} enhanced dry weight of root and shoot over no application of P in chickpea. The dry weight plant^{-1} was significantly influenced by sulphur at all stages during both the years. Application of 20 kg S ha^{-1} recorded significantly higher dry weight plant^{-1} as compared to control. Kadam *et al.* (2006) [6] reported that K at 25 kg ha^{-1} and S at 30 kg ha^{-1} gave maximum dry matter yield. The dry weight plant^{-1} was significantly influenced with biofertilizer inoculation. The maximum dry weight plant^{-1} was recorded at all the stages of crop growth during both the years where seed was inoculated with the PSB + *Rhizobium* and it was significantly higher over the seed inoculation with PSB and *Rhizobium* alone and un-inoculated treatment. Kushwaha (2007) [8] reported that the seed inoculation of chickpea with *Rhizobium*, Phosphotica and dual inoculation with *Rhizobium* + Phosphotica significantly enhanced the growth parameters in chickpea over control. The interaction effect of phosphorus levels, sulphur and bio-fertilizers on dry weight of plant^{-1} was found to be non-significant during both the years.

Table 1: Effect of phosphorus, sulphur and bio-fertilizers on dry weight plant^{-1} of chickpea (g).

Treatment	30 DAS		60 DAS		90 DAS		At harvest	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
Phosphorus levels (kg ha^{-1})								
0	2.48	2.56	6.91	7.02	13.88	14.54	26.12	27.20
30	2.99	3.22	8.79	9.12	16.32	17.15	31.94	32.96
60	3.38	3.82	10.46	10.56	18.70	19.38	33.00	34.70
SEm±	0.04	0.05	0.15	0.12	0.29	0.28	0.43	0.56
CD at 5%	0.13	0.18	0.47	0.40	0.91	0.88	1.37	1.77
Sulphur levels (kg ha^{-1})								
0	2.83	3.07	8.37	8.54	15.65	16.34	29.14	30.36
20	3.07	3.33	9.07	9.26	16.95	17.70	31.56	32.88
SEm±	0.03	0.04	0.12	0.10	0.23	0.23	0.35	0.46
CD at 5%	0.11	0.14	0.38	0.32	0.74	0.72	1.11	1.44
Bio-fertilizers								
Un-inoculation	2.39	2.90	8.24	8.06	14.99	16.04	28.75	29.21

PSB	3.06	3.18	8.79	8.96	16.61	16.97	29.53	30.62
Rhizobium	3.09	3.21	8.85	9.02	16.70	17.06	31.56	32.69
PSB+ *Rhizobium*	3.26	3.51	9.00	9.57	16.90	18.01	31.56	33.96
SEm±	0.04	0.05	0.14	0.13	0.27	0.28	0.45	0.54
CD at 5%	0.12	0.15	0.41	0.38	0.79	0.81	1.30	
Interaction P×S	NS	NS	NS	NS	NS	NS	NS	NS

Number of pods plant^{-1}

It is clear from the data given in Table-2 that the number of pods plant^{-1} increased consistently with increasing levels of phosphorus upto 60 kg P_2O_5 ha^{-1} during both the years. 60 kg P_2O_5 ha^{-1}, recorded significantly higher number of pods plant^{-1} over other levels of P_2O_5 during both the years. Application of 60 kg P_2O_5 ha^{-1} enhanced number of pods plant^{-1} over control during 2014-15 and 2015-16, respectively. Meena *et al.* (2001) [9] reported that the application of 40 kg P_2O_5 ha^{-1} significantly increased the number of pods plant^{-1} of chickpea. Abo-Shetaia *et al.* (2001) [1] reported that application of phosphorus up to 40 kg P_2O_5 ha^{-1} significantly increased the number of pods plant^{-1} of chickpea. It is clear from the data use of sulphur increased the number of pods plant^{-1} consistently with application of 20 kg S ha^{-1} during both the years. 20 kg S ha^{-1} recorded significantly higher number of pods plant^{-1} as compared to control during both the years. Mondal *et al.* (2003) [11] reported that number of pods per plant increased significantly with application of K and S in green, 'gram. The seed inoculation significantly affected the number of pods plant^{-1} during both the year. The maximum number of pods plant^{-1} (75.48 and 77.81) was recorded where seed was inoculated with PSB + *Rhizobium*, which was significantly higher over rest of the treatments during 2014-15 and 2015-16, respectively. Velayutham *et al.* (2003) [15] found that inoculation with PSB significantly increased chickpea the pods plant^{-1} in comparison to no inoculation. The interaction effect of phosphorus levels, sulphur and bio-fertilizers on number of pods plant^{-1} was found to be non-significant during both the years.

Number of seeds pod^{-1}

It is obvious from the data given in Table-2 that the number of seeds pod^{-1} was significantly influenced with various doses of phosphorus. The highest number of seeds pod^{-1} (1.49 and 1.56) recorded with the application of 60 kg P_2O_5 ha^{-1}, which was significantly higher over other levels of phosphorus during both the years. The per cent increment in number of seeds pod^{-1} was recorded due to 60 kg P_2O_5 ha^{-1} over control by 22.14 and 21.15 during 2014-15 and 2015-16, respectively. The number of seeds pod^{-1} was significantly influenced by application of sulphur. The highest number of seeds pod^{-1} (1.40 and 1.48) was recorded with the application of 20 kg S ha^{-1} and significantly higher over control during both the years. Yadav *et al.* (2004) [16] reported that number of seeds per pod of greengram increased with increasing rates of P and S up to 40 kg ha^{-1} and decreased. The per cent increment in number of seeds pod^{-1} was recorded due to 20 kg S ha^{-1} over control by 7.14 and 8.10 during 2014-15 and 2015-16, respectively. The maximum number of seeds pod^{-1} (1.57 and 1.59) recorded where seed was inoculated with PSB + *Rhizobium* and it was significantly higher over un-inoculation, PSB and *Rhizobium* inoculation alone during both the years. The per cent increment in number of seeds pod^{-1} was recorded with PSB + *Rhizobium* inoculation over un-inoculation by 19.74 and 22.01 during 2014-15 and 2015-16, respectively. Meena *et al.* (2002) [10] reported that the use of phosphate solublizing bacteria increased the number of seed pods^{-1} as compared to un-inoculated chickpea. Interaction effect of phosphorus levels, sulphur and bio-fertilizers on number of seeds pod^{-1} was found to be non-significant during both the years.

100-seed weight (g)

The data present in Table-2 regarding the 100-seed weight indicated that different levels of phosphorus did not cause significant variation in 100-seed weight during both the years. The maximum 100-seed weight 20.23 and 20.31 g was found with the application of 60 kg P_2O_5 ha^{-1} during respective years. The 100-seed weigh during both the years of experimentation. did not differ significantly due to sulphur levels. The maximum 100-seed weight (19.50 and 19.60 g) was found with the application of 20 kg S ha^{-1} during respective years. Yadav *et al.* (2004) [16] reported that test weight of greengram increased with increasing rates of P and S up to 40 kg ha^{-1} and decreased. It is clear from the data given in table that non-significant variation was observed in the 100-seed weight due to different seed inoculation treatment given by different bio-fertilizer during both the years. The highest 100-seed weight (20.02 and 20.04) was recorded with PSB + *Rhizobium* inoculation. Meena *et al.* (2002) [10] reported that the use of phosphate solublizing bacteria increased the test weight as compared to un-inoculated chickpea. The interaction effect of phosphorus levels, sulphur and bio-fertilizers on 100-seed weight of chickpea was found to be non-significant during both the years.

Table 2: Effect of phosphorus, sulphur and bio-fertilizer on yield attributes of chickpea

Treatment	No. of pods plant^{-1}		No. of seeds pod^{-1}		100 seed weight (g)	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
Phosphorus levels (kg ha^{-1})						
0	62.04	63.96	1.16	1.23	19.27	19.46
30	70.13	71.52	1.40	1.47	19.39	19.67
60	78.43	80.82	1.49	1.56	20.23	20.31
SEm±	1.22	1.17	0.01	0.02	0.30	0.27
CD at 5%	3.87	3.69	0.06	0.08	NS	NS
Sulphur levels (kg ha^{-1})						
0	67.39	69.22	1.30	1.36	18.85	19.76
20	73.01	74.98	1.40	1.48	19.50	19.60
SEm±	1.00	0.95	0.01	0.02	0.25	0.22

CD at 5%	3.16	3.01	0.04	0.06	NS	NS
Bio-fertilizers						
Un-inoculation	64.86	67.45	1.26	1.24	19.04	19.26
PSB	70.13	71.22	1.09	1.41	19.54	19.60
Rhizobium	70.33	71.92	1.49	1.45	19.10	19.17
PSB+ *Rhizobium*	75.48	77.81	1.57	1.59	20.02	20.04
SEm±	1.20	1.21	0.02	0.02	0.31	0.28
CD at 5%	3.45	3.47	0.05	0.07	NS	NS
Interaction P×S	NS	NS	NS	NS	NS	NS

Yield

Results showed that yield of seed and straw as affected by phosphorus levels, sulphur and bio-fertilizers have been presented in Table 3. Application of phosphorus significantly affected the yield of seed and straw of chickpea. The maximum yield of seed (21.17 and 21.76 qha^{-1}) and straw (24.66 and 25.06 qha^{-1}) was recorded with the application of 60 kg P_2O_5 ha^{-1}, which was significantly higher than other levels of phosphorus during both the years. Tiwari *et al.* (2001) [14] reported that grain production of chickpea increased with increasing levels of P *viz*., 0, 40, 60 kg P_2O_5 ha^{-1} and maximum yield was observed with 60 kg P_2O_5 ha^{-1}, which was 23.1% higher over no phosphorus application. Chaudhary and Goswami (2005) [3] studied the effect of phosphorus (0, 60 and 90 kg ha^{-1}) and sulphur (0, 30 and 45 kg ha^{-1}) on chickpea. They observed that yield and yield attributes were increased significantly up to 60 kg P_2O_5 ha^{-1} and 30 kg S ha^{-1}. Sulphur significantly affected the yield of seed and straw. The maximum yield of seed (20.97 and 21.51 qha^{-1}) and straw (24.39 and 24.82 qha^{-1}) was recorded with the application of 20 kg sulphur ha^{-1} and which was significantly higher over control. Use of bio fertilizers significantly affected the yield of seed and straw. Mondal *et al.* (2003) [11] reported that yield increased significantly with application of K and S in green, 'gram. The interactions between K and S, between irrigation and potassium and between irrigation and sulphur were significant. The highest seed yield of 1370 kg ha^{-1} was obtained when the crop was supplied with 30 kg K_2O ha^{-1} along with 30 kg S ha^{-1}. The maximum yield of seed (20.97 and 21.53 qha^{-1}) and straw (24.41 and 24.82 qha^{-1}) was recorded where seed was inoculated with PSB + *Rhizobium*, which was significantly higher over un-inoculation, PSB and *Rhizobium* alone. Meena *et al.* (2002) [10] reported that the use of phosphate solublizing bacteria increased the yield attributes, is number of pods $plant^{-1}$, seed weight $plant^{-1}$ and test weight as compared to un-inoculated chickpea. Rajani and Rakholiya (2010) [12] found that inoculation with PSB increased yield of chickpea as compared to control. Interaction effect of phosphorus levels, sulphur and bio-fertilizers was found to be non-significant on the yield of seed and straw of chickpea.

Biological yield

It is obvious from the data presented in Table 2 that the maximum biological yield (45.83 and 46.81 q ha^{-1}) was recorded with the application of 60 kg P_2O_5 ha^{-1}, which was significantly higher over 30 kg P_2O_5 and control during both the years. Sulphur significantly affected the biological yield of seed and straw. The maximum biological yield (45.36 and 46.34 q ha^{-1}) was recorded with the application of 20 kg S ha^{-1} which was significantly higher over the control during both the years. A perusal of the data revealed that the PSB + *Rhizobium* inoculation recorded maximum biological yield (45.38 and 46.36 q ha^{-1}), which was significantly higher over rest of the treatments of seed inoculation during both the years. The interaction effect of phosphorus levels, sulphur and bio-fertilizers on biological yield of chickpea was found to be non-significant during both the years. Yadav *et al.* (2004) [16] reported that biological yield of greengram increased with increasing rates of P and S up to 40 kg ha^{-1} and decreased.

Table 3: Effect of phosphorus, sulphur and bio-fertilizers on seed, straw and biological yields and harvest index of chickpea

Treatment	Seed yield (qha^{-1})		Straw yield (qha^{-1})		Biological yield (qha^{-1})		Harvest index (%)	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
Phosphorus levels (kg ha^{-1})								
0	18.23	18.75	21.25	21.58	39.48	40.32	46.17	46.48
30	19.40	20.10	22.79	22.97	42.19	43.07	45.96	46.54
60	21.17	21.76	24.66	25.06	45.83	46.81	46.18	46.71
SEm±	0.31	0.34	0.34	0.37	0.43	0.36	0.58	0.70
CD at 5%	0.99	1.10	1.08	1.18	1.36	1.13	NS	NS
Sulphur levels (kg ha^{-1})								
0	18.23	18.89	21.41	21.58	39.64	40.46	45.97	46.44
20	20.97	21.51	24.39	24.82	45.36	46.34	46.23	46.68
SEm±	0.25	0.28	0.28	0.30	0.35	0.29	0.47	0.57
CD at 5%	0.81	0.89	0.88	0.96	1.11	0.92	NS	NS
Bio-fertilizers								
Un-inoculation	18.42	19.07	21.62	21.81	40.04	40.88	46.02	46.06
PSB	19.01	19.70	22.33	22.50	41.34	42.20	45.97	46.48
Rhizobium	19.99	20.50	23.24	23.66	43.24	44.17	46.20	46.44
PSB+ *Rhizobium*	20.97	21.53	24.41	24.82	45.38	46.36	46.21	46.71
SEm±	0.33	0.34	0.34	0.39	0.50	0.54	0.53	0.58
CD at 5%	0.95	1.00	0.99	1.12	1.44	1.56	NS	NS
Interaction P×S	NS	NS	NS	NS	NS	NS	NS	NS

Harvest index (%)

Harvest index was non-significantly increased with increasing levels of phosphorus (Table-4.10). The highest harvest index (46.18 & 46.71) was recorded with the application of 60 kg P_2O_5 ha^{-1}. Harvest index was non-significantly increased with application of sulphur. The highest harvest index i.e. (46.23 and 46.44) was recorded with the application of 20 kg S ha^{-1}. There was significant variation in harvest index due to different seed inoculation treatments. However, The highest value of harvest index i.e. (46.21 and 46.71 %) was obtained due to *Rhizobium* + PSB. The interaction effect of phosphorus levels, sulphur and bio-fertilizers on harvest index was found to be non-significant.

Economics

The economics of different treatment combinations was worked out on the basis of input-output analysis. The pooled data pertaining to various components of economics of 2014-15 and 2015-16 have been presented in Table 4. The highest cost of cultivation (Rs. 47098) was recorded in treatment 60 kg P_2O_5 ha^{-1}, sulphur (20 kg ha^{-1}) applied with PSB+ *Rhizobium* inoculation, while the lowest cost of cultivation (Rs. 42206) was recorded in control ($P_0S_0B_0$). The highest gross income (Rs. 99580.4) was recorded with 60 kg P_2O_5 ha^{-1}, sulphur (20 kg ha^{-1}) applied with PSB + *Rhizobium* inoculation, and the lowest (Rs. 66088.6) with control ($P_0S_0B_0$). The highest net income (Rs 52482.4) was recorded with 60 kg P_2O_5 ha^{-1}, sulphur (20 kg ha^{-1}) applied with PSB + *Rhizobium* inoculation, and lowest (Rs. 23882.6) under control (P_0 S_0 B_0). The maximum net benefit: cost ratio (Rs 1.11) observed with the treatment combination of 60 kg P_2O_5 ha^{-1}, sulphur (20 kg ha^{-1}) applied with PSB + *Rhizobium* inoculation, while the minimum benefit cost ratio (Rs. 0.56) was recorded with the control (P_0 S_0 B_0). Jain *et al.* (2006) reported that the highest gross return (Rs. 305387.15 ha^{-1}), net return (Rs. 22067.15 ha^{-1}) and benefit: cost ratio (2.60) with application of 50 kg P_2O_5 ha^{-1} + *Rhizobium* + PSB in chickpea crop.

Table 4: Economic of various treatment combinations of chickpea on the basis of pooled data of 2014-15 and 2015-16.

Treatment	Cost of cultivation (Rs ha^{-1})	Gross income (Rs ha^{-1})	Net return (Rs ha^{-1})	Benefit :Cost ratio
$P_0S_0B_0$	42206	66088.6	23882.6	0.56
$P_0S_0B_1$	42366	68204.6	25858.6	0.60
$P_0S_0B_2$	42366	71379.2	29013.2	0.68
$P_0S_0B_3$	42526	74919.2	32393.2	0.76
$P_0S_1B_0$	44006	75651.8	31645.8	0.71
$P_0S_1B_1$	44166	78093.8	33927.8	0.76
$P_0S_1B_2$	44166	81675.6	37509.6	0.84
$P_0S_1B_3$	44326	85744.6	41418.6	0.93
$P_1S_0B_0$	43592	70605.9	27013.9	0.61
$P_1S_0B_1$	43752	70084.4	26332.4	0.60
$P_1S_0B_2$	43752	76262.0	32510.0	0.74
$P_1S_0B_3$	43912	80046.8	36134.8	0.82
$P_1S_1B_0$	45392	80820.0	35428.0	0.78
$P_1S_1B_1$	45552	83425.0	37873.0	0.83
$P_1S_1B_2$	45552	87291.0	41739.0	0.91
$P_1S_1B_3$	45712	91644.8	45932.8	1.00
$P_2S_0B_0$	44978	76709.8	31731.8	0.70
$P_2S_0B_1$	45138	79212.2	34074.2	0.75
$P_2S_0B_2$	45138	82855.4	37717.4	0.83
$P_2S_0B_3$	45298	86965.0	41667.0	0.91
$P_2S_1B_0$	46778	87820.0	41042.0	0.87
$P_2S_1B_1$	46938	90668.6	43730.6	0.93
$P_2S_1B_2$	46938	94860.0	47922.0	1.02
$P_2S_1B_3$	47098	99580.4	52482.4	1.11

Conclusion

Crop on the basis of results obtained from the present study conducted for the two consecutive years. A dose of 60 kg P_2O_5 ha^{-1} and 20 kg sulphur ha^{-1} proved to be most suitable for chickpea cultivation and The inoculation of seed of chickpea with PSB + *Rhizobium* formed to be more suitable for sustainable production of chickpea. Interaction effect between phosphorus, sulphur and biofertilizers was found to be non-significant. A chickpea crop grown with 60 kg P_2O_5, 20 kg S ha^{-1} along with seed inoculation with PSB+*Rhizobium* gave higher net income and benefit-cost ratio.

Recommended

Crop on the basis of results, it is recommended that chickpea crop higher yield and profit the quality grown with application 60 kg P_2O_5, 20 kg S ha^{-1} and seed inoculation PSB+*Rhizobium* for getting higher yield and profit.

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