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EFFECT OF DIFFERENT NUTRIENT SOURCES ON YIELD, QUALITY AND ECONOMICS OF COWPEA (*VIGNA UNGUICULATA* L. WALP.)

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ABSTRACT

An experiment was conducted at Agronomy Instructional Farm, S.K. Nagar, Gujarat, India during *Kharif* season of the year 2019 in loamy sand-textured soil to investigate the Effect of different nutrient sources on yield, quality and economics of cowpea [*Vigna unguiculata* (L.) Walp.]. Eight treatment combinations comprising, with and without application of biofertilizer, with two sources of nitrogen as well as two sources of phosphorus as per recommended dose of cowpea were estimated in factorial concept of randomized block design with four replications. Growth and yield attributing characters of cowpea were significantly influenced by different sources and interaction of biofertilizer, nitrogen and phosphorus. In all cases, single effect of each of seed inoculation with biofertilizer *Rhizobium* + PSB (B_2), ammonium sulphate (N_2) and single super phosphate (P_2) was found superior and recorded significantly higher growth, yield attributing characters, seed yield, stover yield and protein content of cowpea seed than other sources of particular nutrients. As well as recorded the significant interaction effect of biofertilizer, nitrogen and phosphorus sources with the application of biofertilizer + ammonium sulphate + single super phosphate on yield attributes, seed yield and stover yield of cowpea. The results revealed that treatments combination of with biofertilizer + ammonium sulphate + single super phosphate registered maximum gross and net realization with the B: C ratio. Based on findings, it is considered that to attain higher seed yield, monetary returns from cowpea crop, the crop should be fertilized with combined application of seed inoculation of *Rhizobium* + PSB with ammonium sulphate as well as single super phosphate.

Key words : Biofertilizer, Cowpea, Growth and Yield parameters, Monetary returns, Nutrient sources, Quality.

Introduction

Plant nutrients can be obtained from a wide range of unique materials. These can be a variety of biological products, such as microbial inoculants, or natural, synthetic, or recycled wastes. Protein and chlorophyll both require nitrogen as a component (Meena and Chand, 2014). Additionally, it is found in numerous other chemicals that are crucial for plant metabolism physiologically. Higher rate of nitrogen applications may result in fewer nodules and slower nodule formation, which negatively impacts the ability to fix nitrogen (Singh and Nair, 1995). Additionally, N and P have a stimulating impact on the crop's root activity and rooting pattern. For pulse crops, phosphorus is the most important mineral nutrient because it promotes greater root growth and development, which increases their capacity for biological nitrogen fixation. It encourages the growth of lateral and fibrous roots, which makes it easier for bacteria to cause nodulation and as a result, boosts the fixation of atmospheric nitrogen in leguminous crops. Phosphorus is an essential constituent of nucleic. Ammoniacal nitrogen is found in ammonium sulphate and chloride, nitrate nitrogen is present in calcium ammonium nitrate, which contains both ammoniacal and nitrate nitrogen, and amide nitrogen is present in urea. The accessible form of phosphate, such as diammonium phosphate, single super phosphate (SSP), and triple super phosphate (TSP), is found in phosphatic fertilizers. Biofertilizers, a part of integrated nutrient management, are seen as a more affordable, environmentally friendly and renewable alternative to chemical fertilizers for non-bulky plant nutrients. As a result, they play a significant role in India's agricultural system. The usage of biofertilizer may be more crucial for improving fertilizer use efficiency. In order to enhance the amount of *Rhizobium* in the rhizosphere and hence significantly increase the amount of microbiologically fixed nitrogen for plant growth when *Rhizobium* is introduced into pulse seed. When pulse seeds are inoculated with phosphate solubilizing bacteria (PSB), acetic compounds are secreted that act as solubilizers for the phosphorus that is not available in the soil (Khandelwal *et al.*, 2012).

One of the significant Kharif pulse crops is cowpea, also known as lobia in India and farmed for vegetables, grain, fodder, and green manuring. The cowpea [*Vigna unguiculata* (L.) Walp.] is a member of the Leguminaceae family and the Papilionaceae subfamily. It is referred to as vegetarian meat and is high in protein and other nutrients. Due to the availability of short-duration, high-yielding and quickly-growing cultivars, this crop is extremely important. Cowpea pods are an excellent source of protein, fiber, calcium, minerals, and vitamins, especially vitamins A and C. Per 100 g edible amount, it has 60.03 g of carbohydrates, 23.52 g of proteins, 1.26 g of fat, 10.6 g of fiber, 110 mg of calcium, 424 mg of phosphorus and 8.27 mg of iron. (Anonymous, 2019). The cowpea is one of the most important pulse crops in organic farming systems because it improves soil fertility even on marginal areas and helps cropping systems remain sustainable by providing ground cover, plant residue, nitrogen fixation, and weed suppression. In addition, plants need N in the early stages for better germination, the development of more branches and peduncles, which results in an increase in the number of pods, seeds, and noticeably higher yields (Abayomi *et al.*, 2008). The yield is low in India as well production either by increasing yields per hectare of this crop. In light of the aforementioned information and the requirement for the best possible use of diverse nutrition sources in conjunction with *Rhizobium* and PSB culture, an experiment titled "Effect of different nutrient sources on yield, quality and nutrient uptake by cowpea [*Vigna unguiculata* (L.) Walp.]" was done to investigate the effects of nutrient sources on cowpea growth, yield, quality, and monitory returns.

Materials and Methods

During the 2019 *Kharif* season, an experiment was carried out at the Agronomy Instructional Farm, Sardarkrushinagar Dantiwada Agricultural University, SK Nagar. Geographically, Sardarkrushinagar is situated at 24^0 19' North latitude and 72^0 19' East longitudes with an elevation of 154.52 meter above the mean sea level and situated in the North Gujarat Agro-climatic region. With a soil pH of 7.7 and an EC of 0.13 dS m^{-1}, loamy sand-textured soil has low organic carbon (0.270%), available N (156.8 kg/ha), available S (7.3 mg/kg), medium available P_2O_5 (32.8 kg/ha) and high available K_2O (254.9 kg/ha). Evaluated a field experiment in factorial concept of randomized block design (RBD) with four replications. Eight treatment combinations comprising from two sources of biofertilizers *viz.* without biofertilizer (B_1) and with biofertilizer *Rhizobium* + PSB (B_2) with two sources of nitrogen *viz.* urea (N_1) and ammonium sulphate (N_2) as well as two sources of phosphorus *viz.* diammonium phosphate (P_1) and single super phosphate (P_2). *Rhizobium* + PSB each @ 10 ml/kg of seed N-P_2O_5-K_2O:25-40-00 kg/ha. Cowpea variety Gujarat cowpea 5 was sown at a distance of 45 cm × 10 cm. Eight treatments combination were T_1: Without biofertilizer + Urea + DAP, T_2: Without biofertilizer + Urea + SSP, T_3: Without biofertilizer + Ammonium sulphate + DAP, T_4: Without biofertilizer + Ammonium sulphate + SSP, T_5: With biofertilizer + Urea + DAP, T_6: With biofertilizer + Urea + SSP, T_7: With biofertilizer + Ammonium sulphate + DAP, T_8: With biofertilizer + Ammonium sulphate + SSP. Agronomic procedures are used during the crop period in accordance with standards and in a timely manner. Throughout the experiment, observations on the various morphological traits of the plant were recorded using a random sampling technique. Observations were made frequently before and after harvest (related to growth attributes) and during harvest (related to yield attributes, quality parameter and economics) and each of these categories was assessed separately. The initial and final plant population per net plot was recorded at 30 days after sowing (DAS) and at harvest from two spots within each net plot area, respectively. Plant height was measured at 45 DAS and at harvest in centimeters from ground level to the top of the main shoot, from five randomly selected tagged plants within each net plot. The total number of branches and filled pods from the previously tagged five plants were counted at harvest, and their average values per plant were calculated for each treatment. Representative seed samples were collected randomly from the bulk produce of each net plot, and 1000-seeds were counted and weighed using a laboratory balance, noted as the test weight of each treatment. The seed and straw weights of five randomly selected plants from each net plot were recorded as seed and straw yield per plant at harvest. The produce of each net plot area was threshed separately, and the seeds and straw were weighed and recorded as seed and straw yield per net plot. These values were then converted to yield in kilograms per hectare. For seed protein content, the estimation of nitrogen in the seed was conducted using the micro Kjeldahl method as described by Jackson (1978). The protein content in the grain was calculated by multiplying the nitrogen content of the seed (percent) by the factor 6.25, as reported by Gupta *et al.* (1972) and expressed as a percentage on a dry weight basis for each treatment. Protein yield was computed from the data of protein content and seed yield using the following formula (Jackson, 1978).

$$\text{Protein yield (kg/ha)} = \frac{\text{Protein content (\%)} \times \text{Seed yield (kg/ha)}}{100}$$

In order to evaluate most effective and remunerative treatment, relative economics of each treatment was calculated. The gross realization in terms of rupees per hectare was worked out for each treatment taking in to consideration the prevailing market price of the produce. Likewise, the cost of cultivation starting from preparatory tillage to harvest of the crop including threshing and cleaning as well as cost of inputs *viz.* seed, fertilizers, irrigations *etc*. were also worked out. The cost of cultivation was deducted from the gross realization to work out net realization for each treatment and recorded accordingly. The Benefit Cost Ratio (BCR) was calculated on the basis of formula given below:

$$\text{Benefit Cost Ratio (BCR)} = \frac{\text{Gross income (Rs/ha)}}{\text{Total expenditure (Rs/ha)}}$$

The experimental data that was gathered was statistically analyzed using the analysis of variance method (Cochran and Cox, 1957) in accordance with the randomized block design with factorial concept approach. At a 5% level of significance, the calculated value of "F" was calculated and compared to the value of table "F".

Results and Discussion

Effect of biofertilizer sources

Data elaborated in Table 1, among the growth parameters plant height (at 45 DAS and at harvest) and no. of branches per plant were significantly influenced due to the seed inoculation of cowpea with biofertilizers *Rhizobium* + PSB each @ 10 ml/kg of seed (B_2) compared to without biofertilizer inoculation (B_1). Seed inoculation of cowpea with biofertilizer *Rhizobium* + PSB each @ 10 ml/kg of seed (B_2) recorded a significantly higher no. of pods per plant, seed yield per plant and stover yield per plant as compared to without biofertilizer inoculation (B_1). Significantly affected seed yield (1307 kg/ha) and stover yield (2190 kg/ha) by the cowpea seed inoculation with biofertilizer *Rhizobium* + PSB each @ 10 ml/kg of seed (B_2) as compared to without biofertilizer application (B_1). Protein content and protein yield were found higher due to 10 ml/kg of seed inoculation with *Rhizobium* + PSB biofertilizer inoculation (B_2) over without biofertilizer inoculation (B_1). As biofertilizer sources, seed inoculation with *Rhizobium* + PSB each at 10 ml/kg of seed (B_2) significantly increased net realization to (67360 /ha) and benefit: cost ratio to (3.04) compared to without biofertilizer, which had net realization to (55250 /ha) and benefit: cost ratio to (2.68) (Table 2). However, it was found that the impact of *Rhizobium* and PSB as biofertilizer sources on plant population at 30 DAS and harvest as well as the weight of 1000 seeds of cowpea, was not statistically significant.

This may be because *Rhizobium* produces growth regulators and fixes nitrogen from the air in a symbiotic process. It might be caused by the creation of various organic acids, like lactic acid and acetic acid, which solubilize insoluble phosphates. The minimum values of plant height were observed under without inoculation because plants were unable to receive more nutrients. This conclusion is in close agreement with Selvakumar *et al.* (2012), Meena *et al.* (2015), Singh *et al.* (2016) and Verma *et al.* (2017) findings. Additionally, these organisms create phytohormones, compounds that stimulate plant growth. These findings closely related with conclusion gave by Tagore *et al.* (2013). Due to biofertilizer seed inoculation significant improvement observed in the present study for growth parameters, yield attributes, uptake of nutrients and nutrient availability in soil might have increased yield of cowpea. The findings of Khan *et al.* (2013), Boahen *et al.* (2017), Chattarjee and Bandyopadhyay (2017) and Singh and Singh (2017) are in agreement with these results.

Increased protein content it may be caused by higher uptake of nitrogen and phosphorus due to combined effect of *Rhizobium* + PSB during crop growth and more photosynthesis, protoplasm and protein synthesis for higher rate of mitosis. Nitrogen is a crucial component of proteins and amino acids, improving the quality. As well as phosphorus is responsible as essential ingredient for *Rhizobium* for nitrogen fixation, proliferous root development, better growth and flower/seed formation. These results generally concur with those of experiments conducted by Selvakumar *et al.* (2009), Khandelwal *et al*. (2012), Singh *et al*. (2016), Singh and Singh (2017) and Singh *et al*. (2018).

Table 1 : Effect of nutrient sources on growth and yield of cowpea.

Treatment	Plant population/ net plot		Plant height (cm)		No. of pods per plant	1000-seed weight (g)	Seed yield/ plant (g)	Seed yield (kg /ha)	Stover yield/ plant (g)	Stover yield (kg /ha)	Protein content (%)	Protein yield (kg/ha)
	30 DAS	At Harvest	45 DAS	At Harvest								
[A] Biofertilizer sources												
B_1 : Without biofertilizer	236.9	218.3	39.08	58.85	21.85	81.07	5.31	1148	9.16	1930	21.42	246.1
B_2 : With biofertilizer (*Rhizobium* + PSB)	239.2	220.5	45.10	66.69	25.18	82.61	6.54	1307	10.53	2190	22.40	293.8
S.Em. ±	2.65	1.99	0.83	1.11	0.47	0.86	0.15	29.1	0.21	38.6	0.32	8.35
C.D. (P=0.05)	NS	NS	2.44	3.26	1.39	NS	0.44	86	0.62	113	0.95	24.56
[B] Nitrogen sources												
N_1 : Urea	236.6	217.8	39.51	60.50	22.16	81.36	5.39	1164	9.20	1969	21.38	249.7
N_2 : Ammonium sulphate	239.4	221.0	44.67	65.03	24.87	82.32	6.45	1292	10.49	2151	22.44	290.3
S.Em.±	2.65	1.99	0.83	1.11	0.47	0.86	0.15	29.1	0.21	38.6	0.32	8.35
C.D. (P=0.05)	NS	NS	2.44	3.26	1.39	NS	0.44	86	0.62	113	0.95	24.56
[C] Phosphorus sources												
P_1 : Diammonium phosphate	237.4	218.5	40.52	61.01	22.31	81.39	5.42	1167	9.27	1967	21.88	255.8
P_2 : Single super phosphate	238.6	220.3	43.66	64.53	24.72	82.29	6.42	1289	10.41	2154	21.95	284.2
S.Em.±	2.65	1.99	0.83	1.11	0.47	0.86	0.15	29.1	0.21	38.6	0.32	8.35
C.D. (P=0.05)	NS	NS	2.44	3.26	1.39	NS	0.44	86	0.62	113	0.95	24.56
Interaction												
B × N	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
B × P	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
N × P	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
B × N × P	NS	NS	NS	NS	Sig.	NS	Sig.	Sig.	Sig.	Sig.	NS	NS
C. V. %	4.45	3.63	7.89	7.06	8.01	4.21	10.06	9.49	8.51	7.49	5.90	12.37

Effect of Nitrogen sources

The examination of data presented in Table 1, significant increases in plant height and the number of branches per plant among other growth characteristics were noted with an application of ammonium sulphate (N_2) as nitrogen source, which is superior over application of urea (N_1). In comparison between nitrogen sources, the application of ammonium sulphate (N_2) considerably increased the number of pods per plant, seed yield per plant and stover yield per plant of the cowpea crop. Application of ammonium sulphate (N_2) above urea (N_1) had a substantial impact on cowpea seed and stover yield in this case. Increased yields of stover (2151 kg/ha) and seeds (1292 kg/ha) were evidence of this. However, the 1000-seed weight of cowpea and the plant population as a whole were not significantly impacted by different nitrogen sources. The nitrogen sources were found to have a substantial impact on both the protein yield and content of seeds. Protein yield and content were increased when ammonium sulphate (N_2) was applied. Ammonium sulphate (N_2) application yielded the highest net realization of 65832/ha and benefit: cost ratio of 2.98. The application of urea (N_1) had the lowest net realization (56779 /ha) and benefit: cost ratio (2.74; Table 2). This may be because amino acids, proteins, nucleic acids, phytohormones and a number of enzymes and coenzymes all contain important elements of nitrogen and sulfur. They are primarily involved in the early stages of growth, including chromosome replication, the production of deoxyribonucleic acids, and nuclear protein synthesis. Sulfur is categorized as a secondary nutrient and is essential for the growth of all plants. The remarkable increase in growth, yield attributes attained by ammonium sulphate in this study can be explained by the efficient supply of nitrogen and sulphur, which are in form of ammonium and sulphate as essential nutrients for the plant growth while urea can supply only nitrogen to the plant. Since As decreases pH, it causes the breakdown of numerous micro elements, making them accessible to the plant (Ozden, 2010). Ammonium sulphate is the best N-fertilizer source that contains free sulfur and has numerous potential advantages over urea and ammonium nitrate in terms of agronomy and the environment, according to a review by Chien *et al.* (2011). Seed yield was increased significantly through ammonium sulphate over urea as nitrogen sources which closely resembles the outcomes of Ozden (2010), Amin (2011) and Chien *et al*. (2011). It may be caused by the combined effects of nitrogen and sulfur on plant growth and yield-attributing traits, which boost photosynthesis and, ultimately, increase cowpea seed yield. As well as sulphur from ammonium sulphate has synergistic relationship with macro and micronutrients availability and solubility ultimately increasing the crop production. These cowpea protein production and content results could be attributed to the use of ammonium sulphate rather than urea. Urea just contains N, whereas ammonium sulphate adds N and S to the soil. The produced carbohydrates are converted into proteins when nitrogen availability is optimal and the environment is favorable for growth. Because sulphur is crucial for plant nutrition, sulphur deficiency can have a negative impact on both yield and quality. In sulphur deficient plants greater inhibition of protein synthesis and composition of proteins *etc*. Thus, the application of ammonium sulphate is superior over the urea in sulphur deficient soil. These findings for the growth, yield attributes, and yield of cowpea are consistent with those made by Ayub *et al.* (2000), Amin (2011), Khan *et al.* (2011), Hafez and Kobata (2012), Gendy *et al.* (2013), Mohammed and Mahammad (2015), Sebetha *et al.* (2015), Amanullah *et al.* (2016), Biswas and Bao-Luo (2016), Moreira *et al.* (2017), Marva *et al.* (2018), Berhe *et al*. (2019), Sebetha and Modisapudi (2019) and Mohammed *et al.* (2020).

Effect of Phosphorus sources

An appraisal of data showed in Table 1, application of phosphorus sources significantly influenced the growth characters of cowpea. Single super phosphate application resulted in noticeably enhanced plant height at 45 DAS, harvest, and number of branches per plant. With the application of a single super phosphate, significantly higher values for the cowpea crop's pod count, seed production, and stover yield per plant were observed. In comparison to the use of diammonium phosphate, the application of single super phosphate resulted in noticeably increased seed yield (1289 kg/ha) and stover yield (2154 kg/ha). While protein content, plant population and 1000-seed weight were not significantly impacted by phosphorus sources, protein yield was considerably impacted by single super phosphate (SSP). As shown in Table 2, the use of a single super phosphate as a phosphorus source resulted in higher net realization (65742 ha) and benefit: cost ratio (2.98), compared to the use of diammonium phosphate, which had net realization (56868 ha) and benefit: cost ratio (2.74). This might be due to SSP containing a more amount of phosphorus, calcium and sulphur while, DAP containing N and P. Phosphorus boosts early root development and growth, which helps seedlings take root quickly. It also promotes the creation of root nodules, which aids in the fixation of more atmospheric nitrogen in the nodules. Along with phosphorus, calcium and sulfur also play a crucial part in cell division and elongation as well as being components of the cell wall. This increases the stiffness of plants and promotes greater growth. Calcium and sulphur improves the uptake of the other plant nutrients like nitrogen leads to increase growth

Table 2 : Economic of cowpea cultivation influenced by various treatment combinations.

S. no.	Treatment Combinations	Yield(kg/ha)		Treatment Cost or variable cost (Rs /ha)	Cost of cultivation or Common Cost (Rs /ha)	Total Cost (Common cost + Treatment cost) (Rs /ha)	Gross realization (Rs/ha)	Net realization (Rs /ha)	BCR
		Seed	Stover						
1	$B_1N_1P_1$: Without biofertilizer + Urea + DAP	1105	1851	2403	30147	32550	84771	52221	2.60
2	$B_1N_1P_2$: Without biofertilizer + Urea + SSP	1147	1938	2417	30147	32564	88043	55478	2.70
3	$B_1N_2P_1$: Without biofertilizer + Ammonium sulphate+DAP	1153	1933	2619	30147	32766	88432	55667	2.70
4	$B_1N_2P_2$: Without biofertilizer + Ammonium sulphate + SSP	1189	1998	3410	30147	33557	91191	57634	2.70
5	$B_2N_1P_1$: With biofertilizer + Urea + DAP	1185	2005	2463	30147	32610	90943	58333	2.79
6	$B_2N_1P_2$: With biofertilizer + Urea + SSP	1220	2083	2477	30147	32624	93707	61083	2.87
7	$B_2N_2P_1$: With biofertilizer + Ammonium sulphate + DAP	1225	2077	2679	30147	32826	94077	61251	2.87
8	$B_2N_2P_2$: With biofertilizer + Ammonium sulphate + SSP	1600	2596	3470	30147	33617	122391	88774	3.64

Note: Sell price of cowpea seed for 2019-20 70 Rs./kg Sell price of cowpea straw 2019-20 4 Rs/kg at local market.

characters of plant and other micronutrients leading to better growth of plants. Ca is also a prerequisite for making symbiotic leguminous plants susceptible to *Rhizobium* infection because it promotes the incorporation of nitrogen into organic components, particularly proteins. Thus, P, Ca and S from a single application of super phosphate (P_2) fertilizer are superior to diammonium phosphate (P_1) fertilizer. Additionally, the solubility of P in water under rainfed / low soil moisture conditions explains why SSP released P instantaneously, but granular DAP would release P slowly due to a lack of soil moisture needed for its dissolution. As well as SSP supply the Ca and S to the plant which leads the better performance in yield parameters and crop productivity as compared with DAP. The findings of Ali *et al*. (2015) regarding wheat, Singh *et al*. (2015) regarding mungbean, and Jamra *et al*. (2017) regarding mungbean are all corroborated by the results. In addition, SSP has a significant quantity of sulfur, which improves the quality of proteins by aiding in the production of specific amino acids like cysteine and methionine. In order to increase the protein content of cowpea seed, P and S from SSP treatment outperform DAP. These yield-attributing characteristics, growth, and yield results are consistent with those published by Mehdi *et al.* (2003), Dalvi (2010), Devi *et al.* (2012), Darwesh *et al*. (2013), Ayodele and Oso (2014) and Khan *et al*. (2019).

Interaction effect

Cowpea's number of pods per plant, seed yield per plant,

Table 3 : Interaction effect of nutrient sources on number of pods/plant, seed yield/plant, seed yield, stover yield/plant and stover yield of cowpea crop.

Treatments	**B_1: Without biofertilizer**		**B_2: With biofertilizer(*Rhizobium*, PSB)**	
	P_1:Diammonium phosphate	**P_2: Single super phosphate**	**P_1:Diammonium phosphate**	**P_2: Single super phosphate**
Number of pods/plant				
N_1: Urea	20.21	21.94	22.71	23.78
N_2:Ammonium sulphate	22.25	23.00	24.09	30.16
S.Em.±	0.94			
C.D. (P=0.05)	2.77			
C. V. %	8.01			
Seed yield/plant (g/plant)				
N_1: Urea	4.58	5.33	5.57	6.08
N_2:Ammonium sulphate	5.40	5.91	6.16	8.34
S.Em. ±	0.30			
C.D. (P=0.05)	0.88			
C. V. %	10.06			
Seed yield (kg/ha)				
N_1: Urea	1105	1147	1185	1220
N_2:Ammonium sulphate	1153	1189	1225	1600
S.Em. ±	58.3			
C.D. (P=0.05)	171			
C. V. %	9.49			
Stover yield/plant				
N_1: Urea	8.38	9.17	9.37	9.87
N_2:Ammonium sulphate	9.32	9.76	10.02	12.85
S.Em. ±	0.42			
C.D. (P=0.05)	1.23			
C. V. %	8.51			
Stover yield (kg/ha)				
N_1: Urea	8.38	9.17	9.37	9.87
N_2:Ammonium sulphate	9.32	9.76	10.02	12.85
S.Em. ±	0.42			
C.D. (P=0.05)	1.23			
C. V. %	8.51			

stover yield per plant, and stover yield were all significantly impacted by the interaction effect of nutrient sources. Table 3 shows that the treatment combination $B_2N_2P_2$ (with biofertilizer + ammonium sulphate + SSP) significantly increased the number of pods per plant, seed yield per plant, seed yield, stover production per plant, and stover yield (30.16, 8.34 g, 1600 kg/ha, 12.85 g and 2596 kg/ha, respectively). The number of pods per plant, seed yield per plant, seed yield, stover yield per plant, and stover yield were considerably lower for treatment combinations $B_1N_2P_1$ (Without biofertilizer + Urea + DAP) (20.21, 4.58 g/plant, 1105 kg/ha, 8.38 g/plant and 1851 kg/ha, respectively). Thus, it is clear that combining the effects of dietary sources that offer the necessary macronutrients N and P. Additionally, a balanced application of biofertilizer and other nutrient sources was made. The outcome may be attributable to an adequate supply of primary and secondary nutrients that are necessary for improving seed production and stover yield as well as increasing pod formation, seed formation and growth characteristics. Ammonium sulfate and single super phosphate, which offer sulphur and calcium, help to improve the chemical characteristics of the soil and increase the effective use of applied fertilizers, which leads to improved seed yield and quality. Additionally, it promotes the growth of microbes, which in turn increases the solubility of nutrients and the plant's ability to absorb macro- and micronutrients through improved biological processes. These results aligns with the findings of those individuals who Patil *et al.* (2010), Kumar and Pandita (2016), Bunker *et al.* (2018), Mandal and Mondal (2018) and Yadav *et al.* (2019).

Conclusion

Based on findings from the current analysis, it is considered that to attain higher seed yield, monetary returns from cowpea crop, the crop should be fertilized with combined application of seed inoculation of *Rhizobium* + PSB with ammonium sulphate as well as single super phosphate. In summary, the combined application of diverse nutrient sources significantly impacts plant growth, yield, and quality. This study highlights the synergistic effects of multiple nutrients, leading to improved plant development and productivity. By carefully managing nutrient balance and composition, growers can optimize crop performance, achieving higher yields while enhancing harvested produce quality.

Authour's contribution

Conceptualization and designing of the research work (N.I. Patel and K.K. Patel); Execution of field/lab experiments and data collection (K.K. Patel), analysis of data and interpretation (K.K. Patel), preparation of manuscripts (K.K. Patel, M.K. Gamit and N.M. Chaudhari).

References

Abayomi, Y.A., Ajibade T.V., Sammuel O.F. and Sa adudeen B.F. (2008). Growth and yield responses of cowpea [*Vigna unguiculata* (L.) Walp.] genotypes to nitrogen fertilizer (NPK) application in the Southern Guinea Savanna zone of Nigeria. *Asian J. Plant Sci.*, **7(2)**, 170-176.

Ali, M., Ali L., Din M., Muhammad S., Masood Q.W., Ali M.A. and Khalid L. (2015). Comparative performance of wheat in response to different phosphatic fertilizers. *Int. J. Res. Agricult. Forest.*, **2(6)**, 1-9.

Amanullah Iqbal, A., Ali A., Fahad S. and Parmar B. (2016). Nitrogen source and rate management improve maize productivity of smallholders under semiarid climates. *Front. Plant Sci.*, **7(1773)**, 1-9.

Amin, M.H. (2011). Effect of different nitrogen sources on growth, yield and quality of fodder maize (*Zea mays* L.). *J. Saudi Soc. Agricult. Sci.*, **10**, 17-23.

Anonymous (2019). Basic report 16062, Cowpeas, common (blackeyes, crowder, southern), mature seeds, raw. *USDA, National nutrient database for standard reference*, Release 1st April, 2018.

Ayodele, O.J. and Oso A.A. (2014). Effects of phosphorus fertilizer sources and application time on grain yield and nutrient composition of cowpea [*Vigna unguiculata* (L.) Walp]. *Amer. J. Exp. Agricult.*, **4(12)**, 1517-1525.

Ayub, M., Choudhary A., Tanveer A., Amin M.M.Z. and Ahmad I. (2000). Effect of different nitrogen and phosphorus sources on the growth and grain yield of maize (*Zea mays* L.). *Pak. J. Biolog. Sci.*, **3(8)**, 1239-1241.

Berhe, G., Abraha H. and Haftu W. (2019). Evaluation of urea and ammonium sulphate on yield and yield components of sesamum (*Sesamum indicum* L.) under high pH vertisol of Western Tigray, Northern Ethiopia. *Cogent Food and Agriculture*, **5**, 1-11.

Biswas, D.K. and Bao-Luo M. (2016). Effect of nitrogen rate and fertilizer nitrogen source on physiology, yield, grain quality and nitrogen use efficiency in corn. *Canadian J. Plant Sci.*, **96**, 392-403.

Boahen, S., Savala C.E.N., David C. and Abaidoo R. (2017). Growth and yield responses of cowpea to inoculation and phosphorus fertilization in different environments. *Front. Plant Sci.*, **8(646)**, 1-13.

Bunker, R.R., Naroliya R.K., Pareek P.K., Nagar V., Chaniya K.K. and Omprakash (2018). Effect of nitrogen, phosphorus and bio-fertilizers on growth and yield attributes of garden pea (*Pisum sativum* L.). *Int. J. Chem. Stud.*, **6(4)**, 1701-1704.

Chatterjee, R. and Bandyopadhyay S. (2017). Effect of boron, molybdenum and biofertilizers on growth and yield of cowpea (*Vigna unguiculata* L. Walp.) in acid soil of eastern Himalayan region. *J. Saudi Soc. Agricult. Sci.*, **16**, 332–336.

Chien, S.H., Gearhart M.M and Villagarcia S. (2011). Comparison of ammonium sulphate with other nitrogen and sulfur fertilizers in increasing crop production and minimizing environmental impact. *Soil Sci.*, **176(7)**, 327-335.

Cochran, W.G. and Cox G.M. (1957). *Experimental design*. 2nd edition Wiley, New York.

Dalvi (2010). Phosphorus management in summer cowpea (*Vigna unguiculata* L. Walp) and its residual effect on *kharif* transplanted rice (*Oryza sativa* L.) grown under different fertility levels. *Ph. D. (Agri.) (Published)* submitted to N. M. College of Agriculture University, Navsari.

Darwesh, A.D., Maulood P.M. and Amin S.A. (2013). Effect of phosphorus fertilizers on growth and physiological phosphorus use efficiency of three soybean cultivars. *IOSR J. Agricult. Vet. Sci.*, **3(6)**, 32-36.

Devi, K.N., Singh L.N., Devi T.S., Devi H.N., Singh T.B., Singh K.K. and Singh W.M. (2012). Response of soybean [*Glycine max* (L.) Merrill] to sources and levels of phosphorus. *J. Agricult. Sci.*, **4(6)**, 44-53.

Gendy, A.S.H., Said-Al Ahl A.H., Mahmoud A.A. and Mohamed F.Y. (2013). Effect of nitrogen sources, bio-fertilizers and their interaction on the growth, seed yield and chemical composition of guar plants. *Life Sci. J.*, **10(3)**, 389-402.

Gupta, B.R., Pathak R.K., Bhan S. and Singh A. (1972). Effect of NPK on yield, nutrient and quality of toria (*Brassica compenstris* var. toria). *Indian J. Agron.,* **17(2)**, 88-91.

Hafez, E.M. and Kobata T. (2012). The effect of different nitrogen sources from urea and ammonium sulphate on spikelet number in Egyptian spring wheat cultivars on well watered pot soils. *Plant Prod. Sci.,* **15(4)**, 332-338.

Jackson, M.L. (1978). *Soil chemical analysis*. Prentice Hall of India Pvt. Ltd., New Delhi.

Jamra, S., Trivedi S.K., Dhakad H., Simaiya V., Tomar V., Khan S. and Jatav R.C. (2017). Effect of levels and sources of phosphorus application on growth, yield and nutrient use efficiency of black gram (*Phaseolus mungo* L.). *Int. J. Chem. Stud.,* **5(5)**, 1661-1663.

Khan, M., Shah S.S., Khan A., Muhammad S. and Ahmed S. (2019). Efficacy of manually prepared single super phosphate fertilizer on rainfed wheat crop under Sub-Humid climate. *Pak. J. Agricult. Res.,* **32(3)**, 527-534.

Khan, T.A., Robert N., Robert E., Walker C. and Chen D. (2011). Comparing N and S sources to improve yield and nutrient efficiency in canola cropping system in south-eastern Australia. *17th Australian Research Assembly on Brassicas (ARAB),* 154-158.

Khan, V.M., Manohar K.S., Kumawat S.K. and Verma H.P. (2013). Effect of vermicompost and biofertilizers on yield and soil nutrient status after harvest of cowpea [*Vigna unguiculata* (L.) Walp]. *Agricult. Sust. Develop.,* **1(1)**, 79-81.

Khandelwal, R., Choudhary S.K., Khangarot S.S., Jat M.K. and Singh P. (2012). Effect of inorganic and biofertilizers on productivity and nutrients uptake in cowpea [*Vigna unguiculata* (L.) Walp]. *Legume Res.*, **35(3)**, 235-238.

Kumar, A. and Pandita V. K. (2016). Effect of integrated nutrient management on seed yield and quality in cowpea. *Legume Res.,* **39(3)**, 448-452.

Mandal, S. and Mondal S. (2018). Effect of nutrient sources particularly of phosphorus on growth and productivity of summer blackgram under lateritic soil. *J. Krishi Vigyan,* **6(2)**, 71-74.

Marwa, Ahmed A., EI-Agyzy H.A., Khaled Fatma and Shaban A. (2018). Influence of nitrogen sources and bio-fertilizer on soil nutrients, yield and quality of cowpea under saline soil conditions. *Asian Soil Res. J.,* **1(4)**, 1-14.

Meena J.S., Verma H.P. and Pancholi P. (2015). Effect of fertility levels and biofertilizers on growth and yield of cowpea on sandy loam soil of Rajasthan. *An Asian J. Soil Sci.,* **10(1)**, 55-58.

Meena, L.R. and Chand R. (2014). Response of fodder cowpea to varying levels of nitrogen and phosphorus under rainfed conditions of Rajasthan. *Indian J. Small Ruminents,* **20(2)**, 121-123.

Mehdi, S.M., Sarfraz S.M., Khalid B.Y. and Sadiq M. (2003). Response of wheat to different phosphatic fertilizers in varying textured salt affected soils. *Pak. J. Appl. Sci.,* **3(7)**, 474-480.

Mohamed, A.M.E., Ali A.A.S., Salem H.M., Mahrous S.E., Mahmoud F.S., Abdullah A.A., Talaat H.I.S. and Abdullah A.I. (2020). Interaction effects of nitrogen source and irrigation regime on tuber quality, yield and water use efficiency of (*Solanum tuberosum* L.). *Plants*, **9(110)**, 1-20.

Mohammed, Q.K. and Mahammad M.Q. (2015). Effect of different nitrogen fertilizers on growth and yield of wheat. *Zanco J. Pure Appl. Sci.,* **27(5)**, 19-28.

Moreira, V.B., Moraes E.R., Bernardes R.F.B., Peixoto J.V.M. and Lima B.V. (2017). Seeds inoculation and nitrogen fertilization for cowpea production on Latosol in the Western Amazon. *Biosci. J.,* **33(5)**, 1249-1256.

Ozden, O. (2010). Effects of sources and rate of nitrogen fertilizer on yield, yield components and quality of winter rapeseed. *Chilean J. Agricult. Res.,* **70(1)**, 132-141.

Patil, D.S., Khistaria M.K. and Padmani D.R. (2010). Effect of nutrient management and biofertilizer on quality, NPK content and uptake of blackgram in medium black soil. *Int. J. Agricult. Sci.,* **6(1)**, 167-168.

Sebetha, E. and Modisapudi S. (2019). Effect of nitrogen fertilizer source, soil type and season on growth performance of two sorghum cultivars. *Asian J. Plant Sci.,* **18(4)**, 175-180.

Sebetha, E.T., Modi A.T. and Owoeye L.G. (2015). Cowpea crude protein as affected by cropping system, site and nitrogen fertilization. *J. Agricult. Sci.,* **7(1)**, 224-234.

Selvakumar, G., Lenin M., Thamizhiniyan P. and Ravimycin T. (2009). Response of biofertilizers on the growth and yield of blackgram (*Vigna mungo* L.). *Rec. Res. Sci. Technol.,* **1(4)**, 169–175.

Selvakumar, G., Reetha S. and Thamizhiniyan P. (2012). Response of biofertilizer on growth, yield attributes and associated protein profiling changes of blackgram [*Vigna mungo* (L.) Hepper]. *World Appl. Sci. J.,* **16(10)**, 1368-1374.

Singh, B. and Nair T.V. (1995). Effect of nitrogen fertilization on nodulation and nitrogen assimilation in cowpea. *Crop Improvement*, **22**, 133-138.

Singh, G., Choudhary P., Meena B., Rawat R. and Jat B.L. (2016). Integrated nutrient management in blackgram under rainfed condition. *Int. J. Rec. Scientif. Res.,* **7(10)**, 13875-13894.

Singh, K., Manohar R.S., Choudhary R., Yadav A.K. and Sangwan A. (2015). Response of different sources and levels of phosphorus on yield, nutrient uptake and net returns on mungbean under rainfed condition. *Indian J. Agricult. Res.,* **35(4)**, 263-268.

Singh, R. and Singh A.P. (2017). Effect of phosphorus, sulphur and biofertilizer on yield, quality and uptake of nutrients in cowpea (*Vigna unguiculata*). *Annals Plant Soil Res.,* **19(2)**, 175-179.

Singh, R., Singh V., Singh P. and Yadav R.A. (2018). Effect of phosphorus and PSB on yield attributes, quality and economics of summer greengram (*Vigna radiate* L.). *J. Pharmacog. Phytochem.,* **7(2)**, 404-408.

Tagore, G.S., Namdeo S.L., Sharma S.K. and Kumar N. (2013). Effect of *Rhizobium* and Phosphate Solubilizing Bacterial inoculants on symbiotic traits, nodule leghemoglobin and yield of chickpea genotypes. *Int. J. Agron.,* **2013**, 1-8.

Verma, G., Singh M., Morya J. and Kumawat N. (2017). Effect of N, P and Biofertilizers on growth attributes and yields of mungbean [*Vigna radiate* (L.) Wilczek] under Semi-arid Tract of Central India. *Int. Arch. Appl. Sci. Tech.,* **8(2)**, 31-34.

Yadav, A.K., Ramawat N. and Singh D. (2019). Effect of organic manures and biofertilizers on growth and yield parameters of cowpea (*Vigna unguiculata* (L.) Walp.). *J. Pharmacog. Phytochem.,* **8(2)**, 271-274.