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Effect of Nutrient Sources on Nutrient uptake by Cowpea [*Vigna unguiculata* (L.) Walp.] and Soil properties in Soils of North Gujarat

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ABSTRACT: The study on the effect of nutrient sources on nutrient uptake by cowpea and soil properties in soils of North Gujarat may face challenges related to variable soil conditions, including pH and nutrient content, which can influence nutrient availability. Additionally, weather fluctuations and precipitation patterns in the region can impact nutrient uptake and plant growth. At the Agronomy Instructional Farm in Sardarkrushinagar, Gujarat, India eight treatment combinations that included two levels of biofertilizer and two sources each of nitrogen and phosphorus were assessed using a factorial randomized block design with four replications. The findings showed that the individual application of nutrient sources *Rhizobium*+ PSB, AS and SSP resulted in considerably greater N, P and S content as well as N, P, K, S uptake by cowpea. While N content in seed by phosphorus sources as well as K content in seed and stover both found to be non significant due to nutrient sources. *Rhizobium* + PSB application had a significant influenced the soil's available N and P when compared to no application of biofertilizer. While in case of available sulphur was significantly improved with individual application of different nutrient sources. It is concluded that individual application of various nutrient sources resulted into better uptake of nutrients and improved the soil fertility status after harvest of crop.

Keyword: Cowpea, nutrient content, uptake, soil properties, nutrient sources.

INTRODUCTION

Arable land is lost due to urbanization, which is made worse by unsustainable farming methods such excessive tillage, unbalanced fertilization and overuse of pesticides. For healthy soil and increased harvests, wise fertilizer application is essential. The efficiency of fertilizers is influenced by how nitrogen sources affect nitrification (Singh *et al.* 2000). Due of high expenses biofertilizers which are affordable alternatives are essential in India. They improve the efficiency of nutrients, particularly the *Rhizobium* symbiosis, which increases soil fertility and nitrogen fixation. According to Dekhane *et al.* (2011) *Rhizobium* increases N and P uptake in cowpea, while *Rhizobium* and PSB together further enhance nutrient uptake. Also advantageous are rainfed Blackgram (Singh *et al*., 2016). Although Biswas and Bao-Luo (2016) differ, ammonium sulphate performs admirably (Khan *et al*., 2011; Gendy *et al*., 2013; Mohammed and Mahammad, 2015; Moreira *et al*., 2017). Phosphates like TSP have an effect on soil properties and absorption (Mehdi *et al*., 2003). Fertilization with only macronutrients throws the ecosystem out of balance, necessitating micro-macro fertilization with biofertilizers for sustainability. An experiment titled "Effect of nutrient sources on nutrient uptake by cowpea [*Vigna unguiculata* (L.) Walp.] and soil properties in soils of North Gujarat" to investigated the effects of nutrient sources on the nutrients in the soil and the uptake of nutrients by cowpea, focusing on the best use of sources with *Rhizobium* and PSB.

MATERIAL AND METHODS

An experiment was carried out at the Agronomy Instructional Farm at C. P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during the 2019 *kharif* season. The test field featured a loamy sand texture, an EC of 0.13 dS m^{-1}, a pH of 7.7, low organic carbon (0.270%) and available nitrogen and sulfur at 156.8 kg and 7.3 mg per kilogram, respectively. It also had medium accessible phosphorus (32.8 kg/ha) and potassium (254.9 kg/ha).
A factorial randomized block design with four replications was employed for the field experiment. Eight treatment combinations were used, with two nitrogen sources (urea - N_1 and ammonium sulphate - N_2), two phosphorus sources (diammonium phosphate - P_1 and single super phosphate - P_2), and two biofertilizer sources (without biofertilizer - B_1 and

Rhizobium + PSB - B_2 respectively). 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. N-P_2O_5-K_2O was treated in the amount of 25-40-00 kg/ha together with *Rhizobium* + PSB at a rate of 10 ml/kg of seed. Gujarat cowpea variety-5 was sown with a 45 cm × 10 cm spacing. For effective crop management standard agronomic practices were used. Random sampling was used to record observations that were constant. For the purpose of estimating the amounts of nitrogen, phosphorus, potassium and sulfur in seeds and stover, samples from the output of each net plot were gathered. These samples underwent 24 hours of 60°C drying, powdering and grinding. Utilizing the stated formula, nutrient uptake was calculated.

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Nutrient content (\%)} \times \text{Yield (kg/ha)}}{100}$$

The condition of the composite soil sample was assessed before seeding. Prior to and after harvest representative samples from each plot were taken at a depth of 15 cm in order to measure the accessible levels of N, P_2O_5, K_2O and S as well as the organic carbon content. Following a randomized block design with a factorial approach, statistical analysis of the experimental data was performed using analysis of variance. Calculated "F" value and tabulated "F" value were contrasted at a 5% level of significance.

RESULTS AND DISCUSSION

A. Effect of biofertilizer sources

When seeds were inoculated with biofertilizer *Rhizobium* + PSB each at 10 ml/kg of seed (B_2) as opposed to when seeds were not inoculated with biofertilizer (B_1) the amount of nitrogen, phosphorus and sulphur in the seeds and the stover was significantly affected by the biofertilizers except potassium content. Seed inoculation with *Rhizobium* + PSB each @ 10 ml/kg of seed (B_2) as biofertilizer sources significantly influenced N, P, K and S uptake in seed and stover as compared to without seed inoculation (B_1). Soil available N, P_2O_5 and S were found significantly maximum after harvest of cowpea due to seed inoculation with *Rhizobium* + PSB each @ 10 ml/kg of seed (B_2) as biofertilizer sources than the without seed inoculation (B_1). While application of biofertilizer did not impart any significant effect on available K_2O and organic carbon soil status.

Increased seed production, nitrogenase activity and soil nutrient content resulted from the application of N-fixing *Rhizobium* and P-solubilizing bacteria, which also improved nitrogen and phosphorus absorption. Nitrogen fixation was supported by the *Rhizobium*+ PSB synergy by maintaining phosphorus availability. The enhanced root growth and nitrogen fixation caused by these two factors resulted in cowpea's improved nitrogen absorption, which was associated with higher seed-stover yields. This increased availability of nitrogen encouraged nutrient uptake and growth. The organic acids in PSB helped seedlings and stover by facilitating nutrient release. The fact that nutrient intake paralleled yield suggests the importance of biofertilizer. Nutrient availability that was constant probably helped with absorption. Biofertilizer enhanced nutrient uptake, root-shoot development, and soil health. The findings concur with those made public by Patil *et al.* (2010); Dekhane *et al.* (2011); Khandelwal *et al.* (2012); Singh *et al.* (2016); Chatterjee and Bandyopadhyay (2017); Heisnam *et al.* (2017); Khan *et al.* (2017); Nadeem *et al.* (2017); Nissa *et al.* (2017); Singh and Singh (2017); Singh *et al.* (2018). In order to preserve the fertility and health of the soil, biofertilizers are essential since they increase nutrient availability without having any negative side effects. Biofertilizers contain microorganisms that contribute to favorable physical properties that promote soil nutrient mineralization, ultimately resulting in improved availability of vital nutrients. These results are consistent with study by Chaudhary *et al*. (2016).

B. Effect of nitrogen sources

The sources of nitrogen have a substantial impact on the nutritional content of seed and stover. In terms of nitrogen sources, ammonium sulphate (N_2) application recorded the highest N, P, and S content in cowpea seed and stover above application of urea however, K content was unaffected by the application of various nitrogen sources. The use of various nitrogen sources has a substantial impact on the uptake of nutrients, specifically N, P, K, and S. The cowpea crop absorbed the most N, P, K, and S when ammonium sulphate (N_2) was applied. Only available S was found to be considerably higher in the soil following crop harvest when ammonium sulphate (N_2) was applied rather than urea (N_1), but available N, P_2O_5, K_2O and organic carbon were unaffected by the various nutrient sources. Ammonium sulphate (AS), which has a lower hygroscopicity than urea, increased soil N and S levels. Crop development was aided by extended N availability during key stages. As a result of AS's pH-lowering impact, which neutralized the soil and improved nutrient accessibility, there was an increase in phosphorus in seeds and stover. N, S, and P uptake were improved by neutral pH. The N and S contribution of AS enhanced soil quality and facilitated plant S uptake. Due to biomass and nutritional content, there was noticeably higher nutrient uptake with AS application, resulting in larger nitrogen accumulation. This finding is consistent with findings from Khan *et al.* (2011); Gendy *et al.* (2013); Mohammed and Mahammad (2015); Biswas and Bao-Luo (2016); Moreira *et al.* (2017); Marwa *et al.* (2018); Mohammed *et al.* (2020).

C. Effect of phosphorus sources

The sources of phosphorus have a big impact on the nutrients in seed and stover. When compared to an application of diammonium phosphate (P_1), a single super phosphate application considerably increased the P and S content in cowpea seed and stover. While sources of phosphorus had little impact on the nitrogen content of seeds, a single superphosphate had significantly impact on the nitrogen content of stover. Due to various phosphorus sources, N, P, K, and S absorption in seed, stover, and total were all considerably impacted. With a single application of super phosphate (P_2) the cowpea crop greatly increased its uptake of N, P, K, and S. When compared to the use of diammonium phosphate (P_1), a single super phosphate (P_2) had a substantial impact on soil available S.

P increases atmospheric nitrogen fixation, enhancing the availability of P, S, and N. The rhizobial activity is impacted. More readily available nutrients (N, P, Ca, and S) increased the uptake of phosphorus by cowpea seeds and stover via SSP rather than DAP. Fertilization with phosphorus boosted production and growth. Due to enhanced soil sulfur status, SSP boosted the sulfur concentration of seed leftovers. Benefits of sulfur in SSP include promoting root-shoot development and increasing nutrient uptake. Cowpea growth was aided by SSP's improvement of soil qualities and micronutrient availability. The outcomes of this study are consistent with those that were published by Ghosh *et al*. (1999); Mehdi *et al.* (2003); Dalvi (2010); Devi *et al.* (2012); Kumari *et al.* (2012); Darwesh *et al.* (2013); Singh *et al.* (2015); Khan *et al.* (2019).

Table 1: Effect of nutrient sources on N, P and K content and uptake by cowpea.

Treatment	Content (%)						Uptake (kg/ha)								
	N		P		K		N			P			K		
	Seed	Stover	Seed	Stover	Seed	Stover	Seed	Stover	Total	Seed	Stover	Total	Seed	Stover	Total
[A]	Biofertilizer sources														
B_1	3.428	0.652	0.599	0.226	1.352	2.342	39.38	12.61	51.99	6.89	4.37	11.26	15.51	45.27	60.78
B_2	**3.584**	**0.699**	**0.651**	**0.255**	1.404	2.373	**47.01**	**15.34**	**62.35**	**8.53**	**5.62**	**14.15**	**18.39**	**52.01**	**70.40**
S.Em.±	0.052	0.006	0.006	0.004	0.021	0.034	1.34	0.29	1.39	0.22	0.12	0.25	0.46	1.27	1.30
C.D. (P=0.05)	0.152	0.018	0.017	0.011	NS	NS	3.93	0.85	4.08	0.64	0.36	0.73	1.35	3.74	3.81
[B]	Nitrogen sources														
N_1	3.421	0.655	0.610	0.227	1.362	2.317	39.95	12.92	52.87	7.13	4.49	11.62	15.86	45.67	61.53
N_2	**3.591**	**0.696**	**0.640**	**0.254**	1.393	2.398	**46.44**	**15.03**	**61.47**	**8.29**	**5.50**	**13.79**	**18.04**	**51.61**	**69.65**
S.Em.±	0.052	0.006	0.006	0.004	0.021	0.034	1.34	0.29	1.39	0.22	0.12	0.25	0.46	1.27	1.30
C.D. (P=0.05)	0.152	0.018	0.017	0.011	NS	NS	3.93	0.85	4.08	0.64	0.36	0.73	1.35	3.74	3.81
[C]	Phosphorus sources														
P_1	3.500	0.665	0.606	0.225	1.370	2.357	40.92	13.11	54.03	7.08	4.45	11.53	16.00	46.41	62.41
P_2	3.511	**0.686**	**0.644**	**0.256**	1.386	2.359	**45.47**	**14.84**	**60.31**	**8.34**	**5.55**	**13.89**	**17.90**	**50.87**	**68.77**
S.Em.±	0.052	0.006	0.006	0.004	0.021	0.034	1.34	0.29	1.39	0.22	0.12	0.25	0.46	1.27	1.30
C.D. (P=0.05)	NS	0.018	0.017	0.011	NS	NS	3.93	0.85	4.08	0.64	0.36	0.73	1.35	3.74	3.81
Interaction															
B × N B × P N × P B × N × P	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C. V. %	5.90	3.58	3.77	6.41	6.06	5.72	12.37	8.29	9.70	11.26	9.93	7.87	10.85	10.44	7.90

Table 2: Effect of nutrient sources on S content and uptake by cowpea and soil properties.

Treatment	Content (%)		Uptake (kg/ha)			Organic carbon (%)	Av. N (kg/ha)	Av. (P_2O_5) (kg/ha)	Av. K_2O (kg/ha)	Av. S (mg/kg)
	S		S							
	Seed	Stover	Seed	Stover	Total					
[A]	Biofertilizer sources									
B_1	0.209	0.084	2.41	1.62	4.03	0.237	166	33.49	268	8.11
B_2	**0.222**	**0.090**	**2.93**	**1.98**	**4.91**	0.243	**188**	**38.30**	265	**9.27**
S.Em.±	0.002	0.001	0.08	0.05	0.11	0.002	1.7	0.38	2.27	0.07
C.D. (P=0.05)	0.007	0.003	0.23	0.14	0.31	NS	5.1	1.13	NS	0.21
[B]	Nitrogen sources									
N_1	0.203	0.082	2.37	1.61	3.98	0.241	180	36.04	270	8.39
N_2	**0.229**	**0.092**	**2.97**	**1.99**	**4.96**	0.239	175	35.76	263	**9.00**
S.Em.±	0.002	0.001	0.08	0.05	0.11	0.002	1.7	0.38	2.27	0.07
C.D. (P=0.05)	0.007	0.003	0.23	0.14	0.31	NS	NS	NS	NS	0.21
[C]	Phosphorus sources									
P_1	0.208	0.083	2.43	1.64	4.07	0.238	178	36.38	267	8.50
P_2	**0.224**	**0.090**	**2.90**	**1.96**	**4.86**	0.242	176	35.42	266	**8.88**
S.Em.±	0.002	0.001	0.08	0.05	0.11	0.002	1.7	0.38	2.27	0.07
C.D. (P=0.05)	0.007	0.003	0.23	0.14	0.31	NS	NS	NS	NS	0.21
Interaction										
B × N B × P N × P B × N × P	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C. V. %	4.40	5.47	11.72	10.42	9.49	4.03	3.88	4.27	3.41	3.33

CONCLUSIONS

In light of results obtained from present investigation, it is concluded that cowpea crop (cv. Gujarat Cowpea 5) should be fertilized with combined application of seed inoculation of *Rhizobium* + PSB each @ 10 ml/kg of seed with 20 kg N/ha through ammonium sulphate as well as 40 kg P_2O_5/ha through single super phosphate resulted into better uptake of nutrients in loamy sand of North Gujarat. Besides this, it also improved the soil fertility status after harvest of crop.

FUTURE SCOPE

Future studies could look at the function of microbial communities in the cycling of nutrients and how they interact with various nutrient sources. Understanding how microbes affect the availability of nutrients and cowpea uptake might help develop customized soil management strategies that increase crop output while minimizing environmental impact. Additionally, investigating how nutrient-source interactions and soil health are impacted by emerging agricultural technologies like precision agriculture, remote sensing, and biotechnology will allow for more efficient and sustainable farming methods, with implications for both environmental preservation and global food security.

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