ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 11, Issue, 11, pp.8225-8229, November, 2019

DOI: https://doi.org/10.24941/ijcr.37099.11.2019

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

EFFECT OF PHOSPHORUS AND SULPHUR ON YIELD ATTRIBUTES, NUTRIENT CONTENT AND NUTRIENT UPTAKE OF GREEN GRAM IN BUNDELKHAND SOIL

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ARTICLE INFO

Article History:
Received 04th August, 2019
Received in revised form
28th September, 2019
Accepted 15th October, 2019
Published online 26th November, 2019

Key Words:
Green Gram, Nutrient Content, Uptake, Interaction, Seed & Straw Yield.

ABSTRACT

This research was conducted with the aim to quantify the impact of Phosphorus and Sulphur of Green Gram (*Vigna radiata* L.) during winter season of 2014-15, at Agriculture experimental field, Nehru P.G. College Lalitpur, (U.P.). The treatments consisted of 4 Phosphorus levels (0, 30, 60 and 90 Kg P_2O_5 ha^{-1}) and 4 sulphur levels (0, 10, 20 and 40 Kg S ha^{-1}). The Pot experiment was laid out in randomized block design with three replications. Application of 90 kg P_2O_5 ha^{-1} and 40 kg S ha^{-1} significantly increased the Yield Attributes & Nutrient Content, Protein Content and Nutrient Uptake of Green Gram. The seed yield & straw yield at 20 kg S ha^{-1} was significant over control and nutrient uptake, content production at 40 kg S ha^{-1} was significant over control respectively. The maximum N, P, K and S contents and uptakes in Green Gram were recorded with 90 kg P_2O_5 and 40 kg S ha^{-1}, respectively. The interaction between P and S had significant effect on yield and mineral composition of Green Gram and maximum yields were recorded under 60 kg P_2O_5 and 40 kg S ha^{-1} that was statistically at par with 90 kg P_2O_5 and 40 kg S ha^{-1}.

Citation: D.S. Dharwe, H.C. Dixit, C.K. Dotaniya, R.K. Doutaniya, Sandeep Mohbe, M.K. Tarwariya. **2019.** "Effect of Phosphorus and Sulphur on Yield Attributes, Nutrient Content and Nutrient Uptake of Green Gram in Bundelkhand Soil", *International Journal of Current Research*, 11, (11), 8225-8229.

INTRODUCTION

Green Gram (*Vignaradiata* L.) is under cultivation since prehistoric time in India. It is also known as green gram and serve are a major source of dietary protein for the vast majority of people. The food legumes, particularly the grain or pulses are important food stuff in all tropical and subtropical countries Mohbe *et al.* (2015). Pulses deal with those species of the plant which belong to the family and subfamily faboide. They constitute on integral part of human diet as mature dry seeds and may also be used as immature green seeds or as green pods with immature seeds in it. They can be used for animals in the form of hay and straw. The pulses have high protein contents (average 20-25%). In addition to their value as food stuff, they are also important in cropping system. India is the world largest homeland of vegetarian and world leader in pulses production and import to provide protein supplement Singh *et al*., (2012).

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Rapid population growth and low production especially to pulses have enhanced the problem of food security Dotaniya *et al.* (2019). Indian pulses production has been stuck in between 14 and 15 MT since mid-nineties, resulting in poor consumption(33g/capita/day) during 2010 Ali and Gupta (2012).In India especially rice-wheat is the prevalent cropping system and the area and resultantly the production of pulses have been marginalized Singh *et al.* (2013), Mohbe *et al.* (2015). Phosphorus is an essential both as a part of several key plant structure compound and as catalysis in the conversion of key biochemical reaction in plants Dotaniya *et al.* (2014). Phosphorus is also involved in controlling key enzyme reactions and in the regulation of metabolic pathways. Phosphorus is an important plant nutrient and it effects seed germination, cell division, flowering, fruiting, synthesis of fat, starch and in fact most biochemical activities. Judicious use of phosphate fertilizer is supposed to result in better nodulation and efficient functioning of nodules bacteria for fixation of atmospheric nitrogen to be utilized by plant during grain development stage, which in turn leads to increase in grain yield Dharwe *et al.* (2019). Sulphur is an essential element for

plant growth, ranks in importance with N and P in the formation of plant proteins. Sulphurdeficiency has been reported over 70 countries worldwide of which India is one. In generally, Sulphur is also essential for synthesis of vitamin (biotin and thiamine), Sulphur containing amino acids and promotes nodulation in legumes. According to Pandey and Singh (2000) reported that highest grain and straw yield of green gram was obtained by application of Sulphur.

MATERIALS AND METHODS

The field experiment was carried out at Agriculture experimental field, Nehru P.G. College, Lalitpur (U.P.) during *Rabi* season of 2014-15. Lalitpur district could be a part of Bundelkhand region. Betwa River is the boundary between Jhansi and Lalitpur in the north. Most of the area is under the average elevation of 300m–450m from the sea level. Its latitudinal extension is from 24°10' to 25°15' N and longitudinal extension is from 78.10' E to 79° 00' E. Geographically, Lalitpur district falls in the zone of sub-tropical climate and may be characterized by a very hot dry summer and cold winter. The soil of the experimental field was loam in texture having pH 7.9, organic carbon 4.6 g kg^{-1} and available N, P and K 170, 10 and 190 kg ha^{-1}, respectively. The experiment was laid out in randomized block design with three replications. The treatments were four levels each of P (0, 30, 60 and 90 kg P_2O_5 ha^{-1}) and S (0, 10, 20 and 40 kg S ha^{-1}). DAPand SSP as source of P andS were used. Sulphur was applied as elemental Sulphur at the time of sowing. Green Gram was sown in the last week of November, 2014. The crop was grown by adopting all agronomic practices except fertilizer rate. The crop was harvested at various stages of growth. The plant samples were analysed for their N content by modified Kjeldahl method (Jackson 1973). The P and K in di-acid extract (HNO_3 and $HClO_4$) was determined by vanadomolybdate yellow color method and flame photometer severally.

RESULT AND DISCUSSION

Yield Studies: The results on seed and straw yield of summer green gram are summarized within the table 1 the info given in this Sulphur application have a marked impact on seed yield and straw yield of summer green gram Singh *et al.*, (2007). All the higher doses of Sulphur clearly significantly superior over control enhancing the seed and straw yield production of summer green gram. The lowest average value of seed yield and straw yield were recorded in control treatment. The seed yield 2.47 8.11, and 7.52% and straw yield 13.93, 26.59 and 22.09% increased of summer green gram due to 10, 20 and 40kg S/haRam and Katiyar(2013) The higher level of S (40 kg S/ha) tended to decreased 0.54% and 0.43% in seed and straw yield of summer green gram over 20kg S/ha level. However, this reduction in seed yield and straw yield of summer green gram were statistically non-significant. These findings are similar to those of Dharwe *et al*. (2018), Mohbe *et al.* (2018a,b). Phosphorus application had a significant response on seed yield and straw yield production of summer green gram. All the higher doses of P significantly enhanced the seed yield and straw yield production. The percent enhancement were 1.05, 2.11 and 3.58 (seed yield) and 10.31, 18.97 and 20.34 (straw yield) over control (due to 30, 60 and 90 kg P_2O_5/ha) of summer green gram, respectively. A similar effect of P application on green gram and other pulses crop production have also been reported /showed by Asghar *et al.* (2003).The interaction effect P×S on seed and straw yield production of summer green gram were found significant. Highest yield in seed and straw was found with 40 kg S/ha and 90 kg P_2O_5/ha. The same results also observed by Kumar and Kumar, 2013).

Chemical composition of green gram

Nitrogen content: The result given in table clearly indicate that S application have a significant effect on nitrogen content in seed and straw of green gram plant. All higher doses of S application were found significantly increased N content 3.93, 3.37 and 11.2% in seed and 15.33, 22.59 and 35.49% in straw of green gram over control respectively. The result obtained in present investigation indicated a synergetic effect of applied S on tissue N content hence on protein synthesis. These findings are similar to those of Singh and Ram (2001). Who also observed a positive effect in N content in field crop with higher level of S application. P applications have a significant effect on the N content in seed and straw yield of summer green gram crop. P application caused a significant enhancements in N content 0.53, 1.07 and 2.95% in seed and 4.28, 6.42 and 8.57% in straw due to 30, 60 and 90 kg P_2O_5/ha. All the higher doses of Phosphorus 30, 60 and 90 kg/ha application were found significantly superior over control in enhancing the N content in seed and straw of summer green gram. The interaction effect P×S on N content in seed and straw yield of summer green gram were found significant. The highest N content was found with 40 kg S/ha and 90kg P_2O_5/ha.

Phosphorus content: The results given in table 1 clearly indicate that S application have a significant effect on phosphorus content in seed and straw of green gram plant. All higher doses of S application were found significantly increased P content 2.0, 42.5 and 16.6% in seed and 9.88, 16.05 and 22.84% in straw of green gram over control. The P content in seed and straw of green gram with increasing levels of S and maximum values were recorded at 40 kg S/ha. Phosphorus application has a significant effect on the P content in seed and straw yield of summer green gram crop. P application caused a significant enhancements in P content 8.34, 14.59 and 18.75% in seed and 1.70, 3.96 and 5.09% in straw due to 30, 60 and 90 kg P_2O_5/ha. All the higher doses of phosphorus 30, 60 and 90 kg/ha application were found significantly superior over control in enhancing the P content in seed and straw of summer green gram. The favorable effect of S on N content was also reported by Asghar *et al.* (2003). The interaction effect P×S on P content in seed and straw yield of summer green gram were found significant. The highest P content was showed with 40 kg S/ha and 90kg P_2O_5/ha.

Potassium content: The application of S increased the K content 1.56, 2.60 and 4.15% in seed and 5.33, 7.91 and 11.25% straw of summer green gram significantly over control. However, the lower level of S (10 kg S/ha) did not prove significantly superior over control in respect of K content in seed and straw of green gram. The higher levels (20 and 40 kg S/ha) of S registered a significant increase K content in seed and straw of green gram. The maximum value of concentration of K in green gram crop was recorded at 40 kg S/ha. The K content in seed and straw of green gram increased with P application over control respectively (Table 1). The all levels of P proved significantly superior over control. P application caused a significant enhancement in Kcontent 1.04, 2.59 and 4.14% in seed and 2.28, 2.56 and 3.13% in straw due to 30, 60 and 90 kg P_2O_5/ha.

Table 1. Effect of Phosphorus and Sulphur level on Seed &Straw Yield and Nitrogen, Phosphorus, Potassium, Sulphur Content Mean Value (kg/ha)of Green Gram (*Vigna radiate* L.)

Yield Attribute Seed & Straw			Nitrogen Content		Phosphorus Content		Potassium Content		Sulphur Content	
S-Level	Seed Yield	Straw Yield	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw
(kg/ha)	P- level (kg/ha)		P- level (kg/ha)		P- level (kg/ha)		P- level (kg/ha)		P- level (kg/ha)	
S_0	11.96	18.24	3.56	1.24	0.40	0.162	1.93	3.38	0.56	0.35
S_{10}	12.28	20.78	3.70	1.43	0.48	0.178	1.96	3.56	0.59	0.36
S_{20}	12.93	23.09	3.82	1.52	0.57	0.188	1.98	3.65	0.61	0.50
S_{40}	12.86	22.99	3.96	1.68	0.66	0.199	2.00	3.76	0.59	0.48
Mean	12.74	21.27	3.76	1.46	0.52	0.181	1.96	3.58	0.58	0.42
Interaction Effect (P×S)										
SEM ±	0.24	0.96	0.6	0.4	0.01	0.003	0.02	0.012	0.02	0.02
CD at 5 %	0.50	1.96	0.13	0.8	0.03	0.006	0.04	0.026	0.05	0.04

Table 2 : Effect of Phosphorus and Sulphur level on Seed & Straw Protein content and Nitrogen, Phosphorus, Potassium, Sulphur Uptake Mean Value (kg/ha) of Green Gram (*Vigna radiate* L.)

Protein content			Nitrogen Uptake		Phosphorus Uptake		Potassium Uptake		Sulphur Uptake	
S-Level	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw
(kg/ha)	P- level (kg/ha)		P- level (kg/ha)		P- level (kg/ha)		P- level (kg/ha)		P- level (kg/ha)	
S_0	22.29	7.77	42.69	22.75	4.87	2.960	23.09	61.82	6.80	6.52
S_{10}	23.16	8.98	45.57	29.94	5.98	3.713	24.02	73.98	7.34	7.54
S_{20}	23.90	9.49	49.49	35.15	7.41	4.358	25.58	76.62	7.68	11.17
S_{40}	24.93	10.49	51.01	38.61	8.51	4.576	25.78	84.38	7.99	11.63
Mean	23.57	9.18	47.19	31.61	6.69	3.901	24.61	74.20	7.45	9.21
					Interaction Effect (P×S)					
SEM ±	1.15	0.22	1.18	1.20	0.34	0.09	0.70	2.13	0.11	0.46
CD at 5 %	2.34	0.45	2.41	2.46	0.70	0.18	1.43	4.35	0.24	0.95

All the higher doses of phosphorus 30, 60 and 90 kg/ha application were found significantly superior over control in enhancing the K content in seed and straw of summer green gram. These findings are similar to those of Asghar*et al.* (2003), Malvi *et al.* (2019).

Sulphur content: Results (Table 1) indicated that S application have a significant effect on its content in seed and straw of green gram plant. All higher doses of S application were found significantly increased its content 5.37, 8.92 and 5.35% in seed and 2.86, 42.86 and 37.15% in straw of green gram over control.

The S content in seed and straw of green gram with increasing levels of S and maximum values were recorded at 40 kg S/ha. Seed and straw of green gram increased significantly with the application of phosphorus. The maximum S concentration in seed and straw of green gram was recorded with 90 kg P_2O_5 /ha treatment followed by 60, 30 kg/ha and control.

All the levels of P were significantly superior over control in respect of S content. But these levels of P did not differ significantly among themselves in respect of S content in green gram. S content significantly increased 9.81, 19.61 and 33.34% in seed and 5.27, 15.79 and 23.69% in straw of green gram due to 30, 60 and 90 kg P_2O_5/ha**.** A reduction in S content with higher doses of P application in field crop was also reported by Singh and Ram (2001)**.** The interaction effect PXS on S content in seed and straw yield of summer green gram were found significant. The highest S content with 40kg S/ha and 90kg P_2O_5/ha. The same resulted by Kumar *et al*. (2014).

Protein Content

Protein: A study of table 1 reveals that the application of Sulphur increased the protein content in seed and straw of green gram and this effect was significant with each level of Sulphur. All the levels of Sulphur significantly increased the protein content.

The percent enhancement were 3.91, 7.21 and 11.84 in seed and 15.58, 22.14 and 35.01 straw of green gram due to 10, 20 and 40 kg S/ha over control, respectively. The lowest value of protein content in seed and straw of green gram was recorded in control As compared to control; all the levels of S tried in the present investigation were significantly superior in respect of protein content. The maximum value of protein content in seed and straw of green gram was recorded with 40 kg S/ha treatment. P application has a significant effect on the protein content in seed and straw yield of summer green gram crop. P application caused a significant enhancements in protein content 1.21, 1.29% and 2.99% in seed and 4.70, 6.64 and 8.93% in straw due to 30, 60 and 90 kg P_2O_5/ha. All the higher doses of phosphorus 30, 60 and 90 kg/ha application were found significantly superior over control in enhancing the protein content in seed and straw of summer green gram. The same observed by Singh and Singh (2012), Pingoliya *et al.* (2015).Thesame result by Kumar *et al.* (2014) interaction effect PxS on protein content in seed and straw yield of summer green gram were found significant. The highest protein content was found with 40 kg S/ha and 90kg P_2O_5/ha.

Nutrients Uptake:

Nitrogen uptake: The Nitrogen uptake is given in table 2 clearly indicate that S application have a significant effect on nitrogen uptake in seed and straw yield by summer green gram plant. All the higher doses of S application were found significantly increased. The percent enhancement were 6.74, 15.92 and 19.48 in seed and 31.60, 54.50 and 69.71 in straw of green gram due to 10, 20 and 40kg S/ha over control respectively. These finding were similar to those Ram and Katiyar (2013). Phosphorus application had a significant response on N uptake in seed and straw yield by summer green gram. All the higher doses of P significantly enhanced the N uptake in seed and straw yield. The percent enhancement were 2.42, 2.74 and 6.60 (seed yield) and 15.71, 25.76 and 30.15 (straw yield) over control (due to 30, 60 and 90 kg P_2O_5/ha) of summer green gram, respectively. A similar effect of P application on green gram and other pulses crop production. The interaction effect of PxS on N uptake in seed and straw yield of summer green gram were found significant. Highest N uptake was found with 40 kg S/ha and 90kg P_2O_5/ha.

Phosphorus uptake: The S application has a significant effect on phosphorus uptake in seed and straw yield by summer green gram plant. All the higher doses of S application were found significantly increased. The percent enhancement were 22.80, 52.16 and 74.75 in seed and 25.44, 47.23 and 54.60 in straw by green gram due to 10, 20 and 40 kg S/ha over control respectively. Phosphorus application has a significant effect on its uptake in seed and straw yield by summer green gram crop. P uptake significant increased 9.34, 15.67 and 21.34% in seed and 11.68, 22.98 and 26.60% in straw by summer green gram up to 90 kg P_2O_5/ha over control. All the higher doses of phosphorus 30, 60 and 90 kg/ha application were found significantly superior over control in enhancing the phosphorus uptake in seed and straw by summer green gram. The same resulted by Shrinivasa Rao *et al*. (2001). The interaction effect of PXS on phosphorus uptake in seed and straw yield by summer green gram were found significant. The highest P uptake was found with 40 kg S/ha and 90kg P_2O_5/ha.

Potassium uptake: The Potassium uptake is given in table 2 clearly reveals that the application of Sulphur increased the K utilization in seed and straw by summer green gram and this effect was significant with each level of Sulphur. All the levels of Sulphur significantly increased the K uptake by summer green gram. The percent enhancement were 4.03, 10.79 and 11.66 in seed and 19.67, 36.50 and 23.95 in straw by summer green gram due to 10, 20 and 40 kg S/ha over control, respectively. However each added dose of S application up to 40 kg/ha caused a significant increased the K uptake value by summer green gram also reported by Panday *et al.* (2000).P application had a significant response on K utilization in seed and straw yield by summer green gram. All the higher doses of P significantly enhanced the K utilization in seed and straw yield. The percent enhancement were2.15, 4.72 and 7.92 (seed yield) and 32.07, 42.66 and 42.50 (straw yield) over control (due to 30, 60 and 90 kg P_2O_5/ha) of summer green gram, respectively. A similar effect of P application on K utilization have also been reported showed by Dotaniya *et al.*(2016).The interaction effect of PXS on K utilization in seed and straw yield by summer green gram were found significant. The highest K utilization was found with 40kg S/ha and 90kg P_2O_5/ha. These finding were similar to those Malvi*et al.* (2019).

Sulphur uptake: The S application has a significant effect on its uptake value by summer green gram. The percent enhancement were 7.95, 12.95 and 8.86 in seed and 15.65, 71.32 and 62.74 in straw by summer green gram due to 10, 20 and 40 kg S/ha over control, respectively. However each added dose of S application up to 40kg S/ha caused a significant enhancements on its uptake. Positive effects of S application on its utilization value have also been supported by Singh *et al.* (2007). Phosphorus application had a significant response on S uptake in seed and straw yield by summer green gram. All the higher doses of P significantly enhanced the S uptake in seed and straw yield. The percent enhancement were 11.54, 22.12 and 37.29 (seed yield) and 16.76, 34.87 and 40.63 (straw yield) over control (due to 30, 60 and 90 kg P_2O_5/ha) of summer green gram, respectively. The same resulted by Shrinivasa Rao *et al*. (2001). The interaction effect of PxS on S uptake in seed and straw yield by summer green gram were found significant. The highest S uptake was found with 40 kg S/ha and 90kg P_2O_5/ha.

Acknowledgements

Authors are highly thankful to the Nehru P.G. Collage Lalitpur, B.U. Jhansi (U.P.), for providing all assistance through a university laboratory. We are also grateful to Dr. M.L. Reager, Assistant Professor, Karshi Vigyan Kendra, S. K. Rajasthan Agricultural University: Bikaner, 334006 (India) providing motivation and incorporating suggestions during the writing of this chapter. Dr. H.C. Dixit Head of Department, Dr. S.P. Yadav Assistant Professor for help with the writing manuscript and Mr. Aashish Sharma, Technical Officer of the Bundelkhand University, Jhansi for their technical assistance provided with the field management and lab analyses conducted during the study period.

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