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Effect of Phosphorus and Sulphur Levels on Growth and Yield of Summer Greengram [*Vigna radiata* (L.) Wilczek.] in Middle Indo-gangatic Zone

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ABSTRACT

Background: Phosphorus has been pointed out as one of the most important nutrient in pulse production which is responsible for vegetative growth, reproduction and consequently yield of greengram. Sulphur element is important for crop growth and development especially in pulses. At present, 42% of indian soils have been found to the sulphur deficient, sulphur is essential for synthesis of proteins, vitamins, in pulse crops.

Methods: The field investigation was carried out at research farm of TCA, Dholi, muzaffarpur Bihar during *summer* season 2019. The treatment comprised 3 levels of phosphorus and 3 levels of sulphur along with absolute control.

Result: The result revealed that application of 60 kg phosphorus/ha significantly increase the plant height, plant dry matter, crop growth rate and yield indices *viz* number of pods/plant, length of pod, number of grains/pod and 100 seed weight than 20 kg phosphorus/ha and control but was found at par with 40 kg phosphorus/ha. Sulphur levels also had significantly influenced on these growth and yield indices and recorded higher values 30 kg sulphur/ha found at par with 20 kg sulphur/ha and significantly higher over 10 kg sulphur/ha and control. Application of 60 kg phosphorus/ha significantly enhanced the grain and straw yield over 20 kg phosphorus/ha and control but was found at par to 40 kg phosphorus/ha. Among the sulphur levels grain and straw yield increased significantly up to 20 kg/ha sulphur further increase in sulphur level fail to caused significantly effect on grain and straw yields. All the phosphorus and sulphur level had significant impact on grain and straw yields over control. Similar trend was also observed with harvest index also. Optimum dose of phosphorus and sulphur for summer greengram was worked out to be 51 and 24.5 kg/ha respectively.

Key words: Greengram, Optimum dose, Phosphorus, Sulphur.

INTRODUCTION

Agriculture contributes nearly 17% of national growth domestic product and about 65-70% of the population is dependent on agriculture and allied activities for their livelihood (Anonymous, 2019a). Pulses are rich source of protein, vitamins, fibres and minerals (iron, zinc, magnesium) and some essential amino acids which play a vital role in human health (Yadav *et al*., 2017). Pulses are the second most importance food crops after cereals in food security. Pulses are a good source of dietary protein and have unique ability of maintain and restoring soil fertility through biological nitrogen fixation as well as addition of ample amount of residues to the soil and mushrooming the soil microbial population in the soil. In Bihar area of summer greengram is increasing and the production potential of this crop during summer can be fully explored using short duration photo-insensitive varieties. The crop in this season is raised under controlled conditions and there is less infestation of insect, pest, diseases and even weeds. The sky remain clear and duration of sunshine hours is also more which may result in more photosynthetic efficiency subsequently more grain yield with good quality grains.

Greengram is widely grown in arid and semi-arid areas of the country. It is an extremely good source of high standard protein and holds 25-28% protein in addition to 1.0-1.4% oil, 3.3% fibre, 4.8-5.6% ash, 64-66% carbohydrate. In India it is grown an area of 3.64 million ha with production of 2.34 million ton and the average productivity is 498 kg/ha. Bihar covers an area of 1.62 lakh hectare and produce 1.08 lakh tonnes grain with an average productivity of 672 kg/ha (Anonymous, 2019b).

The low productivity of greengram is due to the cultivation of this crop without the application of fertilizer an

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marginal and sub-marginal land. Phosphorus is pointed out as one of the most important nutrient in greengram production. Greengram require a high amount of phosphorus being consumed by plant and bacteria. It encourages initial development of root, increases the moulment of rhizobia, enhance nodulation and estimulate fruiting. Sulphur is important for growth and development of greengram. it is essential for synthesis of protein, vitamin and also known to enhance the nodulation activity thus it increase the atmospheric nitrogen fixation. Sulphur is major source of three amino acids (cyestin, cysteine, methionine) consequently it is important for protein production in plant. At present 42% Indian soils also deficient in sulphur (Rakesh *et al.* 2012). A lot of information on *kharif* greengram is available on these aspects but information on *summer* greengram under Bihar condition is not available. In order to generate location specific information on phosphorus and sulphur the study was carried out to find out the optimum dose of phosphorus and sulphur in summer greengram under agro-ecological condition of Bihar.

MATERIALS AND METHODS

A field experiment was conducted at Tirhut College of Agriculture, Dholi, (25° 98′N 85° 76′E and an altitude of 51.3 on above mean sea level) a Campus of Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur (Bihar) during summer season of 2019. The soil was sandy loam, low in organic carbon (0.39%) available nitrogen (193.5 kg/ha), phosphorus (15.53 kg/ha) potassium (122.20 kg/ha) and medium in available sulphur (21.45 kg/ha). Treatment comprised three level of phosphorus *viz.* 20, 40, 60 kg/ha and three level of sulphur *viz.* 10, 20, 30 kg/ha along with absolute control (without P and S). The recommended dose of nitrogen (23 kg/ha) and potassium (20 kg/ha) were applied. All the dose of nitrogen, phosphorus, potassium and sulphur were applied at the time of sowing through urea, diammonium phosphate, muriate of potash and phospho-gypsum. The experiment was laid out in randomised block design (factorial) and replicated thrice. The greengram variety "HUM-16" was sown in row 30 cm apart using the seed rate of 25 kg/ha. the plant to plant distance of 10 cm was maintained by thinning 14 days after sowing. Before sowing the seed was treated with Rhizobium and PSB culture. Pre-emergence application of pendimethalin was done @ 0.75 kg/ha for controlling the weed the the crop received two irrigations at 23 and 45 days after sowing. The soil organic carbon, available nitrogen, phosphorus, potassium and sulphur were analysed by the adopting the standard procedure. Data collected for various studies of greengram were analysed with the help of "analysis of variance" technique given by Gomez and Gomez (1984). The optimum dose of phosphorus and sulphur was worked out by using the regression equation.

RESULTS AND DISCUSSION

Growth attributes

Application of 60 kg phosphorus/ha although recorded maximum plant height but was at par with 40 kg phosphorus/ha and both recorded significantly higher plant height than 20 kg phosphorus/ha. Similarly plant height recorded among 30 and 20 kg sulphur/ha being at par with and both recorded significantly higher plant height over 10 kg sulphur/ha. Both phosphorus and sulphur levels recorded significantly higher plant height over control (Table 1). Plant dry matter and crop growth rate increased significantly higher values at 60 kg phosphorus/ha. However, plant dry matter and crop growth rate increased significantly up to 20 kg sulphur/ha, further increase in sulphur levels fail to produce significant effect. Phosphorus and sulphur levels recorded significantly higher values of these indices than control. Higher values of these

Table 1: Effect of phosphorus and sulphur levels on plant height, plant dry matter and crop growth rate.

Treatments	Plant height (cm)		Plant dry matter (g/m^2)		Crop growth rate (g/m^2/day)	
	20 DAS	60 DAS	20 DAS	60 DAS	20 DAS	60 DAS
Phosphorus levels (kg/ha)						
20	5.94	36.97	5.94	149.98	1.11	2.80
40	6.73	38.10	6.73	158.04	1.90	3.73
60	7.40	38.92	7.38	163.97	2.63	4.52
SEm±	0.38	0.14	0.38	0.62	0.37	0.37
CD (P=0.05)	NS	0.86	0.80	1.32	0.88	0.78
Sulphur levels (kg/ha)						
10	5.97	37.11	5.93	155.88	1.19	2.96
20	6.84	38.06	6.82	157.65	1.99	3.82
30	7.29	38.80	7.29	158.47	2.44	4.24
SEm±	0.38	0.14	0.38	0.62	0.37	0.37
CD (P=0.05)	NS	0.86	0.80	1.32	0.88	0.78
Control						
Control vs rest	5.27	35.37	5.50	133.00	0.17	1.60
SEm±	0.48	0.52	0.48	0.81	0.53	0.47
CD (P=0.05)	NS	1.11	1.02	1.71	1.13	1.00

growth parameter on higher phosphorus and sulphur levels might be due to phosphorus estimates initial root improvement and growth, thus help in cell division and elongation. It also enhanced root proliferation and their development thereby enhancing uptake of nutrients and water from soil resulting in better plant growth of the plant. Similar findings were also noticed by Kumawat *et al*. (2014) and Gajera *et al*. (2014). Sulphur helps to increase enzymatic activity of plant which accelerate the metabolic process result in great plant vigor, resulting more production of photosynthates and their accumulation in plants system these ultimately increase the growth indices. This similar result was recorded by Kumawat *et al*. (2014).

Yield attributes

Phosphorus and sulphur levels recorded significantly higher number of pods/plant, pod length, grains/pod and test weight than control (Table 2). Application of 60 and 40 kg phosphorus was found at par with respect to number of pods/ plant, pod length, grains/pod and test weight and both recorded significantly higher values than 20 kg phosphorus/ha. Similarly, these indices recorded at 30 and 20 kg sulphur being at par and both recorded significantly higher values of these parameter than 10 kg sulphur/ha. This might be because of raised to higher nutrient absorb and their move which had suitable effect on rate of photosynthesis and production of photosynthates. Efficient portioning of accumulated photosynthates, in turn contribute towards better development of yield indices. These results are supported by Singh *et al.* (2017b) and Das (2017) also recorded the similar result. Sulphur also increase the vegetative growth of plant through the synthesis and activation of many enzyme it also increased the photosynthesis and provide more photosynthates from source of sink resulting favorable increase in no. of pods per plant, length of pod, no. of grain per pod, 100 seed weight. The similar finding was recorded by Ram *et al*. (2013).

Grain and straw yield

Phosphorus and sulphur levels significantly enhanced the grain and straw yield of summer greengram than control (Table 3). Application of 60 kg phosphorus/ha although produced higher grain and straw yields (914 and 1946 kg/ha, respectively) but was found at par with 40 kg phosphorus/ ha (880 and 1882 kg/ha, respectively) and both recorded significantly higher grain and straw yield than 20 kg phosphorus/ha. Application of 30 kg sulphur/ha although produced higher grain and straw yields (920 and 1933 kg/ha, respectively) but was found at par with 20 kg sulphur/ha (879 and 1886 kg/ha, respectively) and both recorded significantly higher grain and straw yield than 10 kg sulphur/ha. Higher grain and straw yields at higher phosphorus and sulphur level might be due to the availability of plant nutrients in adequate proportion and in balanced quantity to the crop plant lead to improved crop growth and better expression of yield induced when consequently reflected to grain and stover yields. These results are supported by Das (2017) and Singh *et al.* (2019c). Sulphur is essential part in synchronize metabolic or enzymatic activity as well as respiration, photosynthesis or rhizobium legume cooperative nitrogen activity, these processes help to increase grain and straw, besides it is essential part of energy transformation, operate many enzymes and important in carbohydrate metabolism. Similar finding was recorded by Patel *et al.* (2013a), Singh *et al.* (2017a). Similar trend was also recorded in harvest index.

Nodulation

Number, fresh and dry weight of nodules increased with advancement of growth stages (Table 4). Number, fresh and

Table 2: Effect of phosphorus and sulphur levels on pods per plant, pod length, grains per pod and test weight.

Treatments	Pods/ plant	Pod length (cm)	Grains /pod	Test weight (g)
Phosphorus levels (kg/ha)				
20	21.36	7.89	12.77	3.00
40	22.76	8.99	13.70	3.61
60	23.17	9.52	14.40	3.89
SEm±	0.60	0.39	0.38	0.28
CD (P=0.05)	1.28	0.83	0.80	0.60
Sulphur levels (kg/ha)				
10	21.37	8.14	12.89	2.97
20	22.74	8.96	13.74	3.59
30	23.14	9.30	14.24	3.94
SEm±	0.60	0.39	0.38	0.28
CD (P=0.05)	1.28	0.83	0.80	0.60
Control				
Control vs rest	18.50	7.13	11.17	1.60
SEm±	0.78	0.50	0.49	0.37
CD (P=0.05)	1.65	1.07	1.04	0.77

Table 3: Effect of phosphorus and sulphur levels on grain yield, straw yield and harvest index.

Treatments	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest index
Phosphorus levels (kg/ha)			
20	830	1780	36.89
40	880	1882	37.71
60	914	1946	38.49
SEm±	20.37	39.34	0.38
CD (P=0.05)	43.18	83.45	0.88
Sulphur levels (kg/ha)			
10	816	1810	36.99
20	879	1886	37.71
30	920	1930	38.89
SEm±	20.37	39.34	0.38
CD (P=0.05)	43.18	83.45	0.88
Control			
Control vs rest	577	1657	32.66
SEm±	26.29	53.21	0.53
CD (P=0.05)	57.74	122.80	1.13

dry weight of nodules/plant did not varied significantly among phosphorus, sulphur levels and control at 20 DAS. However, at 40 DAS, application of phosphorus and sulphur significantly enhanced the number, fresh and dry weight of nodules/plant than control. Among the phosphorus and sulphur levels, application of 60 kg phosphorus and 30 kg sulphur/ha recorded significantly higher number, fresh and dry weight of nodules than 20 and 10 kg sulphur/ha and phosphorus respectively. Higher number, fresh and dry weight of nodules at higher phosphorus and sulphur dose might be due to higher dose of phosphorus increase in the proliferation of lateral and tap root system. Similar result was recorded by Rathour *et al.* (2015). Sulphur application increases nodulation by enhancing the contribution of sulphur hold proteins which are pivotal role for proliferation and growth of rhizobia. Similar finding was recorded by Patel *et al* (2018b).

Optimum dose of phosphorus and sulphur for summer greengram

The response of phosphorus and sulphur on grain yield of summer greengram was worked out to be quadratic. The grain yield of greengram enhanced with enhancing the level of phosphorus and sulphur up to certain levels of phosphorus and sulphur there after it decreased with increasing levels of phosphorus and sulphur. The optimum dose of phosphorus and sulphur for summer greengram was found to be 51.0 (Fig 1) and 24.5 (Fig 2) kg/ha respectively.

Table 4: Effect of phosphorus and sulphur levels on no. of nodule per plant, fresh and dry weight of nodule per plant.

Treatments	No. of nodule per plant		Fresh weight of nodule per plant (g)		Dry weight of nodule per plant (g)	
	20 DAS	40 DAS	20 DAS	40 DAS	20 DAS	40 DAS
Phosphorus levels (kg/ha)						
20	12.77	19.75	149.98	392.99	36.86	59.56
40	13.70	20.54	158.04	399.99	37.71	62.22
60	14.40	21.41	163.97	403.05	38.49	63.72
SEm±	0.37	0.38	0.48	0.52	0.55	0.78
CD (P=0.05)	NS	0.81	NS	1.11	NS	1.66
Sulphur levels (kg/ha)						
10	12.89	20.02	155.88	398.15	36.50	60.61
20	13.74	20.59	157.65	400.06	37.83	62.22
30	14.24	21.10	158.47	400.79	38.27	62.97
SEm±	0.37	0.38	0.48	0.52	0.55	0.78
CD (P=0.05)	NS	0.81	NS	1.11	NS	1.66
Control						
Control vs rest	12.77	18.75	143.00	363.00	33.99	56.68
SEm±	0.46	0.49	0.48	0.52	0.55	0.78
CD (P=0.05)	NS	1.04	NS	1.11	NS	1.66

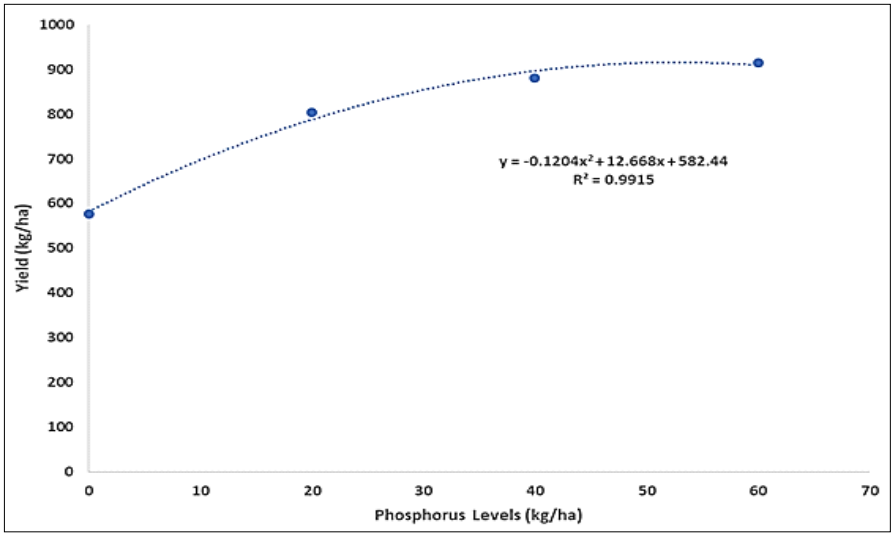

Fig 1: Effect of phosphorus on grain yield of summer greengram.

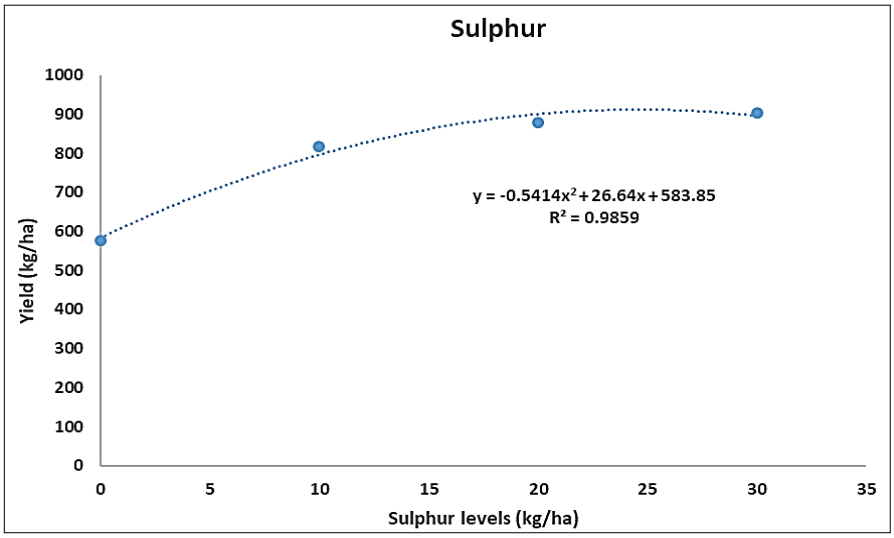

Fig 2: Effect of sulphur on grain yield of summer greengram.

CONCLUSION

Based on present finding of experiment it may concluded that application of phosphorus @ 60 kg/ha and sulphur @ 30 kg/ha may recommended to better growth and higher grain yield of summer greengram. Optimum dose of phosphorus and sulphur for summer greengram was 51 kg and 24.5 kg/ha, respectively.

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