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EFFECT OF PHOSPHORUS AND SULPHUR LEVELS ON GROWTH AND YIELD OF FENUGREEK

RAM LAL JAT, LAXMI NARAYAN DASHORA, SHANKAR LAL GOLADA AND RAMNIWAS CHOUDHARY*

Department of Agronomy, Rajasthan College of Agriculture, MPUAT, Udaipur-313 001

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ABSTRACT

A field experiment was conducted at Udaipur during rabi season of 2010-2011, to study the effect of phosphorus and sulphur on growth and yield of fenugreek. The results indicated that application of 60 kg P_2O_5 ha^{-1} improved the growth of the crop in terms of plant height, dry matter accumulation $plant^{-1}$ and branches per plant. The crop fertilized with 60 kg P_2O_5 ha^{-1} produced significantly higher seed, straw, biological yield and harvest index by 51.8, 19.8, 26.2 and 21.7 % over control and 17.2, 9.6, 11.4, and 5.2 % over 20 kg P_2O_5 ha^{-1}, respectively. Application of 45 kg S ha^{-1} significantly increased the plant height, dry matter accumulation, branches $plant^{-1}$, seed, straw and biological yield and harvest index of fenugreek. The interaction effect revealed that maximum seed yield (19.26 q ha^{-1}), net returns (Rs. 46,352 ha^{-1}) and B/C ratio (3.36) was obtained when it was fertilized with 40 kg P_2O_5 ha^{-1} in combination with 45 kg S ha^{-1}.

Key words: Fenugreek, phosphorus, sulphur, growth parameters, yield

INTRODUCTION

Fenugreek (*Trigonella foenum-graecum* L.) popularly known by its vernacular name "*methi*" is an important condiment legume crop grown mainly in India, In India, it is cultivated mainly in Rajasthan, Gujarat, Uttar Pradesh and Tamil Nadu. Fenugreek occupies prime place amongst the seed spices grown in northern India particularly in Rajasthan. The major districts growing fenugreek in Rajasthan are Sikar, Chittorgarh, Jaipur, Pali, Nagaur, Jhalawar and Alwar. In Rajasthan the area under fenugreek is 62,934 ha with production of 77,369 tonnes and the productivity is 1229 kg ha^{-1} (Government of Rajasthan, 2010). Fenugreek is a multipurpose crop, every part of which is consumed in one or the other form. Its fresh tender leaves and pods are eaten as fried vegetables being rich in iron, calcium, protein and vitamins. Its chopped leaves are mixed in flour to prepare "*parantha*". Its grains are used to form a concentrate feed for animals, besides this, it has immense medicinal utility. Fenugreek seeds have high nutritive values containing protein (9.5%), fat (10%), crude fiber (18.5%), carbohydrate (42.3%) and many other minor nutrients and vitamins, it also contain good percentage of gums (23.06%) mucilage (28%), trigonelline (0.13-30%) and saponine (1.7%), calorific values (food energy) is 370 calories per 100 gm seed. Phosphorus application to legumes plays a key role in formation of energy rich bonds, phospholipids and for development of root system. Sulphur is a constitute of three amino acid *viz*., methionine, cystein and cystine, deficiency of which result in serious malnutrition. Sulphur also improves nodulation in legumes (Khandkar *et al*., 1985). Therefore an experiment was initiated to study the effect of P and S on fenugreek.

MATERIALS AND METHODS

A field experiment was conducted during *rabi* season of 2010-11 on clay loam soil at the Instructional Farm of Agronomy, Rajasthan College of Agriculture, Udaipur. The experiment soil was alkaline in reaction (pH 8.2), low in available nitrogen (247 kg ha^{-1}), medium in available P (20.1 kg P ha^{-1}), high in potassium (326 kg ha^{-1}), low in available S (8.7 kg ha^{-1}) and clay loam in texture. The experiment was laid out in factorial randomized block design consisting of a combination of four levels of phosphorus (0, 20, 40 and 60 kg ha^{-1}) through diammonium phosphate and four level of sulphur (0, 15, 30 and 45 kg ha^{-1}) through gypsum with three replications. Fenugreek cv, Rmt-1 was sown on 15 Nov 2010, using seed rate 25 kg ha^{-1}, row spaced 30 cm apart. Nitrogen was applied as basal dressing @ 25 kg ha^{-1} through urea. The growth characters were recorded at various stages of growth. Yield attributes and yield were recorded at maturity. The economics of various treatments was calculated on the basis of prevailing market price of different inputs and outputs.

RESULTS AND DISCUSSION

Effect of Phosphorus

Application of phosphorus increased significantly all the growth parameters *viz*. plant height, dry matter accumulation $plant^{-1}$ as well as number of branches per plant up to 60 kg P_2O_5 ha^{-1} (Table1). Application of 60 kg P_2O_5 ha^{-1} increased the plant height at 30, 60, and 90 and at harvest by 20.9, 30.8 18.3 and 24.1 % and dry matter accumulation $plant^{-1}$ at 30, 60, 90 and at harvest by 27.5, 39.8, 25.0 and 23.1 % and branches $plant^{-1}$ at harvest by 22.0 %

**Corresponding author Email: slagro_1967@yahoo.co.in*

Krishi Vigyan Kendra Waghai, NAU, Navsari, Gujarat[2]

over control, respectively. In general, overall increase in growth of fenugreek with increased phosphorus levels may be due to its pivotal role in several physiological and biochemical processes which are of vital importance for growth and development of plant. Such improvement under increased phosphorus application might have increased metabolic processes in plants resulting in greater maristematic activity and apical growth, thereby improving plant height, branches per plant and also formation of higher number of leaves per plant ultimately resulting in improved photosynthetic surface area of the plant. The rate of phosphorus absorption and translocation to the leaves is an important factor to increase dry matter accumulation. Similar results were also recorded by Kumar and Singh (2007), Ashif *et al*. (2009) and Singh *et al.* (2010).

Table 1: Effect of phosphorus and sulphur on plant height, dry matter and branches plant^{-1} at harvest of fenugreek

Treatments	Plant height (cm)				Dry matter accumulation (g plant^{-1})				Branches plant^{-1}
	30 DAS	60 DAS	90 DAS	Harvest	30 DAS	60 DAS	90 DAS	Harvest	
Phosphorus (kg ha^{-1})									
0	7.0	31.1	59.6	79.0	0.4	1.6	9.4	18.7	6.0
20	7.6	35.6	63.9	85.5	0.4	1.9	10.5	20.4	6.8
40	8.1	38.3	68.1	91.6	0.4	2.2	11.2	21.8	7.1
60	8.4	40.7	70.5	98.0	0.5	2.3	11.9	23.0	7.3
SEm ±	0.17	0.72	1.42	1.96	0.01	0.15	0.22	0.43	0.07
CD (P=0.05)	0.49	2.09	4.10	5.67	0.03	0.13	0.63	1.25	0.20
Sulphur (kg ha^{-1})									
0	6.9	33.1	59.0	79.3	0.4	1.7	9.4	18.9	6.4
15	7.4	35.6	63.5	85.6	0.4	2.0	10.5	20.3	6.7
30	8.4	37.8	67.7	91.8	0.4	2.1	11.2	21.7	7.0
45	8.5	39.2	71.8	97.4	0.5	2.2	11.8	23.1	7.2
SEm ±	0.17	0.72	1.42	1.96	0.01	0.15	0.22	0.43	0.07
CD (P=0.05)	0.49	2.09	4.10	5.67	0.03	0.15	0.63	1.25	0.20
PxS	NS	NS	NS	NS	NS	NS	NS	NS	NS

It is explicit from the results that application of phosphorus up to 60 kg P_2O_5 ha^{-1} significantly improved yield of fenugreek. Crop productivity estimates *viz*. seed, straw and biological yield increased significantly with increased rate of phosphorus. The extent of this increase with 60 kg P_2O_5 ha^{-1} was 51.8, 19.8, and 26.2 % over control and 17.2, 9.6, and 11.4 per cent over 20 kg P_2O_5 ha^{-1}, respectively (Table 2). Application of 60 kg P_2O_5 ha^{-1} recorded the maximum harvest index (24.1 %). It was 21.7 and 5.2 % higher over control and 20 kg P_2O_5 ha^{-1}, respectively. However, it was at par with 40 kg P_2O_5 ha^{-1}. Application of 60 kg P_2O_5 ha^{-1} recorded significantly higher net returns and B/C ratio which was superior to other levels of phosphorus.

Table 2: Effect of phosphorus and sulphur on yield, harvest index, net returns and B/C ratio of fenugreek

Treatments	Yield (q ha^{-1})			Harvest index	Net returns (Rs ha^{-1})	B/ C ratio
	Seed	Straw	Biological			
Phosphorus ((kg P_2O_5 ha^{-1})						
0	11.1	44.3	55.4	19.8	24784	1.9
20	14.4	48.4	62.8	22.9	33426	2.5
40	16.1	51.3	67.4	23.8	37920	2.7
60	16.8	53.1	70.0	24.1	39784	2.8
SEm ±	0.25	0.82	0.82	0.41	621	0.04
CD (P=0.05)	0.73	2.38	2.36	1.18	1796	0.13
Sulphur (kg ha^{-1})						
0	11.9	44.8	56.7	20.8	26418	1.9
15	14.0	48.2	62.2	22.5	32213	2.3
30	15.8	51.0	66.9	23.6	37455	2.7
45	16.6	53.2	69.8	23.8	39829	2.9
SEm ±	0.25	0.82	0.82	0.41	621	0.04
CD (P=0.05)	0.73	2.38	2.36	1.18	1796	0.13
PxS	Sig.	NS	NS	NS	Sig.	Sig.

The significant increase in seed yield with phosphorus application may be due to improved nutritional condition. There was a significant increase in dry matter accumulation at different growth stages which finally reflected in significant improvement in productivity of crop. Photosynthesis together with availability of assimilates (source) and storage organs (sink) exert an important regulative function of the complex process of yield formation (Nandlal *et al.*, 2007).

Effect of sulphur

Application of sulphur increased significantly all the growth parameters in fenugreek *viz*. plant height, dry matter accumulation as well as branches per plant up to 45 kg S ha^{-1} (Table 1). Application of 45 kg S ha^{-1} increased the plant height at 30, 60, and 90 and at harvest by 23.7, 18.2, 21.7 and 22.8 % and dry matter accumulation by 27.5, 28.4, 25.2 and 22.2 % and branches $plant^{-1}$ at harvest by 12.3 % over control, respectively. The improvement in crop growth with the application of sulphur could be ascribed to its pivotal role in regulating the physiological and metabolic system in plant. Singh and Meena (2004) opined that overall improvement in growth characters of plant owing to sulphur application may be due to sulphur enhanced cell multiplication, elongation and expansion, imparts a deep colour to leaves due to better chlorophyll synthesis resulting in greater amounts of dry matter in comparison to sulphur deficient plant. Khatkar *et al*. (2007) and Cimrin *et al*. (2008) reported similar results. The seed, straw and biological yield increased significantly with increased rate of sulphur over control. The extent of increase with 45 kg S ha^{-1} was 39.4, 18.7, and 23.0 % over control and 19.0, 10.3, and 12.3 % over 30 kg S ha^{-1}, respectively (Table 2). Application of 45 kg S ha^{-1} recorded maximum harvest index (23.8 %). It was higher by 14.4 and 5.7 % respectively over control and 15 kg S ha^{-1}. However, this level was at par with 30 kg S ha^{-1}. In case of sulphur application the highest B/C ratio (2.92) was obtained with 45 kg S ha^{-1} as compared to other levels of sulphur Thus cumulative influence of sulphur application seems to have maintained balance between source and sink through improving both the events of crop development (vegetative and reproductive), which ultimately resulted in increased seed yield. Singh and Singh (2005) reported that increase in seed yield was mainly due to enhanced rate of photosynthesis and carbohydrate metabolism as influenced by sulphur application.

Table 3: Interaction effect of phosphorus and sulphur levels on seed yield (q ha^{-1}) of fenugreek

Sulphur (kg ha^{-1})	Phosphorus (kg P_2O_5 ha^{-1})			
	0	20	40	60
0	7.5	12.4	13.3	14.5
15	11.1	13.8	15.0	15.9
30	12.4	15.2	16.8	18.9
45	13.3	16.0	19.2	18.0
CD (P=0.05)	1.45			

Interaction effect

Interaction results showed that combine application of phosphorus and sulphur significantly affected on seed yield, net returns and B/C ratio of fenugreek (Table 3 and 4). For the same level of phosphorus, increasing levels of sulphur responded up to 30 kg S ha^{-1} in the net returns of fenugreek significantly, when phosphorus was fertilized at 0, 20 and 60 kg ha^{-1}. However, when phosphorus was applied at 40 kg ha^{-1}, the response of sulphur was noted up to 45 kg S ha^{-1}. Similarly, at the same level of sulphur, increasing levels of phosphorus responded up to 40 kg P_2O_5 ha^{-1} in the seed yield, net returns and B/C ratio of fenugreek significantly, when sulphur was fertilized at 0 and 15 kg ha^{-1}. However, when sulphur was applied at 30 and 45 kg S ha^{-1}, the response of phosphorus was noted up to 60 and 40 kg P_2O_5 ha^{-1}, respectively. Maximum seed yield (19.2 q ha^{-1}), net returns (Rs 46,352 ha^{-1}) and B/C ratio (3.3) was recorded with the application of 40 kg P_2O_5 ha^{-1} + 45 kg S ha^{-1} but it was remained at par with 60 kg P_2O_5 + 30 kg S ha^{-1} and 60 kg P_2O_5 + 45 kg S ha^{-1}.

Table 4: Interaction effect of phosphorus and sulphur levels on net returns and B/C ratio of fenugreek

Sulphur kg ha^{-1}	Phosphorus (kg P_2O_5 ha^{-1})				Phosphorus (kg P_2O_5 ha^{-1})			
	0	20	40	60	0	20	40	60
	Net return (Rs /ha)				B:C ratio			
0	14551	27851	30191	33080	1.1	2.1	2.2	2.3
15	24643	31901	35107	37202	1.9	2.4	2.5	2.6
30	28788	35735	40028	45270	2.2	2.6	2.9	3.1
45	31156	38219	46352	43587	2.4	2.8	3.3	3.0
CD (P=0.05)	3592				0.26			

On the basis of the results it may be concluded that the maximum seed yield (19.26 q ha^{-1}), net returns (Rs. 46,352 ha^{-1}) and B/C ratio (3.36) of fenugreek was obtained when it was fertilized with 40 kg P_2O_5 ha^{-1} in combination with 45 kg S ha^{-1}.

REFERENCES

Ashif, A., Sammauria, R. and Yadav, R.S. (2009) Response of fenugreek (*Trigonella foenum-graecum*) to various fertility levels and biofertilizer inoculations. *Indian Journal of Agricultural Sciences* **79**: 145-147.

Cimrin, K.M.,Togay, Y.,Togay, N. and Sonmez, F. (2008) Effect of different sulphur and pyrite levels on yield, yield components and nutrients uptake in the lentil (*Lens culinaris*). *Indian Journal of Agricultural Sciences* **78**: 543-547.

Government of Rajasthan (2010) Vital Agricultural Statistics, Directorate of Agriculture Rajasthan, Government of Rajasthan, Jaipur.

Kumar, A. and Singh, R. (2007) Response of fenugreek (*Trigonella foenum-graecum* L.) to different phosphorus and cutting management practices. *Indian Journal of Agricultural Sciences* **77**: 154-157.

Khandkar, V.R., Shinde, D.A., Kandalkar, V.S., Jamely, N.R. and Jain, N.K. (1985) Growth nodulation yield of rainfed black gram as influenced by phosphate and sulphur fertilization in vertisol. *Indian Journal of Plant Physiology* **25**: 318-322.

Khatkar, R; Thomus, A. and Shalu, J.A. (2007) Effect of Bio-fertilizers and sulphur levels on growth and yield of blackgram (*Vigna mungo* L.). *Legume Research* **30**: 233-234.

Nandlal, J.K., Tehlan,S.K., Malik, T.P. and Mehra, R. (2007) Effect of nitrogen and phosphorus levels on growth and seed yield of fenugreek. (*Trigonella foenum-graecum*). *Haryana Journal of Horticulture Sciences* 36: 413-414.

Singh, Amar and Meena N.L. (2004) Effect of nitrogen and sulphur on growth, attributes and seed yield of mustard (*Brassica juncea*) in eastern plain of Rajasthan. *Indian Journal of Agronomy* **3**: 186-188.

Singh, D., Nepalia, V. and Singh, A.K. (2010) Performance of fenugreek (*Trigonella foenum-graecum*) varieties at various fertilizer levels and biofertilizer inoculation. *Indian Journal of Agronomy* **55**: 75-78.

Singh, S. and Singh V. (2005) Effect of nitrogen, sulphur and zinc on Indian mustard (*Brassica juncea*.) *Indian Journal of Agricultural Sciences* **75**: 828-830.