Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; SP1: 1138-1141

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Effect of different levels of nitrogen, phosphorus and Sulphur on growth and yield of Rajmash (*Phaseolus Vulgaris* L.) Variety HUR 15

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Abstract
In the experiment four level of nitrogen (30, 60, 90 & 120 kg/ha), three levels of phosphorus (0, 30 & 60 kg/ha) and two levels of sulphur (15 & 30 kg/ha) were tested. The experiment was laid out in double split plot design with three replications accommodating 24 treatments combination in total 72 plots, allocated randomly in each replication. Rajmash variety HUR 15 selected as test crop for experimentation. Nitrogen at the rate of 120 kg/ha proved significantly superior to 90, 60 and 30 kg/ha in respect of all growth and yield attributes which recorded highest grain yield 13.59 q/ha. Higher level of phosphorus i.e. 60 kg/ha proved significantly superior to 30 kg/ha and control in respect of growth and yield attributes, which recorded highest grain yield 12.08 q/ha. Sulphur application proved beneficial in bringing about significant improvement in yield attributes. 30 kg S/ha produced highest grain yield 11.47 q/ha.

Keywords: Rajmash, nodulation, *rhizobia*, dry matter, yield potential

Introduction

Application of scientific knowledge, thinking and techniques to practical problems brought green revolution in the country and attained self-sufficing in the production of cereals but as far as pulses and oilseeds are concerned 'the decades old plateau' is still unchanged. Food legumes are a vital component in Indian cropping systems owing to their ability to provide significant quantities of proteins to the vegetarian diet. The indigenous production of grain legumes is not presently sufficient to meet the national requirement. With the rising trend in population, the situation is bound to worsen unless the efforts are made to increase the production levels. Rajmash (*Phaseolus vulgaris* L.) is a newly introduced rabi crop in North India. Traditionally, this crop was cultivated in hilly tract of Jammu & Kashmir, H.P. and Uttarakhand. In early eighties, it has been reported that it is possible to grow rajmash in northern plain in the winter (Anonymous, 1982). Globally french bean is cultivated over an area of 29.92 million hectares with an annual production of 23.23 million tons while in India it is cultivated over an area of about 10.80 million hectares with an annual production of 4.87 million tons (Anonymous, 2010). Nutritional study of this important crop was mainly confined to the primary nutrients while as secondary nutrients were least attended and micronutrients forgotten. Among secondary nutrients sulphur deficiency is reported in Inceptisols of Kashmir valley and identified as yield limiting factor, particularly in production of pulses and oilseed crops (Shrivastava *et al.*, 2000). French Bean or rajmash is quite nutritious and potential source of protein, carbohydrates and minerals. The mineral matter, crude fiber and ether extract are concentrated in seed while crude protein and energy are stored in the cotyledons (Singh and Yadav, 1997). Varieties evolved under the All India Coordinated Pulse Improvement Project are highly adaptive to winter condition of plains and they may yield to the tune of 2.5 to 3 t/ha with the good management. Unlike other pulses, rajmash is inefficient in symbiotic nitrogen fixation (Ali and Lal, 1992) as it lacks nodulation due to the absence of NOD gene regulator (Kushwaha, 1994) even with native Rhizobia and commercially produced cultures. Hence, the nitrogen requirement of rajmash is different from other pulse crops and application of nitrogen through fertilizers is imperative for exploiting its yield potential. In non-nodulus grain legumes like rajmash, nitrogen plays significant role in increasing the yield. Consequently heavy dose of nitrogen is required for exploiting the yield potential. Therefore, it responds to higher doses of nitrogen as compared with other legumes (Sharma *et al.* 1996). As nodulation is poor in rajmash, it requires more nitrogen and phosphorus for root development, nodulation and better plant growth and hence responds even to application of fertilizer phosphorus (Ssali and Keya, 1986).

Favorable response of phosphatic fertilizer to grain legumes is well established. Low phosphorus and nitrogen in the soil often limits production of common bean (Singh *et al*, 2006). Sulphur also plays an important role in the production of grain legumes.

It promotes root growth and helps in the conversion of nitrogen into protein. Information on integrated effect of N, P and S in rajmash is lacking and clear understanding pertaining to judicious, combination of these nutrients to sustain higher level of productivity is essential. Nutritional study of this important crop was mainly confined to the primary nutrients while as secondary nutrients were least attended and micronutrients forgotten. Sulphur has been found to be an indispensable element for higher pulse production and it is an integral part of proteins, sulpholipids, enzymes etc. (Das and Misra, 1991), besides it is involved in various metabolic and enzymatic processes including photosynthesis, respiration and legume-rhizobium symbiotic nitrogen fixation (Rao *et al.*, 2001). Sulphur response has been observed for several legume crops including french bean and its application to sulphur deficient soils have been found to increase the crop yield and improve the quality of crop produce (Kumar *et al.*, 2009).

In this study an attempt was made to test the possibilities of influencing yield of rajmash by using nitrogen, phosphorus and sulphur in varying rates with objective to find out the response of different rates of N, P & S on growth and yield of rajmash.

Materials and Methods

The experiment was conducted on Agronomy Research Plot of Allahabad Agricultural Institute, Allahabad. The soil of experiment site (Table-1) had sandy clay loam texture with organic carbon (0.43 %) with normal p^H (7.2), low available nitrogen (173.25 kg/ha), sulphur (14 ppm) and medium phosphorus (13.63 kg/ha) & potassium (326.25 kg/ha) contents. In the experiment four level of nitrogen ($N_{1:}$ 30, $N_{2:}$ 60, N_3: 90 & $N_{4:}$ 120 kg N/ha), three levels of phosphorus (P_0: 0, P_1: 30 & P_2: 60 kg P_2O_5/ha) and two levels of sulphur (S_1:15 & $S_{2:}$30 kg s/ha) were tested. The experiment was laid out in double split plot design with three replications accommodating 24 treatments combination in total 72 plots, allocated randomly in each replication. The distance between row to row was 40 cm, plant to plant 20 cm in net plot size 4x3 meter. Rajmash variety HUR 15 selected as test crop for experimentation which is recommended for cultivation as rabi season crop in Uttar Pradesh plains. At the time of sowing half of nitrogen in the form of diammonium phosphate & urea, full phosphorus in the form of single super phosphate & diammonium phosohate and full sulphur in the form of single super phosphate & elemental sulphur, were applied according to treatments. Potash was given uniformly to all plots at the rate of 50 kg/ha as muriate of potash. Half of the nitrogen applied through urea as top dressing in standing crop at 30 days after sowing. All other agronomic management practices were followed as per recommendation.

Table 1: Physical and chemical properties of the experimental field

Properties	Values	Method employed
Physical properties		
a. Sand (%)	60	Bouyoucos hydrometer (Piper, 1966)
b. Silt (%)	10.6	
c. Clay (%)	29.4	
A. Texture class	Sandy clay loam	
Chemical properties		
a. Organic carbon	0.43 %	Walkly and Black method (1934)
Available nitrogen	173.25	Kjeldah method (Jackson 1973)
c. Available Phosphorus	13.63	Olson's method (1954)
d. Available potash	326.25	Jackson (1973)
e. Soil pH	7.2	pH meter
Available sulphur	14 ppm	Turbidity method

Result and Discussion

The result (Table-2) revealed that every increment in rate of nitrogen brought about marked increase in growth attributes like plant height, number of branches and dry matter production per plant as well as yield attributes like production of pods per plant, number of grains per pod, seed index and finally the grain yield per hectare. Application of nitrogen at the rate of 120 kg/ha proved its superiority over 90, 60 & 30 kg N/ha with regards to all yield attributes and thus resulted into higher grain yield per hectare. Nitrogen application at the rate of 120 kg/ha recorded significantly highest height of plants 34.14 cm, dry weight per plant 23.01 g, number of branches per plant 9.75, number of pods per plant 11.82, number of grains per pod 4.03, seed index 26.62 g, rajmash seed yield 13.59 q ha^{-1} and straw yield 20.16 q ha^{-1}. Application of 90 kg N/ha was recorded as the second best combination for both growth & yield attributes and economic yields. Increasing rates of nitrogen, though resulted in more yield but optimum rate was 120 kg/ha (Rana & Singh 1998). Prajapati *et al.*, (2003) reported higher values of plant height of French bean due to application of 120 kg N ha-1 from Gujarat. In accordance with vegetative growth, every increment in rate of nitrogen brought about significant increase in pods, seed index and finally the economic yield per hectare. Adequate availability of nitrogen at the stage of tissue differentiation from somatic to reproductive phase, leading to enhanced meristematic activity and development of floral primordial, is self-explanatory for greater number of flower production with later develop into pods (Hedge and Srininvas, 1989). Non nodulated legumes like rajmash, higher yields were obtained, only when nitrogen to the extent of 120 kg/ha or more was applied (Sharma 2001, Patel *et al.*, 2007). Nitrogen at moderate rates led to significant enhancements in yield components and grain yield (Tadessl and Dechassa, 2017)

Table 2: Effect of nitrogen, phosphorus and sulphur on growth, yield attributes and grain yield of rajmash

Treatments	Plant Height (cm)	Dry weight/ plant (g)	Number of branches/ plant	Number of pods/ plant	Number of grains/ pod	Seed index (g)	Seed yield (q/ha)
N_1	28.34	18.83	7.44	9.53	3.28	24.29	7.72
N_2	29.44	20.10	8.26	10.43	3.48	25.68	10.66
N_3	33.22	22.02	9.24	11.28	3.85	26.23	13.13
N_4	34.14	23.01	9.75	11.82	4.03	26.62	13.59
C.D. (5%)	***1.22***	***1.03***	***0.43***	***0.54***	***0.14***	***0.81***	***0.86***
P_0	30.69	20.28	8.33	10.36	3.54	25.20	10.43
P_1	31.21	21.01	8.65	10.75	3.67	25.70	11.31
P_2	31.96	21.68	9.04	11.20	3.76	26.22	12.08
C.D. (5%)	***1.00***	***0.56***	***0.39***	***0.36***	***0.11***	***0.67***	***0.38***
S_1	31.05	20.80	8.57	10.67	3.64	25.57	11.07
S_2	31.52	21.18	8.78	10.86	3.68	25.84	11.47
C.D. (5%)	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***

Increasing rates of phosphate fertilization showed significantly higher in growth & yield attributes as well as economic yield. Higher level of phosphorus i.e. 60 kg P_2O_5/ha proved significantly superior to 30 kg P_2O_5/ha and control in respect of growth attributes. Phosphate application at the rate of 60 kg/ha recorded significantly highest height of plants 31.96 cm, dry weight per plant 21.68 g, number of branches per plant 9.04, number of pods per plant 11.20, number of grains per pod 3.76, seed index 26.22 g and rajmash seed yield 12.08 q ha^{-1} and straw yield18.51q ha^{-1}. Phosphorus is known to play various role in plant metabolic activities. Increase in branching of rajmash due to increasing levels of phosphorus application was reported by Sharma (2001). Yield components are mutually interdependent to structural component of yield, increased dry matter accumulation and multi-branching under adequate phosphorus incorporation, proved instrumental in increasing the yield. Recommended level of P @ 60 kg/ha proved better than 75% of recommended P by Singh and Dubey (2015) and increase in yield attributes due of to P application has been reported earlier by Rana *et al.*, (2001).

Sulphur application proved beneficial in bringing about significant improvement in almost all the growth attributes viz. height of plant, number of branches, dry matter production per plant and yield attributes. Application of 30 kg sulphur per hectare increased highest height of plants 31.52 cm, dry weight per plant 21.18 g, number of branches per plant 8.78, number of pods per plant 10.86, number of grains per pod 3.68, seed index 25.84 g, rajmash seed yield 11.47 q ha^{-1} and straw yield 17.96 q ha^{-1}. Thus, the plants well supplied with sulphur are expected to have efficient photosynthetic mechanism and better equipped for efficient translocation to sink site, consequently resulting into improved grain yield. Similar result was reported in other crop by Shivan *et al.*, 2000. Various yield attributing characters like number of pods plant-1, number of seeds pod-1 and 100 seed weight increased significantly as the dose of sulphur was increased by Ganie *et al.*, (2014).

Shubhashree *et al.*, (2011) reported that plant height, number of branches per plant, leaf area index, total dry matter production, number of pods per plant, seeds per pod, 100 seed weight and seed yield per plant significantly higher with 80:75:30 N:P_2O_5:K_2O kg ha-1. These results are in agreement with Kumar *et al.* (2004), Jagdale *et al.*, (2005), Veeresh (2003), Chaudhary (2009) and Wondimu & Tana (2017). On the basis of result it may be concluded that application of 120:60 and 30 kg of N: P and S per hectare may enhanced the productivity of rajmash in alluvial soil of central plain zone of U.P.

References

1. Ali M, Lal S. Technology for rajmash cultivation in the plains. Indian Fmg. 1992; 42:25-26.
2. Anonymous. Food and Agriculture Organization of the United Nations. FAOSTAT database, 2010. http://www.fao.org
3. Anonymous, Annual Report. All India Coordinated Pulse Improvement Project, Directorate of Pulse Reasearch, Kanpur, 1982, 7-8.
4. Chaudhary S. Growth and yield of french bean (*Phaseolus vulgaris* L.) as influenced by different levels of row spacing, seed rate and nitrogen. International Journal of Agricultural Sciences. 2009; 5(2):549-551.
5. Das NR, Misra RS. Effect of sulphur and variety on yield of summer groundnut in West Bengal. Indian J Agronomy. 1991; 36:604-605.
6. Ganie MA, Akhter F, Bhat MA, Najar GR. Growth, Yield and quality of french bean (*Phaseolus vulgaris* L.) as influence by Sulphur and boron application on inceptisols of Kashmir, The Biscan. 2014; 9(2):513-518.
7. Hedge DM, Srinivas K. Optimization of nutrient management in field crops. Indian J Agron. 1989; 34(2):180-184.
8. Jackson ML. Soil chemical analysis. Prentice Hall of India, Pvt. Ltd., New Delhi, 1973, 498.
9. Jagdale RB, Khawale VS, Baviskar PK, Doshinge BB, Kore MS. Effect of inorganic and organic nutrients on growth and yield of French bean (*Phaseolus vulgaris* L.). J Soil Crops. 2005; 15:401-405.
10. Shubhashree KS, Alagundagi SC, Hiremath SM, Chittapur BM, Hebsur NS, Patil BC. Effect of nitrogen, phosphorus and potassium levels on growth, yield and economics of rajmash (*Phaseolus vulgaris*), Karnataka J Agric. Sci. 2011; 24(3):(283-285).
11. Kumar M, Sinha KK, Roy Sharma RP. Effect of organic manure, NPK and boron application on the productivity of French bean in sandy loam soil of north Bihar. Indian J Pulses Res. 2004; 17:42-44.
12. Kumar RP, Singh ON, Singh Y, Dwivedi S, Singh JP. Effect of integrated nutrient management on growth, yield, nutrient uptake and economics of french bean (*Phaseolus vulgaris*). Indian J Agricultural Sciences. 2009; 79:122-128.
13. Kushwaha BL. Response of French bean (*Phaseolus vulgaris* L.) to nitrogen application in north Indian plains. Indian J Agron. 1994; 39:34-37.
14. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorus in soils by eztraction with sodium bicarbonate, U.S. Dept. Agric. Circular No. 1954,

939.
15. Patel MM, Patel IC, Patel AG, Patel PH, Patel NB, Tikka SBS. Effect of *Rhizobium* inoculation and nitrogen levels on yield of rajmash. J Food Legumes. 2007; 20(2):214-215.
16. Piper CS. Soil and plant analysis, (Interscience Publishers, New York, USA), 1966, 368.
17. Rana RS, Rana SS, Chahota RK, Sharma GD, Mankotia B. Influence of row spacing and fertility levels on the productivity and economics of rajmash (*Phaseolus vulgaris* L.) in dry temperate region of H.P. Himachal Journal of Agricultural Research. 2001; 27:11-18.
18. Rao S, Singh KK, Ali M. Sulphur: A key nutrient for higher pulse production, Fertilizer News. 2001; 46:31-48.
19. Sharma HM, Singh RNP, Singh H, Roy Sharma RP. Effect of rates and timings of N application on growth and yield of winter Rajmash. Indian J Pulses Res. 1996; 9(1):25-30.
20. Sharma SK. French bean green pod and seed production as influenced by nitrogen and phosphorus application. Annals of Agricultural Research. 2001; 22(1):130-132.
21. Shivran PL, Ahalwat IPS, Shivran DR. Effect of phosphorus and Sulphur on Pigeonpea (*Cajanus cajan*) and succeeding Wheat (*Triticum aestivum*). Indian Journal of Agronomy. 2000; 45(1):25-30.
22. Singh Y, Singh ON, Sharma SN. Effect of nitrogen and micronutrients on growth, yield and nutrient uptake by French bean. Indian J Pulse Res. 2006; 19:67-69.
23. Singh R, Dubey YP. Effect of Organic and Inorganic Nutrients on Yield of Rajmash (*Phaseolus vulgaris* L.) in Dry Temperate Zone of Himachal Pradesh, Universal Journal of Agricultural Research. 2015; 3(1):1-3.
24. Singh V, Yadav DS. Studies on Sulphur and zinc nutrition on green gram (*Phaseolus radiatus* L.) in relation to growth attributes, seed protein yield and S, Zn uptake, Legume Research. 1997; 20:224-226.
25. Shrivastava UK, Rajput RL, Diwivedi ML. Response of soybean-mustard cropping system to sulphur and bio-fertilizers on farmer's field. Legume Research. 2000; 23:277-278.
26. Ssali H, Keya SO. The effect of phosphorus and nitrogen fertilizer level on nodulation, growth and dinitrogen fixation of three bean cultivars. Trop. Agric. 1986; 63:105-109.
27. Tadessel N, Dechassa N. Effect of Nitrogen and Sulphur Application on Yield Components and Yield of Common Bean (*Phaseolus vulgaris* L.) in Eastern Ethiopia. Academic Research Journal of Agricultural Science and Research. 2017; 5(2):77-89.
28. Veeresh NK. Response of French bean (*Phaseolus vulgaris* L.) to fertilizer levels in Northern Transitional Zone of Karnataka. M.Sc. (Agri.) Thesis, Univ. Agric. Sci., Dharwad (India), 2003.
29. Walkley A, Black IA. An examination of Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. Soil Sci. 1934; 37:29-37.
30. Wondimu W, Tana T. Yield Response of Common Bean (*Phaseolus vulgaris* L.) varieties to Combined Application of Nitrogen and Phosphorus Fertilizers at Mechara, Eastern Ethiopia, J Plant Biol. Soil Health. 2017; 4(2):1-7.