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Effect of different levels of nitrogen and sulphur on growth parameters, yield parameters and economics of moong bean

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ABSTRACT

The field experiment was conducted at the Agriculture Research Farm of lovely professional university, Punjab during the period of April to July in the summer season of 2022, to study the effect of nitrogen and sulphur on growth parameters, yield parameters, and economics of moong. The study was carried out in a randomized complete block design with three replications and eight treatments. Analysis of the soil parameters was also done. The study concludes that 100% Recommended dose of fertilizer led to the highest growth parameters viz., plant height (57.49 cm) followed by T_6 (55.75) taken at different time intervals viz., 15, 30, 45, 60, and at harvest. Grain yield was more in that treatment where only RDF was applied. Results showed that RDF had more impact on the growth parameters, yield parameters, and economics among all the treatments.

Key words: *Nitrogen, Sulphur, Growth, Yield, Fertilizers.*

Introduction

The need for increased food production is overwhelming due to the world's rising population in general and developing countries in particular. Along with focusing on staple crops and vegetables, a variety of pulses are crucial for supplying the rising demand for human food (Das *et al*., 2017). The primary goal and focus of numerous research studies are to enhance soil crop management practices by altering sowing times and production techniques to increase yield in order to feed the world's rapidly growing population. Moongbean is a significant pulse crop with high nutritional value, and it not only contributes to a healthy diet for humans but also helps to increase soil fertility by fixing atmospheric nitrogen (Ali *et al*., 2020). It belongs to the Leguminosae family and is frequently referred to as a green grain and scientifically as *Vigna radiata*. Sometimes, moongbean is grown specifically for hay, green manure, or as a cover crop.

According to Raina (2016), due to its short lifespan and adaptability to spring and summer cropping systems, moongbean can withstand conditions of water scarcity. The main cause of the low productivity of moongbean is due to improper fertilizer application doses on marginal and sub-marginal lands, which leads to low soil fertility. Next to

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nitrogen, phosphorus is a crucial nutrient for plant growth. The availability of phosphorus in Indian soils is poor to medium, so phosphorus plays a more crucial role in pulses than any other nutrient. One of the most limiting nutrients for crop growth in tropical soils has been identified as phosphorus, which is culpable for the decline in moong bean yields on all types of soil in terms of total vegetative growth, secondary branches, and leaf development (Khan *et al.*, 2017). The application of phosphorus can enhance root growth, disease resistance improving flower formation and seeding abilityto absorb water and nutrients (Vaishali *et al*., 2020). The key element that significantly influences the growth characteristics and yield of this crop is the effective management of the fertilizer (Bansal *et al*., 2015). The most significant factor limiting crop yields is nitrogen (Ali *et al*., 2020). Sulphur is required for the synthesis of vitamins such as biotin and thiamine, as well as amino acids such as cystine, cysteine, and methionine (Parashar *et al.,* 2020).

Sulphur influences active nodulation in legumes, which plays a significant role in N-fixation. It is a component of the nitrogenase enzyme, encourages nodulation in legumes, and improves biological N-fixation (BNF). A lack of Sulphur can significantly lower the productivity of pulses (Das *et al.*, 2017). In addition, it aids in the biosynthesis of oil, the metabolism of carbohydrates, proteins, and fats, and the formation of chlorophyll. For these reasons, Sulphur is now regarded as the fourth major nutrient element after N, P, and K. According to Yadav *et al*. (1997), moongbean's growth and yield characteristics are improved by the combined application of nitrogen and sulphur.

Materials and Methods

The present experiment was carried out at the experimental field of the Department of Agriculture, Lovely Professional University, Phagwara, Punjab during the summer season of 2022. Out of six agro-climatic zones of Punjab, the area lied in the Central Plain region. The texture of experimented field soil was sandy loam. The test crop of the moongbean variety is TMB-37. TMB 37 variety is suitable for both seasons viz., spring and summer seasons. This variety is released by Punjab Agriculture University for general cultivation in Punjab and TMB 37 variety matures in 60 days. It has good culinary qualities with medium-sized grains. The experiment was conducted on sandy-loam soil with a pH (7.9). The soil samples representing 30cm depth by the "V-shaped" method was taken from the field. The collected sample was dried, crushed, and sieved. The following initial parameters are given in Table 1. The experiment was laid out in randomized block design (RBD) with three replications and eight treatment combinations consisting of T_1 (20kg Sulphur), T_2 (12.5 kg nitrogen + 20 kg sulphur), T_3 (10 kg sulphur), T_4 (12.5 kg nitrogen +10 kg sulphur), T_5 (12.5 kg nitrogen), T_6 (25 kg nitrogen), T_7 (12.5 kg nitrogen + 40 kg phosphorus), and T_8 (control). N, P, and S were applied at basal application. Nitrogen was applied through urea, phosphorus through single super phosphate and sulphur was applied through gypsum. Packages and practices of PAU were followed in the field. Moong bean seeds were sown on 18th April 2022 in lines. To keep the field weed and disease-free, various intercultural operations were carried out as needed, such as hand weeding and insecticide spraying. Observations on various growth parameters viz., plant height, dry matter, number of nodules per plant, and yield-related attributes viz., number of pods per plant, number of grains per pod, seed index, grain yield, and stover yield were recorded, using standard procedures. The data were analyzed as per the standard procedure of OPSTAT software.

Economic indices were determined using the current market rates. The cost of cultivation was calculated by accounting for all costs associated with growing the crop. By multiplying the yield (grain + stover) per hectare under various treatments with the going market rate, the total gross return (Rs per hectare) was calculated. By deducting the cost of cultivation from the individual treatments' gross returns, net return (Rs per hectare) was calculated. The following formula was used to determine the benefit-cost ratio.

$$\text{Benefit: Cost ratio} = \frac{\text{Net profit (Rs per hectare)}}{\text{Cost of cultivation (Rs per hectare)}}$$

Results and Discussion

Effect of nitrogen and sulphur on growth attributes: Plant height of all the stages of crop with different nutrient levels which had a significant effect on the plant height of the moong bean crop. Plant height increased continuously in all the stages and was significantly affected by different fertilizer levels. The maximum plant height obtained from T_7 (57.49 cm) at the time of harvest is statistically similar to the T_6 (55.75cm), while the minimum plant height was recorded from the T_8 (47.47cm) which is the control treatment, and no fertilizers are applied in this treatment in Table 2. Phosphorus' impact on growing plants' metabolism, growth yield, and yield parameters might be because of the increase in plant height under this treatment. A sufficient supply of phosphorous, which indirectly contributes to nitrogen supply and its availability enabled the plants to grow with greater vigour in terms of plant height. These results concurred with Erman *et al*., (2009), who found that the application of phosphorus significantly affected the plants' height, dry matter accumulation, number of nodules, grain yield, biological yield, and number of pods. The differences between the treatments T_7 and T_6 were significant and higher over T_8 (control). With rising sulphur levels, plant height also increased consistently and significantly at all stages of crop growth. However, the 10 kg and 20 kg of sulphur were superior to control at all stages of crop growth but did not have a significant impact on plant height. The increase in plant height in T_2 (54.21cm) was statistically similar to the T_4(53.55), T_1(50.13), and T_3(49.38) respectively.

Different doses of fertilizers influenced dry matter accumulation on all crop growth stages as shown in Table 3. Maximum dry matter accumulation per plant was observed in T_7 (32.87 g) from the rest of the treatments during harvest and they are statistically significant with T_6 (31.20 g) per plant. The minimum dry matter accumulation per plant was recorded in T_8 (16.54g).

The data pertaining to the number of pods per plant as affected by different nitrogen and sulphur levels are presented in Table 4. Which reveals that different nutrient levels had significantly affected on this parameter. The highest number of pods per plant was recorded in T_7 (26.80cm) followed by T_6 (24.27cm), T_2 (23.52cm), and T_4 (22.87 cm) which were statistically at par with one another. While significantly least number of pods per plant was recorded in the control plot T_8 (15 cm). The ability of per plant to produce a greater number of pods may have been made possible by the increased vigour and strength of the plants that attained as a result of better photosynthetic activities, adequate light availability, and balanced nutrient supply during the plant's growing stages. The findings of Ahmad *et al*.

Table 1. Initial parameters of the soil

Serial no.	Parameters	Values	Methods
1.	Soil pH	7.9	pH meter method
2.	Organic carbon (%)	0.42	Walkey and Black method
3.	Available nitrogen (kg per hectare)	170	Kjeldahl method
4.	Available phosphorus (kg per hectare	12	Olsen's method
5.	Available potassium	180	Ammonium acetate method
6.	Available sulphur (kg per hectare)	35	Williams and Steinberg method

Table 2. Influence of nitrogen and sulphur on plant height.

Treatments	Plant height (cm)				
	15 DAS	30 DAS	45 DAS	60 DAS	At Harvest
T_1	6.73	19.10	35.39	49.1	50.13
T_2	7.17	21.98	37.87	53.8	54.21
T_3	6.60	18.28	33.13	48.4	49.38
T_4	6.93	21.78	37.63	52.8	53.55
T_5	6.78	20.77	35.66	51.4	52.20
T_6	7.62	22.98	38.88	54.8	55.75
T_7	7.75	23.41	40.23	56.1	57.49
T_8	6.52	17.89	31.38	46.6	47.47
LSD (P=0.005)	NS	2.84	4.17	5.9	6.03

T_1 (20kg Sulphur), T_2 (12.5 kg nitrogen + 20 kg sulphur), T_3 (10 kg sulphur), T_4 (12.5 kg nitrogen + 10 kg sulphur), T_5 (12.5 kg nitrogen), T_6 (25 kg nitrogen), T_7(12.5 kg nitrogen + 40 kg phosphorus), and T_8 (control)

(1992), Ahmed *et al*. (2003) and Hussain (1994), who claimed that nitrogen and phosphorus increased the number of pods per plant, are supported by these results.

Effect of nitrogen and sulphur on yield attributes

Significant effect of fertilizer on the number of grains per pod shown in Table 4. The maximum number of grains per pod obtained from T_7 (11.93 grains per pod) was (12.5-40) kg NP per hectare. Similarly, the treatments T_6 (9.80), T_2 (9.40), and T_4 (9.22) were statistically similar in producing the number of grains pod, respectively. While the minimum number of grains (6.88 per pod) was obtained from T_8 which was the control plot (no fertilization). This might be due to the balanced application of nitrogen and phosphorus to T_7, which promotes plant growth that increases fruit-bearing branches, seed development, and root proliferation and therefore more grains per pod are produced. The maximum number of nodules at 30 DAS are obtained from T_7 (12) per plant and which were significantly similar to the T_6 (12), T_5 (11), T_4 (11), and T_2 (11), while the minimum number of nodules are observed in T_8 which is the control (9 nodules) per plant. This might be because phosphorus promotes growth, nodulation, and root development and it also hastens crop maturity and enhances the quality of the crop (Choudhary *et al*., 2015).

Phosphorus promotes the growth of new cells, increases plant vigour, and speeds up the development of leaves, all of which aid in capturing more solar energy and making better use of nitrogen, which contribute to higher growth attributes. According to Malik *et al.*, (2003); Escalante *et al.* (2014), and Rathour *et al.* (2015) these findings are pertinent.

Table 3. Influence of nitrogen and sulphur on dry matter accumulation

Treatments	Dry matter (g per plant)				
	15 DAS	30 DAS	45DAS	60DAS	At Harvest
T_1	0.14	0.63	14.97	19.28	20.35
T_2	0.16	1.21	19.25	25.89	28.86
T_3	0.13	0.60	14.10	17.76	18.57
T_4	0.14	1.13	17.44	22.97	25.08
T_5	0.13	0.87	16.97	22.06	23.57
T_6	0.16	1.68	20.38	27.96	31.20
T_7	0.17	1.72	20.88	28.92	32.87
T_8	0.08	0.87	13.1	15.98	16.54
LSD (P=0.005)	NS	0.63	1.18	3.31	2.23

T_1 (20kg Sulphur), T_2 (12.5 kg nitrogen + 20 kg sulphur), T_3 (10 kg sulphur), T_4 (12.5 kg nitrogen +10 kg sulphur), T_5 (12.5 kg nitrogen), T_6 (25 kg nitrogen), T_7(12.5 kg nitrogen + 40 kg phosphorus), and T_8 (control)

Table 4. Influence of nitrogen and sulphur on yield attributes, grain yield and biological yield of moong bean crop.

Treatments	No of pods per plant (cm)	No. of grains per pod	No. of nodules (30 DAS)	Grain yield (kg per hectare)	Seed index (100 seeds)	Biological Yield (Kg per hectare)
T_1 (Sulphur)	21.27	8.73	10	856	3.65	2719
T_2(nitrogen +Sulphur)	23.52	9.40	11	921	4.36	3355
T_3 (Sulphur)	20.05	7.07	10	824	3.52	2544
T_4 (nitrogen + Sulphur)	22.87	9.22	11	898	3.81	3117
T_5 (nitrogen)	22.42	8.85	11	880	3.37	3086
T_6 (nitrogen)	24.27	9.80	12	972	4.43	3666
T_7 (100% RDF)	26.80	11.93	12	983	4.57	3943
T_8 (control)	15.00	6.88	9	743	3.50	2349
LSD (P=0.005)	2.67	0.88	1.80	30.44	NS	179.88

T_1 (20kg Sulphur), T_2 (12.5 kg nitrogen + 20 kg sulphur), T_3 (10 kg sulphur), T_4 (12.5 kg nitrogen +10 kg sulphur), T_5 (12.5 kg nitrogen), T_6 (25 kg nitrogen), T_7(12.5 kg nitrogen + 40 kg phosphorus), and T_8 (control)

Effect of nitrogen and sulphur on yield

After analyzing the data of grain yield, seed index, and biological yield of summer green gram are summarized in Table 4. The data show that nitrogen application have a marked effect on grain yield and biological yield of summer green gram. The application of 40 kg phosphorus per hectare gave significantly more grain yield than the control. A maximum value of 983 kg grain yield was recorded in T_7 (100% RDF) per hectare and a minimum value of 743 kg per hectare grain yield was recorded in T_8(control). The treatment differences were significant among themselves as well as over control. The sulphur application showed a decline in yield at 10 kg sulphur per hectare as compared to 20 kg Sulphur per hectare.

The highest seed index of 100 grains were obtained (4.57g) from T_7 (100% of RDF) followed by T_6 (4.43g) and T_2 (4.36g), whereas the lowest was obtained from T_8 (3.50 g) which is the control. The increase in the seed index of 100 seeds weight may be due to the combination of 40 kg phosphorus per hectare and 12.5 kg nitrogen per hectare, which increased the seed weight and size of the grain of the summer moong bean crop.

The maximum biological yield was recorded at 3943 kg per hectare at 40 kg Phosphorus per hectare and the minimum biological yield was 2349 kg per hectare in control. The differences between the treatments were significant among themselves and over the control. There was a rise in biological yield with doses of phosphorus. All the doses of sulphur are clearly significantly superior over control and enhancing the grain yield production of summer green gram. The lowest average value of grain yield and biological yield were recorded in the (T_8) control treatment. Nitrogen application to moongbean crops improves grain yield. These results supported the observations made by Patel *et al.* (2016) and Varma *et al.* (2017) in moong bean.

Effect of nitrogen and sulphur on economics

Further data presented in Table 5 revealed that the cost of cultivation which include (fertilizers cost, seeds cost, labor cost, and insecticides cost) obtained the highest in T_7 (32,841 Rs per hectare) which was significantly higher over the rest of the treatments and lowest is obtained fromT_8 (32,070 Rs per hectare). Similarly, the application of nitrogen with phosphorus in T_7 (100% RDF) gave a higher gross return (72,764 Rs per hectare) followed by T_6 (71,484 Rs per hectare), T_2 (67,496 Rs per hectare) than the rest of the treatments and the lowest gross returns is obtained from T_8(53,736 Rs per hectare) which is control treatment. The benefit-cost ratio also revealed the highest in T_7 (1.21) and the lowest is revealed in T_8 (0.67). The significant and maximum economics was observed with the application of nitrogen (12.5 kg per hectare) along with phosphorus (40 kg per hectare). According to Kumawat *et al.* (2017), it may be because phosphorus promotes root growth, development, and nodulation in moong beans, which increases N_2-fixation. As a result, after the crop was harvested, nitrogen depletion under the phosphorus treatment was lower than the control plot.

Conclusion

Based on the present findings it is recommended that the application of phosphorus fertilizer @ 40kg per hectare with @ 12.5 kg N per hectare should be applied in moong bean for higher productivity,

Table 5. Influence of different nitrogen and sulphur levels on moong bean crop economics

Treatments	Cost of cultivation (Rs per hectare)	Gross return (straw + grain) (Rs per hectare)	Net return (Gross-cost of cultivation) (Rs per hectare)	B:C ratio
T_1 Sulphur)	32,976.66	61,934	28,957.34	0.87
T_2 (Nitrogen +Sulphur)	33,122.66	67,496	34,373.34	1.03
T_3 (Sulphur)	32,536.704	59,472	26,935.3	0.82
T_4 (Nitrogen + Sulphur)	32,682.70	65,502	32,819.3	1.00
T_5 (Nitrogen)	32,216	64,252	32,036	0.99
T_6 (Nitrogen)	32,362.2	71,484	39,121.8	1.20
T_7 (100% RDF)	32,841	72,764	39,923	1.21
T_8 (Control)	32,070	53,736	21,666	0.67

maximum gross returns, and higher net returns with a higher Benefit-cost ratio. Phosphorus has been found to have positive and significant effects on moong bean yield. Farmers should adopt recommended dose of fertilizer for Moong bean.

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