Original Research Article

Influence of Nitrogen and Sulphur levels on growth and yield of Lentil (*Lens culinaris* M.)

Abstract

The field experiment entitled **''Influence of Nitrogen and Sulphur levels on growth and yield of Lentil (*Lens culinaris* M.)''** conducted during *Rabi* 2021 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.2), low in organic carbon (0.22 %), available N (171.48 kg/ha), available P (12.3 kg/ha) and available K (235.7 kg/ha). The experiment was laid out in Randomized Block Design with nine treatments which are replicated thrice. The treatments *viz;* 1: N-10 kg/ha + S-10 kg/ha, 2: N-10 kg/ha + S-20kg/ha, 3: N-10 kg/ha + S-30 kg/ha , 4: N-20 kg/ha + S-10 kg/ha , 5: N-20 kg/ha+ S-20 kg/ha , 6: N-20 kg/ha + S-30 kg/ha , 7: N-30 kg/ha + S-10 kg/ha , 8: N-30 kg/ha + S- 20 kg/ha ,9: N-30 kg/ha + S-30 kg/ha. Treatments consisted of three levels of Nitrogen (10, 20, 30 kg ha-1) and four levels of Sulphur (10, 20 and 30 kg ha-1). The results obtained that application of Nitrogen 30kg/ha along with Sulphur 30kg/ha recorded significantly higher Plant height (42.68cm), Number of nodules/plant (7.33) Plant dry weight (19.30g/plant), Number of Pods/plant (159.42), Number of Seeds/pod (1.80), Seed yield (1719.3kg/ha) and Stover yield (2814 kg\ha) and Harvest Index (37.92%). Higher Gross returns (87684.30 INR/ha), Net return (59773.60 INR/ha) and Benefit cost ratio (2.14) were obtained in the treatment with application of Nitrogen 30kg/ha along with Sulphur 30kg/ha. Sulphur application up to 30 kg ha-1 increased significantly the uptake of N and K by the crop. Protein content in grain increased significantly with the addition of N (30 kg ha-1) and sulphur (30 kg ha-1). Yield of lentil increased linearly with increasing levels of Sulphur. Therefore, it is concluded that the application of Nitrogen 30kg/ha + Sulphur 30kg/ha was more productive and economically feasible.

Key words: *Nitrogen, Sulphur, Growth, Yield, Economics, Lentil*

INTRODUCTION

"The **lentil** (*Lens culinaris or Lens esculenta*) is an edible legume. It is locally known as Masoor. It is an annual plant known for its lens-shaped seeds. It is about 40 cm (16 in) tall, and the seeds grow in pods, usually with two seeds in each. As a food crop, the majority of world production comes from Canada (33%) and India (25%), producing 58 % combined total of world total. A significant amount of vitamin A and B is also provided by lentil" **(Zafar et al., 2003)**[1]

"Lentil is one of the oldest annual grain legumes consumed and cultivated in the world. Originating from South western Asia as early as 6000 B.C., lentil is rich in proteins and contains high concentrations of essential amino acids like isoleucine and lysine, as well as other nutrients like dietary fiber, folate, vitamin B1, and minerals**.** Lentil is widely consumed in various parts of the world as loaves, soups, pies, curries etc., especially in vegetarian cultures. It is also an important source of dietary protein in the Mediterranean and South Asian regions. Pulses are reported to be second after oil seeds in requirement of sulphur" **(Tandon, 1991)** [2]

The conditions under which lentils are grown differ across different growing regions. In the temperate climates lentils are planted in the winter and spring under low temperatures and vegetative growth occurs in later spring and the summer. Rainfall during this time is not limited. In the subtropics, lentils are planted under relatively high temperatures at the end of the rainy season, and vegetative growth occurs on the residual soil moisture in the summer season. Rainfall during this time is limited. In West Asia and North Africa, some lentils are planted as a winter crop before snowfall. Plant growth occurs during the time of snow melting. Under such cultivation, seed yields are often much higher.

In 2020, global production of lentils was 6.5 million tonnes, led by Canada with 45% and India with 18% of the world total. Saskatchewan is the most productive growing region in Canada, producing 95% of the national total. In India, Madhya Pradesh and Uttar Pradesh are largest producers, both producing more than 70% of the total. Other major producers include West Bengal and Bihar.

Nitrogen is an important element for the growth and development of most plants. Nitrogen is also an integral part of chlorophyll, which is the primary absorber of light energy needed for photosynthesis. The Supply of nitrogen is related to carbohydrate utilization.

"Nitrogen (N) deficiency is frequently a major limiting factor for high yielding crops all over the world" (**Salvagiotti *et al.*, 2008 [3]; Namvar *et al.*, 2011 [4]**). "The most important role of N in the plant is its presence in the structure of protein and nucleic acids which are the most important building and information substances of every cell. In addition, N is also found in chlorophyll that enables the plant to transfer energy from sunlight by photosynthesis. Thus, the supply of N to the plant will influence the amount of protein, amino acids, protoplasm and chlorophyll formed. Consequently, it influences cell size, leaf area and photosynthetic activity" (**Caliskan *et.al.*, 2008 [5]**). Therefore, adequate supply of N is necessary to achieve high yield potential in crops. In general, N deficiency causes a reduction in growth rate, general chlorosis, often accompanied by early senescence of older leaves, and reduced yield

Sulphur is an important secondary plant nutrient, playing a vital role in various physiological processes in the plant including the formation of amino acid (methionine, cystein, and cystyne), synthesis of proteins and chlorophyll. It activates enzymes and involves in the metabolic activities of vitamins (biotin and thiamine) and part of co-enzyme A and pyrophosphate. Sulphur deficiency can be responsible for poor flowering, fruiting and stunted growth. Pulses are reported to be second after oil seeds in requirement of sulphur. Cultivation of high yielding varieties under the intensive cropping system and use of sulphur free fertilizers resulted into increasing deficiency of sulphur. As lentil crop is grown with poor irrigation assurance, it may need sulphur application to increase the water use efficiency also. **Aditya Delu (2021)[6]**

MATERIALS AND METHODS

This experiment was conducted during *Kharif* 2021 at Crop Research Farm, Department of Agronomy, NAI, SHUATS, Prayagraj, (U.P.) which is located at 25.28^{o}N latitude, 81.54^{o}E longitude and 98 m altitude above the mean sea level. This area is situated on the right side of the river Yamuna by the side of Prayagraj, Rewa road, about 5 km away from Prayagraj city. The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.8), low in organic carbon (0.112 %), available N (278.93 kg/ha), available P (10.8 kg/ha) and available K (206.8 kg/ha). The experiment was laid out in Randomized Block Design, with nine treatments consists of *viz.*, 1: N-10 kg/ha + S-10 kg/ha, 2: N-10 kg/ha + S-20kg/ha, 3: N-10 kg/ha + S-30 kg/ha , 4: N-20 kg/ha + S-10 kg/ha , 5: N-20 kg/ha+ S-20 kg/ha , 6: N-20 kg/ha + S-30 kg/ha , 7: N-30 kg/ha + S-10 kg/ha , 8: N-30 kg/ha + S- 20 kg/ha ,9: N-30 kg/ha + S-30 kg/ha and were replicated thrice. Lentil variety Krish-KLS-09-03 was taken as test crop. The crop matures in about 105-110 days. The yield potential of the crop is 18-20 q/ha. The main field was prepared by ploughing with the help of cultivator. Sowing should be done in rows 30 cm apart and it should be sown at a lower depth (3 - 4 cm).All the nutrients such as (N, P_2O_5, K_2O) were applied to the soil in form of urea, SSP and MOP respectively. The 100 % recommended dose of fertilizer is 20:40:40 NPK (kg/ha). The growth parameters were recorded at periodical intervals of 20,40,60,80,100 DAT and at harvest stage from the randomly selected five plants in each treatment. Statistically analysis was done and mean compared at 5% probability level of significant results.

RESULTS AND DISCUSSION

Influence of Nitrogen and Sulphur levels on growth attributes of Lentil

Influence of Nitrogen and Sulphur levels on growth attributes of Lentil are presented in table 1. The results obtained that maximum Plant height (42.68 cm), Number of nodules/plant (7.33), Dry weight (19.30 g/plant) were recorded with the application of Nitrogen 30kg/ha along with Sulphur 30kg/ha. However the treatment combination of Nitrogen 30 kg/ha+ Sulphur 20 kg/ha is statistically at par in plant height (42.56), Number of nodules/plant (7.00), Dry weight (18.92) with Nitrogen 30kg/ha along with Sulphur 30kg/ha. Maximum plant height might be due to the application of nitrogen which shows significant effect on height and growth of the plants and enlargement of the tissues. Increased availability of sulphur to plants helps in better development and thickening of xylem and collenchyma tissue which resulted in increased plant height. Application of sufficient amount NPK

to the plant provides sufficient nutrition for nodule activation and growth. Application of sulphur significantly increased the uptake of P by lentil crop. The nitrogen uptake by grain and straw increased significantly with increased levels of S upto 1719 kg/ha and 2814 kg/ha respectively. Even if there was no consistent increase, the increase of number of root nodules with proper nutrition of plants with Sulphur increases the amount of glucose flowering to the roots and ATP biosynthesis. These are in conformity with the present findings of **B.K. Patel *et al.*, (2020)** [7] **.**The maximum dry matter accumulation depends upon the photosynthesis and respiration rate, which finally increases the plant growth with respect to increased plant height, number of nodules etc.

Influence of Nitrogen and Sulphur levels on yield attributes of Lentil

Influence of nitrogen and sulphur levels on yield attributes of lentil are given in the table no.2. The results obtained that maximum Number of Pods/plant (159.42), Number of Seeds/pod (1.80), Seed yield (1719.3kg/ha) and Stover yield (2814 kg\ha) and Harvest Index (37.92%) were recorded with the application of Nitrogen 30kg/ha along with Sulphur 30kg/ha. However the treatment combination of Nitrogen 30 kg/ha+ Sulphur 20 kg/ha is statistically at par in Number of Pods/plant (158.66), Number of Seeds/pod (1.76), Seed yield (1674.11 kg/ha) and Stover yield (2804 kg\ha) and with the treatment combination of Nitrogen 30kg/ha along with Sulphur 30kg/ha. However, highest harvest index (37.92%) was noticed in N at 30 kg/ha + S at 30 kg/ha. Similar findings were also considered from **Sanjeev Kumar Chaubey et al. (2019)** [8].Maximum Test weight is recorded with the treatment combination of Nitrogen 30 kg/ha+ Sulphur 20 kg/ha and the minimum test weight is observed with the application of Nitrogen 30kg/ha along with Sulphur 30kg/ha. Improved availability of sulphur and favourable nutritional environment might have helped the plants at the peak growth period and flowering stages which ultimately increased the number of pods per plant, number of seeds per pod and test weight. Improved growth characters might have also resulted into the improved source sink relationship and sink size. Application of nitrogen can significantly increase the number of pods per plant by influencing the soil chemical characteristics and nutrient absorption from the soil. **M. Moniruzzaman *et al.*, (2020)** [9]**.** Seed yield can be increased by increasing the levels of nitrogen which in turn shows effect on vegetative and yield parameters. This increase in S uptake might be attributed to increased content of S and grain and straw yield of lentil with sulphur application. The result of the present investigation is in corroboration with those of **Deo and Khaldelwal (2009)**[10]**.**There was an overall increase in plant

growth characters viz. plant height and dry matter accumulation which might have increased the stover yield. The increased yield of lentil due to sulphur application at increasing levels have also been reported by **Teja *et al.*, (2021) [11].**

Economics

Influence of Nitrogen and Sulphur levels on Economics of Lentil is given in table 3

Significantly higher gross return (87684.30 INR/ha) was recorded with treatment combination of Nitrogen 30 kg/ha+ Sulphur 30 kg/ha. Similarly higher net returns (59773.60 INR/ha) and B:C ratio (2.14) was recorded under treatment combination of Nitrogen 30 kg/ha+ Sulphur 30 kg/ha

Conclusion

It is concluded that for obtaining highest yield in lentil during *Rabi* season, application of Nitrogen 30 kg/ha along with Sulphur 30g Kg/ha recorded maximum plant height, number of nodules, dry weight, number of pods per plant, number of seeds per pod, seed yield, stover yield and Harvest index and is economically viable. Maximum Gross return, Net return and Benefit cost ratio were also recorded with the treatment combination of Nitrogen 30 kg/ha along with Sulphur 30g Kg/ha.

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Table no. 1 Influence of Nitrogen and Sulphur levels on growth attributes of Lentil

S.No.	Treatments	AT HARVEST			AT 100 DAS - AT HARVEST	
		Plant height(cm)	Number of nodules/plant	Dry weight (kg/plant)	Crop growth rate (g/m2/day)	Relative growth rate (g/g/day)
1	Nitrogen 10 kg/ha+ Sulphur 10 kg/ha	38.16	4.33	15.48	5.05	0.0113
2	Nitrogen 10 kg/ha+ Sulphur 20 kg/ha	38.52	4.33	15.51	3.03	0.006
3	Nitrogen 10 kg/ha+ Sulphur 30 kg/ha	38.84	4.66	15.64	2.61	0.005
4	Nitrogen 20 kg/ha+ Sulphur 10 kg/ha	40.2	5.00	15.87	1.67	0.0032
5	Nitrogen 20 kg/ha+ Sulphur 20 kg/ha	40.62	5.33	16.37	2.19	0.0042
6	Nitrogen 20 kg/ha+ Sulphur 30 kg/ha	40.86	6.00	17.39	3.52	0.0065
7	Nitrogen 30 kg/ha+ Sulphur 10 kg/ha	42.4	6.33	18.67	3.51	0.006
8	Nitrogen 30 kg/ha+ Sulphur 20 kg/ha	42.56	7.00	18.92	3.64	0.0061
9	Nitrogen 30 kg/ha+ Sulphur 30 kg/ha	42.68	7.33	19.3	4.19	0.007
	F test	S	S	S	S	NS
	SEm (±)	0.02	0.31	0.17	0.46	0.001
	CD (0.05%)	0.1	0.93	0.5	1.37	-

Table no. 2 Influence of Nitrogen and Sulphur levels on Yield attributes of Lentil

S. No	Treatments	No. pods/ plant	No. seeds/ pod	Test weight (g)	Seed Yield (Kg/ha)	Stover Yield (Kg/ha)	Harvest Index (%)
1.	Nitrogen 10 kg/ha+ Sulphur 10 kg/ha	147.48	1.34	19.04	1154.23	2563	31.05
2.	Nitrogen 10 kg/ha+ Sulphur 20 kg/ha	148.52	1.37	19.06	1192.73	2582	31.59
3.	Nitrogen 10 kg/ha+ Sulphur 30 kg/ha	149.84	1.40	19.12	1236.84	2612	32.13
4.	Nitrogen 20 kg/ha+ Sulphur10 kg/ha	151.36	1.54	19.02	1377.82	2648	34.22
5.	Nitrogen 20 kg/ha+ Sulphur 20 kg/ha	153.12	1.56	19.03	1415.21	2686	34.50
6.	Nitrogen 20 kg/ha+ Sulphur 30 kg/ha	154.44	1.62	19.04	1487.89	2724	35.32
7.	Nitrogen 30 kg/ha+ Sulphur10 kg/ha	157.62	1.72	19.04	1620.62	2783	36.80
8.	Nitrogen 30 kg/ha+ Sulphur 20 kg/ha	158.66	1.76	19.06	1674.11	2804	37.38
9.	Nitrogen 30 kg/ha+ Sulphur 30 kg/ha	159.42	1.80	19.02	1719.30	2814	37.92
	F test	S	S	NS	S	S	S
	SEm (±)	0.57	0.02	0.03	23.82	3.49	0.16
	CD (5%)	1.70	0.07	-	71.41	10.46	0.49

Table no. 3 Influence of Nitrogen and Sulphur levels on Economics of Lentil

S. No	Treatments	Cost of cultivation (INR/ha)	Gross return (lNR/ha)	Net return (lNR/ha)	B:C ratio
1.	Nitrogen 10 kg/ha+ Sulphur 10 kg/ha	26210.20	58865.73	32655.53	1.24
2.	Nitrogen 10 kg/ha+ Sulphur 20 kg/ha	26843.05	60829.23	34346.18	1.30
3.	Nitrogen 10 kg/ha+ Sulphur 30 kg/ha	27475.90	63078.84	35602.94	1.29
4.	Nitrogen 20 kg/ha+ Sulphur10 kg/ha	26427.60	70268.82	43841.22	1.65
5.	Nitrogen 20 kg/ha+ Sulphur 20 kg/ha	27060.45	72175.71	45115.26	1.70
6.	Nitrogen 20 kg/ha+ Sulphur 30 kg/ha	27693.30	75882.39	48189.09	1.74
7.	Nitrogen 30 kg/ha+ Sulphur10 kg/ha	26645.00	82651.62	56006.62	2.10
8.	Nitrogen 30 kg/ha+ Sulphur 20 kg/ha	27277.85	85379.61	58101.76	2.12
9.	Nitrogen 30 kg/ha+ Sulphur 30 kg/ha	27910.70	87684.30	59773.60	2.14

Fig no. 1 Effect of Nitrogen and Sulphur on Plant height of lentil at different day interval

Fig no. 2 Effect of Nitrogen and Sulphur on Number of nodules of lentil at different day intervals