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Response of different phosphorus, sulphur and zinc levels on yield and economics of lentil cultivation in sub-humid region of Rajasthan

***SUNDAR ANCHRA, M.K. KAUSHIK, J. CHOUDHARY, B. UPADHYAY, R.H. MEENA, VINOD SAHARAN, RAGHUVIR SINGH MEENA AND SUMAN DHAYAL**

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

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ABSTRACT

The experiment was conducted during rabi season of 2020-21 and 2021-22 at the Rajasthan College of Agriculture, MPUAT, Udaipur (Rajasthan). The experiment consisted of 18 treatments comprising different levels of phosphorus (three- 30,40 and 50 kg P_2O_5 ha^{-1}), sulphur (three- 15, 20 and 25 kg S ha^{-1}) and zinc (two- control and 0.5 % $ZnSO_4$). The experiment was laid out in factorial randomized block design (FRBD) and replicated thrice. The results revealed that application of 50 kg P_2O_5 ha^{-1} recorded significantly higher biological yield, seed and haulm yield, net returns and benefit cost ratio. Among sulphur levels seed and haulm yield, biological yield, net returns and benefit cost ratio were higher under application of 25 kg S ha^{-1} and same results were found with foliar spray of 0.5 % $ZnSO_4$ at 55 days after sowing. Thus, it can be concluded that application of 50 kg P_2O_5 ha^{-1} with 25 kg S ha^{-1} and 0.5 % $ZnSO_4$ foliar spray at 55 DAS in lentil is productive as well as profitable.

Keywords: Biological yield, haulm yield, returns and benefit cost ratio

INTRODUCTION

For India's largely vegetarian population, pulses are a significant group of crops that offer high-quality protein. As they work well in crop rotation and mixed or intercropping systems used in many agro-ecological zones, pulses are an essential part of a cropping system in India. Despite being the world's largest producer and consumer of pulses, India's production is quite poor on average (Chaubey *et. al.,* 2019). As a result, our nation has to enhance its output of pulses. One of India's most significant pulse crops, lentils are adaptable to a variety of soil types and climatic conditions. After Canada, India is the second-largest producer of lentils in the world. Lentils are India's fifth-largest pulse crop, after chickpea, pigeon pea, mungbean, and urdbean (Singh *et. al.,*2015). Pulse crops span 28.34 million hectares and produce 817 kg ha^{-1}, with a combined production of 23.2 million tonnes (Anonymous, 2020). With 18.00 lakh ha and 11.00 lakh tonnes of production, respectively, India ranked first in both categories, accounting for 39% and 22% of the global totals (Government of India, 2019-20). Since lentil is a leguminous pulse crop, Rhizobium bacteria use root nodules to fix atmospheric nitrogen, which is then converted into a form that plants can use in the presence of the nitrogenase enzyme. Lentil cultivation on marginal and sub-marginal terrain, improper and uneven fertilizer use, and a lack of site-tested specialized lentil varieties are all potential causes of these reduced yields. The majority of soils used for growing lentils have low to medium levels of accessible phosphorus (P), therefore they benefit from the use of P fertilizer (Singh and Sharma, 2005). The adoption of suitable agrotechniques can increase lentil productivity. Growing an appropriate variety that is well suited to the local climate and applying enough phosphorus will improve crop performance, seed output, and lentil quality, among other agro-techniques. The soil fertility is deteriorating and lentil yield is declining to a greater extent as a result of heavy crop pressure, the use of unbalanced chemical fertilizers without soil testing, extensive use of diammonium phosphate (DAP) lacking sulphur and micronutrients like zinc fertilizers. Additionally, the limited use of a single superphosphate exacerbated soil sulphur deficit. P applied is largely fixed in the soil. Thus, P and S deficiency, which is typical in most soils, has been primarily blamed for the fall in lentil output (Rajput & Mandloi, 2009 and Goswami & Singh, 2016). The situation gets even more pitiful when farmers seek to produce high-yielding lentil varieties for better harvest and net income. In order to increase crop yields, P and S with zinc

**Corresponding author: sundaranchra@gmail.com*

fertilization has also been found to be effective. There is a shortage of information regarding balanced nutrition and how to increase lentil yield. Consequently, the current experiment was started.

MATERIAL AND METHODS

At the Instructional Farm (Agronomy), Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology (MPUAT), Udaipur (Rajasthan), which is located at 24^{o}35'N latitude, 74^{o}42'E longitude and at an altitude of 581.13 metres above mean sea level, the experiment was carried out during the *rabi* season for two consecutive years, 2021-21 and 2021-22. Agroclimatic zone IVa (Sub-humid Southern Plain and Aravali Hills) of Rajasthan applies to this area. Three replications of a factorial randomized block design were used to set up the experiment. Three factors made up the treatments: phosphorus levels (i) 30 (ii) 40 and (iii) 50 kg P_2O_5 ha^{-1}; sulphur levels (i) 15 (ii) 20 and (iii) 25 kg S ha^{-1}; zinc fertilization (i) control and (ii) 0.5% ZnSO4.The analysis of the data reveals that during the year 2020–21, the maximum and minimum weekly mean temperatures during the crop period varied from 24.50°C to 33.70°C and 6.90°C to 16.30°C, respectively. The similar changes for the experiment's second year (2021–2022) were 23.80–31.40°C and 3.3–12.4°C. After that, there was a sharp increase in the average maximum and minimum temperature from the middle of February until the end of the crop season. In the years 2020–21 and 2021–22, respectively, the mean weekly relative humidity ranged from 56.6 to 94.00 % and 65.7 to 94.2 %.In 2020–2021 and 2021–2022, respectively, 972.6 and 822.2 mm of rainfall in total. Over the course of the two investigation years, there was more rain than usual. The number of hours with bright sunshine ranged from 0.7 to 8.1 in 2020-21 and from 0.8 to 9.2 in 2021-22. The soil at the test site had a clay loam texture and reacted somewhat alkaline (pH 7.9 and 8.3). The soil had low levels of available nitrogen (286.1 and 289.3 kg ha^{-1}), medium levels of available phosphorus (18.3 and 21.2 kg ha^{-1}), but high levels of available potassium (335.6 and 349.6 kg ha^{-1}), low levels of sulphur (10.18 and 10.57 mg kg^{-1}) and high levels of available zinc (1.86 and 1.94 ppm) during both of the investigational years, which were 2020–21 and 2021–22. Gypsum and phosphorus were administered in full doses at sowing beneath the seed in furrows. At 55 DAS, zinc was administered as a foliar spray using zinc sulphate.Sowing of Kota masoor-2 variety of lentil was done in 30 cm apart lines. Other agronomics practices were followed for this region. Seed and biological yield were recorded under each plot. Haulm yield of lentil was obtained by subtracting the seed yield from biological yield. Later the yield recorded under each plot was converted into kg ha^{-1}. For economics, total expenses subtracted from the respective gross income and net return was worked out. Benefit cost ratio was calculated for each treatment by dividing net return with cost. The two years' worth of field data were combined, and the F-test was used for statistical analysis. On the basis of the t-test, the significance of the treatment differences was tested. Critical differences at 5% levels of probability were compared to the significant difference between treatment means.

RESULTS AND DISCUSSION

Effect on Yield

Phosphorus level

Data on yield under the influence of different levels of phosphorus presented in table 1 and Fig 1 reveals that seed, haulm and biological yields varied significantly. Significantly higher seed, haulm yields and biological yield were recorded with the application of 40 kg P_2O_5 ha^{-1} (1755, 3797 and 5552 kg ha^{-1}) and was found being at par with 50 kg P_2O_5 ha^{-1}. The magnitude of increases in seed, haulm and biological yields due to 40 kg P_2O_5 ha^{-1} were to the tune of 9.34, 12.90 and 11.75 per cent, respectively as compared to 30 kg P_2O_5 ha^{-1}. The similar findings were recorded by Chaubey *et. al.,* 2019 and Goswami & Singh, 2016.

Sulphur level

Data presented in Table 1 and Fig. 1 indicates the variable trend in seed and haulm yield of lentil with increasing level of sulphur application. Seed yield (1790 kg ha^{-1}), haulm yield (3795 kg ha^{-1}) and biological yield (5585 kg ha^{-1}) increased significantly with increasing level of sulphur. Maximum yields were recorded with 25 kg S ha^{-1}, seed yield found significant with 20 kg S ha^{-1} and haulm and biological yield found at par with 20 kg S ha^{-1}. The magnitude of increases in seed, haulm and biological yield due to 25 kg S ha^{-1} were 9.48, 10.64 and 10.24 per cent as compared to 15 kg S ha^{-1} treatment. Choubey et al 2013, Goswami & Singh, 2016 and Rajput & Mandloi, 2009 were reported same results.

Table 1: Effect of phosphorus, sulphur and zinc levels on seed, haulm and biological yields of lentil

Treatments	Seed yield (kg ha^{-1})			Haulm yield (kg ha^{-1})			Biological yield (kg ha^{-1})		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
Phosphorus level (kg ha^{-1})									
30	1604	1606	1605	3352	3374	3363	4956	4980	4968
40	1731	1779	1755	3752	3813	3797	5511	5592	5552
50	1789	1790	1790	3835	3853	3827	5591	5643	5617
S.Em ±	24	27	18	55	62	41	61	67	46
CD (P=0.05)	69	78	51	159	179	115	177	194	129
Sulphur level (kg ha^{-1})									
15	1623	1648	1635	3439	3422	3430	5062	5070	5066
20	1714	1736	1725	3739	3783	3761	5453	5519	5486
25	1788	1792	1790	3756	3835	3795	5543	5627	5585
S.Em ±	24	27	18	52	62	41	61	67	46
CD (P=0.05)	69	78	51	149	179	115	177	194	129
Zinc level									
Control	1666	1689	1677	3510	3556	3533	5176	5245	5211
0.5 % $ZnSO_4$	1750	1762	1756	3779	3804	3791	5529	5566	5547
S.Em ±	20	22	15	42	51	33	50	55	37
CD (P=0.05)	56	64	42	122	147	94	144	158	105

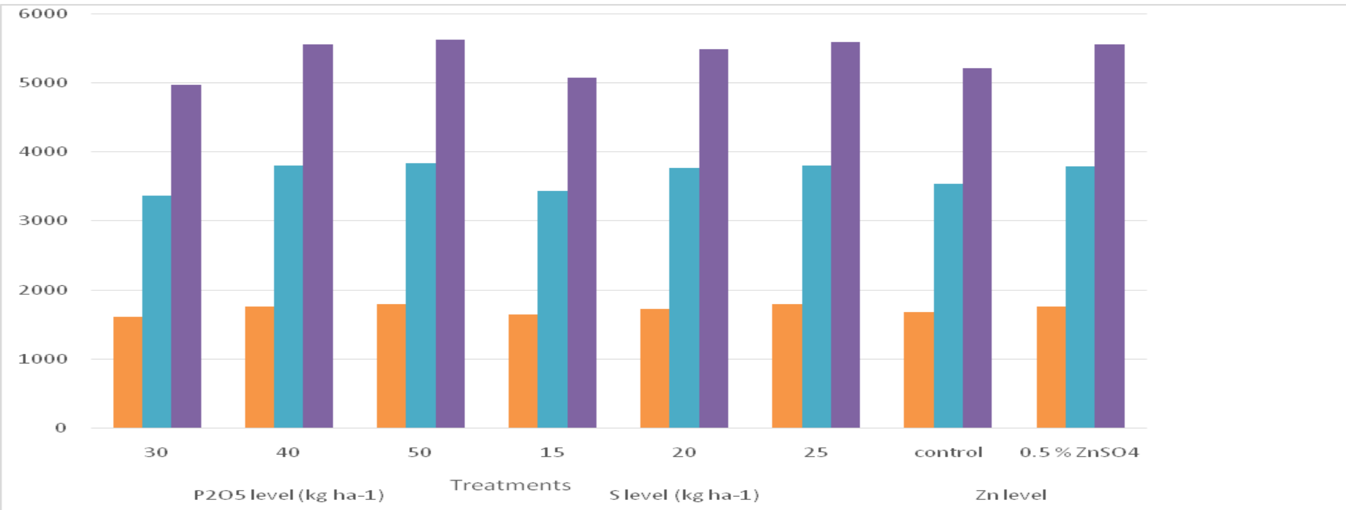

Fig 1: Effect of phosphorus, sulphur and zinc levels on seed, haulm and biological yields of lentil

Zinc level

Lentil seed and haulm production are significantly affected by zinc application. With 0.5% $ZnSO_4$ as foliar spray, the highest recorded seed yield (1756 kg ha^{-1}), haulm yield (3804 kg ha^{-1}), and biological yield (5547 kg ha^{-1}) were all significantly greater than the control. In comparison to the control treatment, 0.5% ZnSO4 applied as foliar spray increased seed, haulm and biological yield by 4.71, 7.30, and 6.44 per cent, respectively. Similar results were noted by Anant *et. al.,* 2021, Goswami & Singh, 2016 and Singh & Sharma, 2005.

Table 2: Effect of phosphorus, sulphur and zinc levels on net return and B-C ratio of lentil

Treatments	Net return (₹ ha^{-1})			B-C ratio		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
Phosphorus level (kg ha^{-1})						
30	73213	76888	75051	1.97	1.96	1.96
40	82183	89439	85811	2.27	2.24	2.25
50	83813	89527	86670	2.28	2.28	2.28
S.Em ±	1601	1578	1124	0.042	0.042	0.030
CD (P=0.05)	4601	4537	3172	0.120	0.121	0.084
Sulphur level (kg ha^{-1})						
15	73580	78848	76214	2.00	1.99	1.99
20	81158	86543	83850	2.25	2.23	2.24
25	84471	90462	87467	2.27	2.26	2.27
S.Em ±	1601	1579	1124	0.042	0.042	0.030
CD (P=0.05)	4601	4537	3172	0.120	0.121	0.084
Zinc level						
Control	76247	82224	79236	2.07	2.06	2.07
0.5 % $ZnSO_4$	83226	88345	85785	2.28	2.26	2.27
S.Em ±	1307	1289	918	0.034	0.035	0.024
CD (P=0.05)	3757	3704	2590	0.098	0.099	0.068

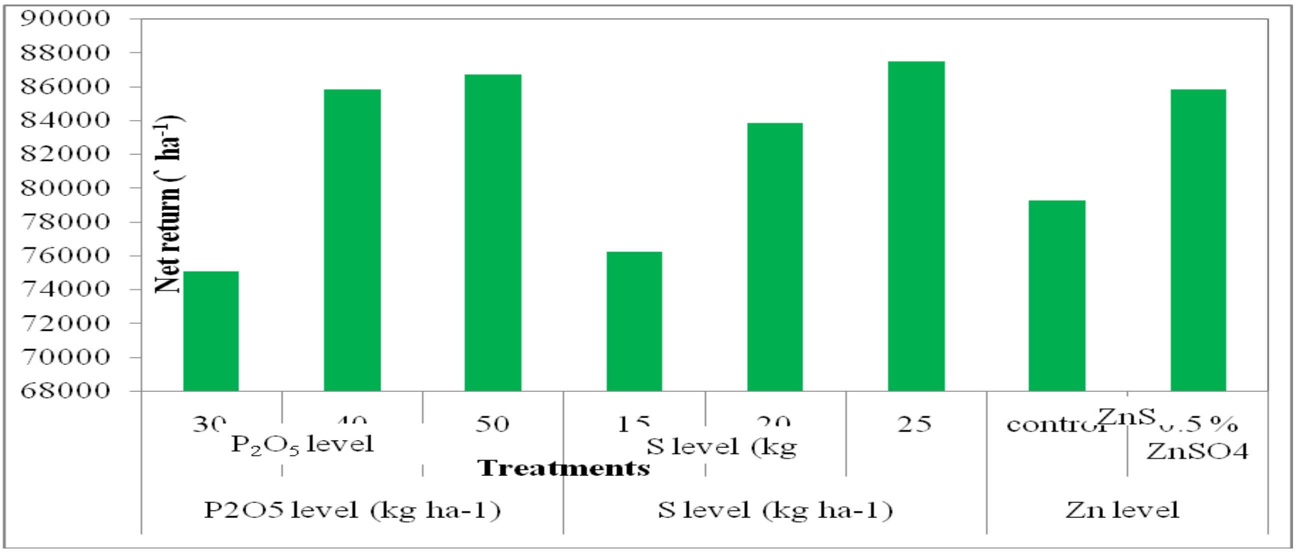

Fig 2: Effect of phosphorus, sulphur and zinc levels on net return of lentil

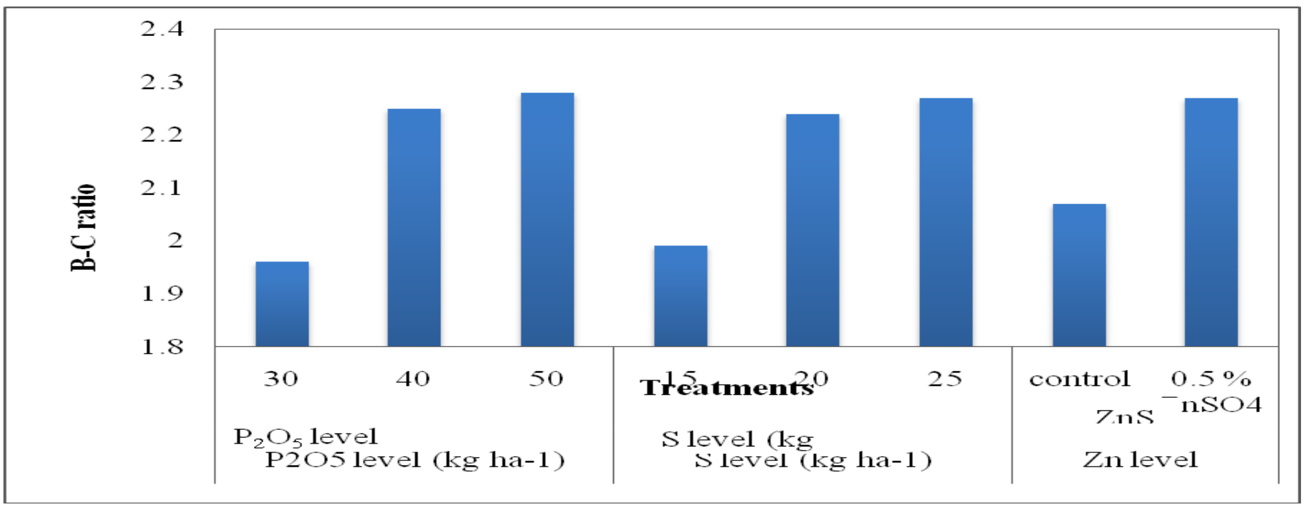

Fig 3: Effect of phosphorus, sulphur and zinc levels on B-C ratio of lentil

Effect on Economics

Phosphorus level

A perusal of data presented in Table 2 and Fig 2 & 3 shows that the net return as well as benefit cost ratio increased with increasing level of phosphorus. In comparison to the application of 30 kg P_2O_5 ha^{-1}, 40 kg P_2O_5 ha^{-1} significantly increased net returns and benefit cost ratio over both the years and on pooled data basis and was found at par with 50 kg P_2O_5 ha^{-1}. The increase in net returns and B:C ratio owing to the adoption of 40 kg P_2O_5 ha^{-1} over 30 kg P_2O_5 ha^{-1} was 10,760₹ha^{-1} and B:C 0.29, respectively reflecting increases of 14.34 and 14.79 per cent, according to data compiled over two years. Similar results were noted by Anant *et. al.,*2021 and Choubey*et. al.,* 2013.

Sulphur level

Among sulphur levels application of 25 kg S ha^{-1} had a substantial impact on net returns and B:C. In both the years and on pooled analysis basis, the application of 25 kg S ha^{-1} produced considerably higher net return (87467₹ha^{-1}) and B:C (2.27) than the application of 15 kg S ha^{-1}. Data compiled over two years show that application of 25 kg S ha^{-1} greatly outperformed to 15 kg S ha^{-1}, with increment in net returns of 11253 ₹ha^{-1} and B:C of 0.28 compared to 15 kg S ha^{-1} by14.76 and 14.07 per cent, respectively. The results reported by Choubey*et. al.,*2013 and Delu & Brar, 2021 were comparable.

Zinc level

In comparison to control, application of zinc as 0.5 % $ZnSO_4$, as foliar spray resulted in considerably greater net returns and B:C from the crop over the course of both the years and on pooled analysis of data. Data gathered over two years reveal that Z_1 considerably boosted net returns and B:C by 8.27 and 9.66 per cent, respectively, when compared to control level. Anant *et. al.,* 2021 and Goswami & Singh, 2016 were reported same results.

CONCLUSION

From the above findings, it can be concluded that combined application phosphorus, sulphur and zinc as foliar spray give better results. Thus, it can be inferred from the study that the combined application of 50 kg P_2O_5 ha^{-1} and 25 kg S ha^{-1} along with 0.5 % $ZnSO_4$ as foliar spray may be an optimum dose to get higher yield and benefit from lentil crop under prevailing agro climatic conditions of zone IVa (Sub-Humid Southern Plain and Aravali Hills) of Rajasthan.

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REFERENCES

Anant, S., Chandrakar, D.K. and Das, D. 2021. Effect of phosphate and zinc solubilizing microbes on growth, yield and economics of fieldpea (*Pisum sativum* L.) under conditions of chhattisgarh. *International Journal of Current Microbiology and Applied Sciences*. **10**(3): 635-642.

Anonymous, 2020. Agricultural Statistics at a Glance, Government of India, Ministry of Agriculture Cooperation and Farmers Welfare, Director of Economics and Statistics.

Chaubey, S.K., Chaubey, S., Dwivedi, D.P., Singh, A.K. and Singh, U.P. 2019. Production and productivity of lentil (*Lens culinaris* M.) as influenced by various levels of phosphorus and sulphur. *Agriways*. **7**(1): 29-32.

Choubey, S.K., Dwivedi, V.P. and Srivastava, N.K. 2013. Effect of different levels of phosphorus and sulphur on growth, yield and quality of lentil (*Lens culinaris* M). *Indian Journal Scientific Research and Technology.* **4**(2): 149-150.

Delu, A. and Brar, B.S. 2021.Effect of different level of sulphur on growth and yield of lentil crop: A review. *International Journal of Chemical Studies*. **9**(1): 193-197.

Goswami,P. and Singh, R.S. 2016. Effect of P, S, Zn and Bio-Inocualnts on growth and yield of summer mungbean (*Vigna radiate* L.). *An International quarterly Journal of life science*. **11**(3): 1775-1780.

Government of India 2019-20. Area, production and productivity of masoor (Lentil) in India 1970-71 to 2019-20. Ministry of Agriculture and Farmers Welfare.

Rajput, R.L. and Mandloi, B.S.G.S. 2009. Effect of sulphur levels and sources on productivity of linseed (*Linum usitatissimum*). *Bhartiya Krishi Anusandhan Patrika.***25**: 2-4.

Singh, V. and Sharma, S.K. 2005. Response of mothbean (*Vigna acconitifolia*) to zinc and thiourea under dryland condition. *Annals of Agricultural Research.* **26**(2): 313-314.

Singh, A.K., Singh, S.S., Prakash, V., Kumar, S. and Dwivedi, S.K. 2015. Pulses Production in India: Present Status, Bottleneck and Way Forward. *Journal of Agricultural Research.* **2**(2): 75-83.