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Response to foliar application of different nutrient on lentil (*Lens culinaris* Medik.) as relay crop under rice assessed in terms of performance of yield and economics in the Eastern Region of India

***A. HOQUE, [1]H. SINGH, [2]R. K. SRIVASTAVA AND [3]A. BARMAN**

Department of Agronomy, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar, 848125 (India); [1]Department of Agronomy, Dr. Rajendra Prasad Central Agricultural University, TCA Campus, Dholi, Muzaffarpur, 843121, Bihar (India); [2]Directorate of Seed and Farms, RPCAU, Pusa, Samastipur; [3]Division of Agronomy, ICAR-Indian Agricultural Research Institute, New Delhi, 110012

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ABSTRACT

A field trial was conducted during 2020-21 in rabi season at the Research Farm of Tirhut College of Agriculture, Dholi, Bihar to compare the performance of the foliar application of nutrients on lentil (Lens culinaris Medik.) as relay crop in rice. An experiment was laid out in a Randomized Block Design with three replications having ten treatments. Two foliar applications of 0.5% NPK @ 19-19-19 + 0.5% $ZnSO_4$ at pre-flowering and pod initiation stages produced significantly higher yield attributes like pods plant^{-1}, 100 seed weight and finally grain yield followed by 2% DAP + 0.5% $ZnSO_4$. The former treatment was also found best in terms of Gross Return (₹ 75327 ha^{-1}), Net Returns (₹ 46361 ha^{-1}), and Benefit: Cost Ratio (1.60) over rest treatments. Conclusively, lentil should be grown by two foliar sprays of 0.5% NPK @19-19-19 + 0.5% Zinc Sulphate along with 100% of the Recommended doses fertilizer to enhance its productivity and profitability.

***Keywords*:** Economics, foliar application, lentil, NPK, yield attribute and yield, $ZnSO_4$

In terms of both area and production, lentil (*Lens culinaris* Medik.) is India's most important pulse crop. It is cultivated mainly during the *rabi* season. It is grown for different uses such as pulse or grain legume, forage and green manure etc. There are so many reasons behind the lower productivity of lentil viz., poor soil conditions, lack of agronomic management practices particularly essential nutrient, deficit of irrigation facilities and heavy flower drop etc. It can be cultivated as a mixed or single crop and relay crop as well. But it is grown as a paira crop in some parts of the state under residual soil moisture conditions on marginal lands, it is typically produced as a rainfed crop. In West Bengal, relay cropping is known as Utera crop and Paira cropping in Chhattisgarh and Bihar. Lentil seed is usually sown (as a relay crop) in the standing rice crop but 15-20 days before harvesting of the previous crop. By planting the succeeding crop as a relay crop in a standing paddy crop, the area of lentil can be enlarged, permitting the preceding crop's fertilizer and moisture to be used more efficiently and effectively in the succeeding crop. On the other hand, foliar administration of plant nutrients is the easiest way to boost crop growth and thereby final yield (Kuttimani, 2012). Salient objectives of foliar nutrient application with desired nutrients at appropriate time and doses may be instrumental in enhancing the nutrients use efficiency and minimize the soil pollution by reducing fertilizer application to the soil (Abou El-Nour, 2002). Foliar spray ensures the availability of water and nutrients to the active food synthesis site with minimum wastage and quickly supplies the food which leads to the regulation of plants source-sink relationships under adverse or stress conditions (Premaradhya *et al*., 2018). The use of microelement in the form of a foliar application is more advantageous than soil application. Hence, the purpose of this field experiment was to determine the best option from various foliar applications of nutrients, either singly or in combination, in various treatments by evaluating them in terms of agronomical production parameters such as yield attribute, yield, and economics of lentil as a relay crop in rice-lentil cropping system.

The field experiment was carried out in *rabi* season of 2020-21 at the Research Farm of Tirhut College of Agriculture, Dholi, Muzaffarpur, Bihar. Geographically, the aforesaid farm is located on the southern bank of the Burhi Gandak river with of 52.18 meters altitude above MSL and it lies between 25^{0}39′ N latitude and 85^{0}57′ E longitude. The soils of the Burhi Gandak region are saline calcareous in nature having very poor fertility. Composite soil samples collected from the experimental fields and thereafter it was analyzed as per standard

Short Communication

Email: akramul199731@gmail.com

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procedures and thus categorized under sandy loam. On the basis of soil analysis, it was low in organic carbon (0.40%), available nitrogen (189.4 kg ha^{-1}), available P_2O_5 (19.63 kg ha^{-1}) and K_2O (122.48 kg ha^{-1}), whereas pH was strongly alkaline with reading 8.3 and EC in normal range with observation of 0.39 ds m^{-1} (Muhr *et al*., 1963). The current study was done under a Randomized Block Design (RBD) layout with ten treatments and three replications. The treatments involved (1) Water Spray, (2) 2% Urea, (3) 2% DAP, (4) 0.5% KNO_3, (5) 0.5% NPK @ 19-19-19, (6) 0.5% $ZnSO_4$, (7) 2% Urea + 0.5% $ZnSO_4$, (8) 2% DAP + 0.5% $ZnSO_4$, (9) 0.5% KNO_3 + 0.5% $ZnSO_4$ and (10) 0.5% NPK @ 19-19-19 + 0.5% $ZnSO_4$. In all the aforesaid treatments, nutrients were applied invariably at two growth stages as a foliar application, *i.e*., first at pre flowering stage and second at pod initiation stage. Weeds were controlled by hand weeding at two separate periods, 30 DAS and 60 DAS, in order to keep the experimental field clean and weed-free.

$$B : C \text{ ration} = \frac{\text{Net return (₹/ha)}}{\text{Cost of cultivation (₹/ha)}}$$

Yield attributes

Treatment comprised two foliar sprays of 0.5% NPK @ 19-19-19 + 0.5% $ZnSO_4$ sprayed at pre-flowering and pod initiation stages though statistically at par with two foliar sprays of 2% DAP + 0.5% $ZnSO_4$ sprayed at pre-flowering and pod initiation stages, but former produced significantly higher no. of pods $plant^{-1}$ (149) and 100 seed weight (g) than rest of the treatments. On the other hand, minimum values of aforesaid yield attributes were associated with water spray (Table 1). It might have been possible due to enhance availability of nutrients by foliar spraying to the lentil crop, which led to increased number of pods $plant^{-1}$ markedly. Venkatesh and Basu (2011) reported similar results but for the chickpea in respect to number of pods. Another reason might have been because of the optimum plant nutrient availability in balance manner, which caused plant produced more pods $plant^{-1}$ as a result of the phosphorus treatment, as compared to the other treatments, and phosphorus also considerably increased plant reproductive capacity, *i.e*., blooming. Zinc might have been used largely in the creation of Auxin, which aided

Table 1: Effect of foliar application of nutrients on yield attribute and yield of lentil crop

Treatments	No. of pods $plant^{-1}$	100-seed weight (g)	Seed Yield (kg ha^{-1})
T_1: Water Spray	83	2.03	976
T_2: 2% Urea	105	2.09	1065
T_3: 2% DAP	113	2.09	1215
T_4: 0.5% KNO_3	102	2.08	1057
T_5: 0.5% NPK @ 19-19-19	129	2.13	1260
T_6: 0.5% $ZnSO_4$	97	2.06	1040
T_7: 2% Urea + 0.5% $ZnSO_4$	125	2.12	1251
T_8: 2% DAP + 0.5% $ZnSO_4$	140	2.15	1411
T_9: 0.5% KNO_3 + 0.5% $ZnSO_4$	119	2.11	1235
T_{10}: 0.5% NPK @ 19-19-19 + 0.5% $ZnSO_4$	149	2.16	1477
SEm(±)	**6.36**	**0.10**	**71.17**
LSD (0.05)	**19.04**	**NS**	**213.10**

Table 2: Effect of experimental variables on economic parameters of lentil crop

Treatments	Cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B : C ratio
T_1: Water Spray	28556	49776	21220	0.74
T_2: 2% Urea	28628	54315	25687	0.90
T_3: 2% DAP	28844	61965	33121	1.15
T_4: 0.5% KNO_3	28831	53907	25076	0.87
T_5: 0.5% NPK @ 19-19-19	28806	64260	35454	1.23
T_6: 0.5% $ZnSO_4$	28716	53040	24324	0.85
T_7: 2% Urea + 0.5% $ZnSO_4$	28788	63801	35013	1.22
T_8: 2% DAP + 0.5% $ZnSO_4$	29004	71961	42957	1.48
T_9: 0.5% KNO_3 + 0.5% $ZnSO_4$	28991	62985	33994	1.17
T_{10}: 0.5% NPK @ 19-19-19 + 0.5% $ZnSO_4$	28966	75327	46361	1.60

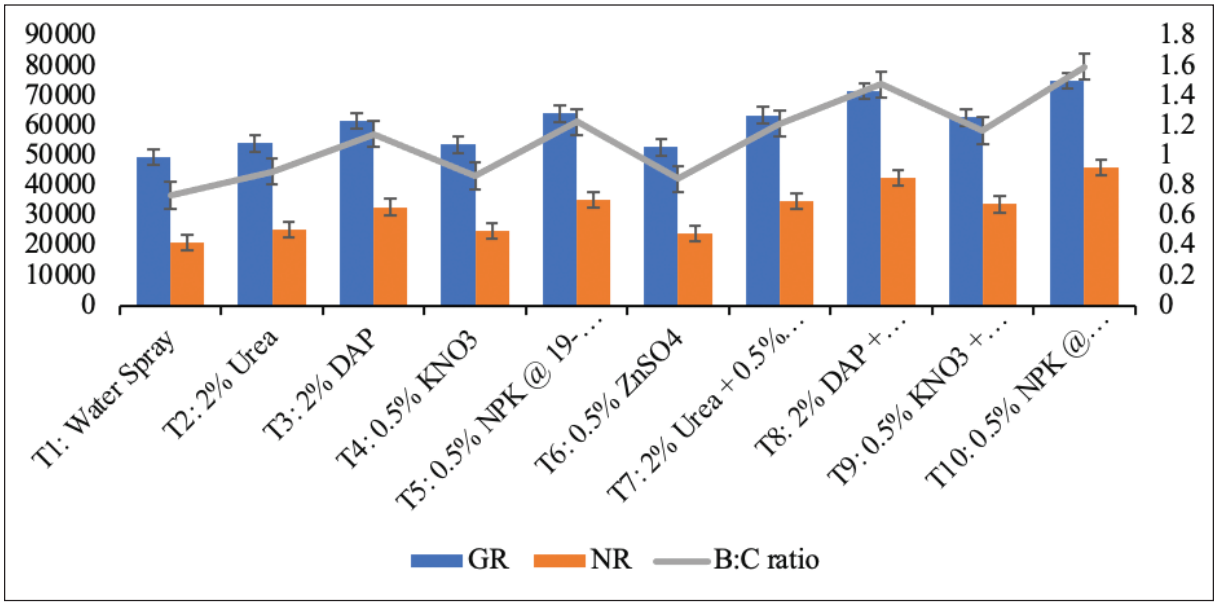

Fig. 1: Impact of varying foliar nutrient treatments on the economic parameters of lentil crop

in the regulation of plant development, resulting in more pods per plant. Ali *et al*. (2017) also advocated similar findings. Conclusively, foliar application of 0.5% NPK @ 19-19-19 along with 0.5% $ZnSO_4$ might have been worked synergistically and effectively to achieve markedly higher yield attributing parameters under present experiment.

Yield

Use of integrated two foliar applications of 0.5% NPK @ 19-19-19 + 0.5% $ZnSO_4$ sprayed at pre-flowering and pod initiation stages gave the maximum seed yield (1477 kg ha^{-1}) of lentil and it proved its significant impact in higher production as compared to the rest treatments except two foliar applications of 2% DAP + 0.5% $ZnSO_4$ sprayed at same aforesaid two stages. It shows that beneficial effect of yield attributing parameters of the present experimentation was cumulatively translated into the final yield more or less in similar pattern (Table 1). It is largely due to increased nutrient supply and decreased nutrient losses. Because of the lentil plants indeterminate growth habit, it could aid in rapid nitrogen absorption during the reproductive stage, when nutrient demand is at its peak. It might have been owing to increased nitrogen availability throughout crop season due to basal application N, N-fixation, and NPK@ 19-19-19 spray. As a result, flower drop or abortion were decreased, which ultimately increased pod setting and resulted in a higher seed yield. In pulses, the number of pods $plant^{-1}$ is considered to be most important yield component. Increased yield with the application of nutrients at the proper time or stage was also observed by Singh and Singh (2012).

Economics

Cost of cultivation showed marked variation due to experimental variables. Higher economic return is a key factor of treatment for a certain agro-climatic condition because farmers are more concerned with maximizing their net return per investment of rupee.

The foliar application of various nutrients significantly influenced the gross return and net return; two foliar applications of 0.5 % NPK @ 19-19-19 + 0.5 % $ZnSO_4$ sprayed at pre-flowering and pod initiation phases, followed by two foliar sprays of 2 % DAP + 0.5 % $ZnSO_4$ at the same stages, yielded the highest gross return (₹ 75327 ha^{-1}), while the lowest gross return was discovered using water spray (Table 2). The net return as calculated by deducting the gross return from the cultivation cost, was found the maximum (₹ 46361 ha^{-1}) under two foliar applications of 0.5% NPK @ 19-19-19 + 0.5% $ZnSO_4$ sprayed, followed by two foliar applications of 2% DAP + 0.5% $ZnSO_4$ at pre-flowering and pod initiation stages, and the lowest net return was found under water spray. Thus, the highest gross return and net return accrued with application of 0.5% NPK@ 19-19-19 + 0.5% $ZnSO_4$ spray at pre-flowering and pod initiation stages might have been because of higher seed yield of lentil.

A lot of factors, including input costs, labour demands, and, most importantly, weather conditions during the agricultural season, influenced the economy. Foliar use of 0.5% NPK@ 19-19-19 + 0.5% $ZnSO_4$ had the best benefit: cost ratio (1.60) (Fig. 1). These findings are in close conformity with Jadhav and Kulkarni (2016).

Lentil should be grown with two foliar sprays of 0.5% NPK @19-19-19 + 0.5% Zinc Sulphate at pre-flowering and pod initiation stages, along with 100% of the recommended doses of fertilizer in order to increase the lentil crop's production and profitability. These technologies may be used as a foundation to improve the socio-economic situations of farmers in general, and mainly small and marginal farmers, by increasing productivity per unit area.

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