



Effect of Zinc as Foliar Application on Growth, Quality and Yield of Lentil (*Len culinaris*)

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ABSTRACT

Background: The field experiment was conducted to effect of zinc as foliar application on growth, quality and yield of lentil (*Len culinaris*) at the farm of Lovely Professional University, Phagwara, Punjab during rabi season 2022-23.

Methods: Study was conduct on total seven treatment combinations, T₀ control (0%), T₁ (100% RDF), T₂ (75% RDF+ Zn 0.02%), T₃ (75% RDF + Zn 0.04%), T₄ (50% RDF + Zn 0.06%), T₅ (50% RDF + Zn 0.08%) and T₆ (50% RDF + Zn 0.10%) replicated thrice in RBD design.

Result: All the growth parameters and yield were found significant. Maximum plant height (28.29 cm) and number of branches (21.67) of lentil in 90 DAS were seen in T₃ (75% RDF + Zn 0.04%). There was a significant main effect of applying zinc as foliar application on growth, quality and yield of lentil. The maximum grain yield was recorded as 1695.00 kg/ha in T₅ (50% RDF + Zinc @0.08%) and minimum was recorded as 1111.67 kg/ha in T₀ (actual control). Thus, zinc applied topically improved the growth, output, quality and financial gains of lentil farming, demonstrating zinc's potential as a useful agronomic technique.

Key words: Foliar application, Lentil, Npk, Plant height, Yield, Zinc.

INTRODUCTION

In India, lentil (*Lens culinaris*) is the second most important winter season legume after chickpea and is a significant chilly season grain legume crop. The family Fabaceae (Leguminosae) includes lentils. 2n=14 is its chromosomal number. Based on the size of the seed, it may be divided into two primary groups: the Bold Seeded Group and the Small Seeded Group. India's agricultural economy greatly depends on lentils. They support the way of life for millions of smallholder farmers who grow lentils as their main source of income. Its contribution to reducing poverty and creating jobs in rural areas highlights their economic worth even more. Domestic production, import-export dynamics and consumer demand all affect the lentil's market value in India. Proteins, dietary fiber, vitamins and minerals are among the many vital elements that lentils are high in. They are a great source of plant-based protein, which is essential for preserving general health and muscle mass, especially in the vegetarian diets that are common in India. Significant amounts of iron, folate, magnesium and potassium are also present in lentils, which support cognitive function, cardiovascular health and general wellbeing (Jain *et al.*, 2023).

The top producers of lentils in the world presently are Bangladesh, China, India, Canada, Turkey, Australia, Nepal and the United States. Lentils are grown in several Indian states, according to the most recent data from the Ministry of Agriculture and Farmers' Welfare. Approximately 1.5 million hectares will be cultivated with lentils in India during the 2023–2024 agricultural year (Ministry of Agriculture, 2024). Because of the favorable weather and government programs encouraging pulse cultivation, this represents a slight increase over previous years. India holds a prominent position in the global lentil production landscape. Around

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1.35 million tons of lentils are expected to be produced in India overall in the 2023-2024 season (FAO, 2024). Changes in seasonal climate and market dynamics could affect this production level. There has been fluctuations in the average productivity of lentils in India. According to current reports, 900 kg of lentils can be produced on a hectare on average (ICAR, 2024).

About 90,000 hectares are expected to be planted with lentils in Punjab for the 2023-2024 growing season (Punjab State Government, 2024). This region reflects the state's role in lentil production as it represents a consistent level of cultivation. Punjab yields about 850 kg per hectare on average (Agricultural Statistics, 2024). This productivity level is a result of the state's effective farming methods and ideal growing environment.

Inadequate amounts of iron and zinc are the most prevalent micronutrient deficiencies in the globe. The primary factor contributing to micronutrient deficiencies is the over dependence on crop-based diets, which have poor mineral bioavailability. An essential component for plant

development is zinc (Zn). Plants lacking in zinc have lower yields and suffer large financial losses. IGP, the rice-growing region in general and the rice-wheat and rice-lentil cropping system in particular are areas where zinc deficiency is particularly common (Joshi 1998 and Ali *et al.*, 2012). A zinc deficit negatively impacts plants by decreasing their ability to synthesize proteins.

In order to identify the optimal Zn level for lentils in the Punjab region where the research was to be conducted, this study sought to ascertain the effects of various Zn levels on the grain production and certain phenological traits of the LL1373 lentil cultivar.

MATERIALS AND METHODS

The field experiment entitled "Effect of zinc as foliar application on growth, quality and yield of lentil (*Len culinaris*)" was conducted in *rabi* season at Agriculture Research Farm of Lovely Professional University, Phagwara, Punjab (India) in 2022. The farm is situated at a geographical altitude of 31.290p N and a longitude of 75.7021p E, or 5423 meters above sea level. Punjab has a tropical monsoon climate with average temperatures between 10 and 46 degrees Celsius, with summer highs of 49 degrees Celsius and lows of 1 degree Celsius in the winter.

Treatment and design

This factorial RBD experiment, which was conducted in three replications, had seven treatment combinations. T₀ control (0%), T₁ (100% RDF), T₂ (75% RDF+ Zn 0.02%), T₃ (75% RDF + Zn 0.04%), T₄ (50% RDF + Zn 0.06%), T₅ (50% RDF + Zn 0.08%) and T₆ (50% RDF + Zn 0.10%) were the seven Zn levels that were given foliar three times at 30 DAS, 60 DAS and 90 DAS. Lentils of the LL1373 variety were sown in lines with a 30-cm row spacing. A 45 kg/ha seeding rate was used. The agrochemical used was commercial-grade zinc sulfate (ZnSO₄). Every fourteen days, the crop was manually weeded to maintain its development. To control termites and ants, 20% EC chloropyrifos was applied at 500-1200 mlha⁻¹.

Experimental design and data analysis

This factorial RBD experiment had three replications and seven treatment combinations. Using statistical analysis

software (OPSTAT), an ANOVA of a randomized block design (RBD) was conducted on all recorded data in order to determine the impact of zinc as foliar treatment on lentil growth, quality and yield.

Observations recorded

For the purpose of collecting data at different stages of development-30, 60 and 90 DAS-five plants were chosen and tagged. After the plants with random tags were taken out, the height of each one was measured from the base of the final fully opened leaf to the ground. The height of the plants was calculated in cm using the average of these measurements. When the tagged plants were harvested, the number of branches per plant was counted and the average was calculated. The leaf area index was calculated using the ground area and leaf area of the plant. Using a SPAD meter, the chlorophyll index of five different plants was determined. Three leaf sections (the tip, middle and bottom) were used to get the mean data. Raising biomass levels is critical to crop development. Each of the five randomly chosen plants had the number of fully developed, ripe pods carrying seeds counted when it was time for harvest. At the time of harvest, the average number of seeds in each pod was calculated from three pods from five randomly selected plants in the plot. The bulk yield of five randomly chosen plants in each replication was used to count the hundred seeds for each entry and then each plant's weight was measured in grams using a single pan electronic balance. After being sun-dried to a predetermined moisture content, seeds were weighed in grams from the net plot. kg/ha was calculated by multiplying the seed yield per plot by a multiplicative factor. Straw yield may be calculated by deducting the weight of grains per plot from the gross weight of the bundle and converting to kg/ha.

RESULTS AND DISCUSSION

Growth characteristics

For every growth parameter, a significant result was reported (Table 1 and 2) at the 5% level. The plant highest height at 30 DAS was 11.44 cm at T₃ (75% RDF Zn @ 0.04%), whereas their minimum height was 8.63 cm at T₀ (actual control). The height of the plants at 60 DAS was

Table 1: Growth characteristics (Plant height) of lentil on foliar application of zinc.

Symbol	Treatment	Plant height (cm)		
		30 DAS	60 DAS	90DAS
T ₀	Actual control	8.63±0.06	17.3±0.17	24.36±0.73
T ₁	100% RDF	9.52±0.34	17.68±0.09	25.14±0.15
T ₂	75% RDF + Zinc @ 0.02%	10.18±0.20	18.38±0.24	26.50±0.60
T ₃	75% RDF + Zinc @ 0.04%	11.44±0.13	19.92±0.09	28.29±0.64
T ₄	50% RDF + Zinc @ 0.06%	11.16±0.27	19.07±0.17	27.67±0.56
T ₅	50% RDF + Zinc @0.08%	10.75±0.14	18.69±0.09	26.74±0.37
T ₆	50% RDF+ Zinc @ 0.10%	10.12±0.24	17.93±0.03	25.99±0.49
SEm		0.19	0.12	0.40
SEd		0.26	0.16	0.57
CD at 5%		0.55	0.36	1.19

found to be minimal at 17.30 cm at T_0 (actual control) and highest at 19.92 cm at T_3 (75% RDF Zn @ 0.04%) following the application of zinc sulfate. The plant height at 90 DAS was 24.36 cm at T_0 (actual control) and 28.29 cm at T_3 (75% RDF Zn @ 0.04%). Similar situations have demonstrated notable growth and yield increases when zinc was used at different amounts. Under Indo-Gangetic Bihar conditions, foliar application of zinc (0.04%) is advantageous and economical for lentil production (Singh and Bhatt 2013). When it came to the number of branches per plant, the range at harvest was 11.67 to 21.67. The T_3 treatment (75% RDF Zn @ 0.04%) had the most branches per plant at 21.67, while the T_0 treatment (actual control) had the fewest branches at 11.67. According to Singh and Bhatt (2013), the analysis revealed that Zn has the maximum number of branches, with 0.04% (16.3). At 23.81, the highest chlorophyll index was discovered in T_3 (75% RDF Zn @ 0.04%) was 23.81. and it was discovered that the lowest value at T_0 (actual control) was 10.89. At T_3 (75% RDF Zn @ 0.04%), a maximum leaf area index of 2.30 was recorded and at T_0 (control), a minimum of 2.08. Compared to 30-60 DAS CGR, the crop growth rate of 60-90 DAS crops was much greater. In the 30-60 DAS and 60-90 DAS time periods, the maximum CGRs of 0.89 and 0.93 were observed at T_3 (75% RDF Zn @ 0.04%) and the minimums of 0.72 and 0.76 at T_0 (control).

Quality

The data results for NPK and protein content were significant (Table 3) at the 5% level. Protein content rises in tandem with Zn levels. At T_6 (50% RDF zinc @ 0.10%), the greatest protein content was measured at 32.77%, whereas at T_0 (control), the minimum protein level was 23.56%. At T_6 (50% Zn RDF @ 0.10%), the highest N concentration was reported as 5.24%, while at T_0 (actual control), the minimum was recorded as 3.77%. Whereas in phosphorous, highest content was recorded as 2.10% in T_2 (75% RDF + Zinc @ 0.02%) and lowest was recorded as 1.58% in T_6 (50% RDF+ Zinc @ 0.10%). Potassium concentration of 2.15% at T_6 (50% Zn RDF @ 0.10%) and a minimum of 0.94% at T_0 (actual control). According to Singh and Bhatt (2013), the highest N concentration in a comparable cast was determined to be 1.98% (Zn 0.08%), the highest P content to be 0.73% (Zn 0.02%) and the highest K content to be 0.95% (Zn 0.02%).

Yield characteristics

At the 5% level, the yield parameter data (Table 4) were significant. At T_5 , the highest recorded number of pods/plants was 56.87 (50% Zn RDF @0.08%), while at T_0 (control), the lowest recorded number of pods/plants was 41.80. Similar to this, 0.08% Zn (63.8) had the greatest pods/plant (Singh and Bhatt 2013). At T_5 (50% Zn RDF

Table 2: Growth characteristics of lentil on foliar application of zinc.

Symbol	Treatment	Number of branches/plant	Chlorophyll index	Leaf area index	Crop growth rate (g/m ² /day)	
		At Harvest	90 DAS	90 DAS	30-60 DAS	60-90 DAS
T_0	Actual control	11.67±0.88	10.89±0.40	2.08±0.09	0.72±0.01	0.76±0.03
T_1	100% RDF	12.33±0.88	12.93±0.82	2.19±0.02	0.74±0.01	0.79±0.03
T_2	75% RDF + Zinc @ 0.02%	14.67±0.88	16.75±1.37	2.24±0.01	0.78±0.01	0.85±0.01
T_3	75% RDF + Zinc @ 0.04%	21.67±0.88	23.81±0.95	2.30±0.01	0.89±0.01	0.93±0.01
T_4	50% RDF + Zinc @ 0.06%	19.00±0.58	19.16±1.26	2.28±0.01	0.84±0.01	0.93±0.02
T_5	50% RDF + Zinc @ 0.08%	17.33±0.88	17.93±1.13	2.26±0.01	0.87±0.01	0.88±0.01
T_6	50% RDF+ Zinc @ 0.10%	14.67±0.88	14.87±0.63	2.22±0.01	0.82±0.01	0.88±0.01
SEm		0.87	0.79	0.03	0.01	0.02
SEd		1.23	1.12	0.04	0.01	0.02
CD at 5%		2.57	2.34	0.09	0.02	0.05

Table 3: Quality of lentil on foliar application of zinc.

Symbol	Treatment	N content (%)	P content (%)	K content (%)	Protein content (%)
T_0	Actual control	3.77±0.05	1.73±0.01	0.94±0.01	23.56±0.32
T_1	100% RDF	4.12±0.04	1.79±0.01	1.13±0.01	25.74±0.24
T_2	75% RDF + Zinc @ 0.02%	4.20±0.04	2.10±0.10	1.27±0.01	26.27±0.23
T_3	75% RDF + Zinc @ 0.04%	4.43±0.03	1.73±0.01	1.36±0.01	27.66±0.19
T_4	50% RDF + Zinc @ 0.06%	4.63±0.07	1.68±0.01	1.41±0.02	28.93±0.42
T_5	50% RDF + Zinc @ 0.08%	4.98±0.04	1.63±0.01	1.67±0.01	31.10±0.23
T_6	50% RDF+ Zinc @ 0.10%	5.24±0.04	1.58±0.02	2.15±0.13	32.77±0.24
SEm		0.04	0.04	0.05	0.24
SEd		0.05	0.06	0.07	0.34
CD at 5%		0.11	0.12	0.15	0.71

Table 4: Yield characteristics of lentil on foliar application of zinc.

Symbol	Treatment	At harvest Pots/plant	At harvest Seeds/pot	At harvest 1000 seed weight (g)	At harvest Grain yield	At harvest Harvest index
T ₀	Actual Control	41.80±0.59	1.47±0.07	32.33±0.33	1111.67±23.57	37.96±0.22
T ₁	100% RDF	44.47±0.59	1.50±0.06	34.33±0.33	1340.33±17.82	39.18±0.17
T ₂	75% RDF + Zinc @ 0.02%	50.90±1.02	1.50±0.06	41.67±0.88	1453.67±4.63	39.65±0.11
T ₃	75% RDF + Zinc @ 0.04%	53.67±0.99	1.47±0.03	40.67±1.20	1544.33±12.39	40.53±0.11
T ₄	50% RDF + Zinc @ 0.06%	56.67±0.57	1.53±0.03	41.33±0.33	1643.00±7.37	40.62±0.11
T ₅	50% RDF + Zinc @0.08%	56.87±0.81	1.83±0.09	44.00±0.58	1695.00±14.57	40.58±0.18
T ₆	50% RDF+ Zinc @ 0.10%	51.70±1.13	1.53±0.03	37.33±0.88	1476.00±2.65	39.88±0.06
SEm		0.78	0.06	0.77	14.68	0.16
SEd		1.10	0.08	1.10	20.76	0.22
CD at 5%		2.30	0.17	2.29	43.31	0.46

@0.08%), the greatest number of seeds/pod was 1.83, while at T₀ (actual control), the least was 1.47. In T₅ (50% Zn RDF @ 0.08%), the greatest weight of 1000 seeds was 44.00 g, whereas in T₀ (actual control), the lowest weight was 32.33 g. A comparable investigation discovered that the maximum weight of 1000 seeds was 25 g (Zn 0.08%) (Singh and Bhatt, 2013). In T₅ (50% RDF + Zinc @0.08%), the highest grain production was measured at 1695.00 kg/ha, whereas in T₀ (actual control), the minimum was measured at 1111.67 kg/ha. According to the data, T₅ at 0.08% zinc was the best treatment, but T₆ at 0.10% zinc caused a yield decrease because of zinc toxicity. Similarly, 1238.6 kg/ha (Zn 0.04%) was determined to be the maximum grain yield (Singh and Bhatt 2013). The harvest index falls between 37.96 and 40.62. At T₄ (50% RDF + Zinc @ 0.06%), the highest was 40.62, whereas at T₀ (actual control), the minimum was 37.96.

CONCLUSION

The study shows that applying zinc topically to lentil plants improves their nutritional content, yield characteristics and a number of growth metrics. In the end, the foliar application of zinc particularly at a concentration of 0.08% significantly enhances the development, production and nutritional quality of lentils, indicating that it is a useful and economical technique for lentil cultivation in the area under study.

Conflict of interest

There is no conflict of interest in manuscript and manuscript had not submitted to other journal.

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