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Effect of Zinc Foliar Application on Seed Yield of Lentil (*Lens culinaris* Medikus) and Its Yielding Components

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Authors' contributions

This work was carried out in collaboration between all authors. Author PP designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors SM and PS managed the analyses of the study. Author PS managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Zinc plays a greater role during reproductive phase especially during fertilization. A field experiment was conducted in district seed farm AB block, Kalyani, Nadia, Bidhan Chandra Krishi Viswavidyalaya (B.C.K.V) during 2016-17 and 2017-18 in Randomized Block Design (RBD) and replicated thrice to check the response of lentil against different concentration of $ZnSO_4 \cdot 7H_2O$. Zinc foliar application applied at preflowering and podding stage. It has been observed that all the zinc applications have better results than the control. Among different treatments 0.04% and 0.08% zinc shown better result. Among humans, Zinc (Zn) deficiency is a well documented global health problem, affecting nearly half of the world population. Zn content of the seed increased maximum in 0.08% Zn treatment but seed yield is maximum in 0.04% Zn treatment. Therefore, it is concluded that foliar application of zinc improves lentil productivity and lentil production.

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Keywords: Lentil; zinc foliar application; biofortification; seed yield.

1. INTRODUCTION

Lentil (*Lens culinaris* Medikus) is one of the early crops domesticated and cultivated by man and have been continued to be an important food source for over 8000 years [1]. The high protein content of lentil (about 25%) has made them a nutritious substitute for meat. It is an important pulse crop grown during rabi season in Indian subcontinent. Lentil is a deployed (2n=14), self-pollinating, annual species with a haploid genome [2]. Zn deficiency is wide spread and very common in Indo-Gangetic Plains , in the rice growing tract in general and rice-wheat and rice-lentil cropping system in particular [3]. Physiologically role of zinc in a plant is either as a metal constituent in an enzymes or as a functional co-factor of number of enzymes reactions. In general zinc deficient plant show signs of low levels of auxins such as IAA. It is required for synthesis of IAA [4,5]. After flowering, high concentration of zinc in plant enhances cell differentiation. Zinc plays a greater role during reproductive phase especially during fertilization. Remarkably pollen grain contains zinc in very high quantity. At the time of fertilization most of zinc is diverted to seed only [6,7,8]. Zinc (Zn) deficiency is a well documented global health problem, affecting nearly half of the world population, particular in developing countries. Lentil has been identified as an ideal crop for micronutrient biofortification and a possible whole food solution to the global micronutrient malnutrition [9]. Knowledge of the different forms of Zn fertilizer and timing of foliar Zn application is crucial for enhancing grain Zn. The most effective method for increasing grain Zn is the soil and foliar application method, which may result in an about 3-fold increase in grain Zn concentration. Among the different forms of Zn fertilizer that were tested, the application of Zn as $ZnSO_4$ was most effective in increasing grain Zn, compared to other forms of Zn [10]. High seed Zn concentrations ensure good root growth and contribute to better protection against soil borne pathogens [11]. Besides checking response of different zinc treatment in growth development and yield of lentil, concentration of zinc in lentil seeds also being observed. This field experiment was undertaken, keeping in view the importance of zinc especially during sensitive phase may boost the performance of lentil in the west Bengal region of India; with an objective to improve the lentil productivity, production and zinc concentration by foliar supplementing of zinc.

2. MATERIALS AND METHODS

A field experiment was conducted at district seed farm AB block, Bidhan Chandra Krishi Viswavidyalaya, Kalyani during 2016-17 and 2017-18 in randomized block design (RBD) and replicated thrice. The experimental plot size was 10.0 m × 5.0 m. The experiment consist of 4 treatments (concentration levels) of Zn, namely (control) Zn1 (0.0%), Zn2 (0.025%), Zn3 (0.05%), Zn4 (0.075%). Foliar applications were carried out at pre-flowering and post podding stages. Every time, light irrigations were provided two days before the treatment applied. The chosen agrochemical was none other than commercial grade zinc sulphate ($Zn\ SO_4{\cdot}7H_2O$) which contains 21% Zn (active ingredient). Tested lentil genotypes were WBL-77 or Maitree, a farmer and consumer accepted cultivar of west Bengal region and BM-8 (BARI Masoor 8) and Precoz micronutrient accumulator and promising cultivar. Sowing of lentil was performed on 20th of November during both occasions. Seeds were sown at 3 cm depth at 30 cm row distance. Nutrients particularly, nitrogen, phosphorus, potassium and sulphur were applied as basal dose as well as other agronomic management practice was as per recommended practices and was kept similar for all the treatments. One hand weeding after three weeks of sowing was performed to maintain optimum plant population. Two watering was done at pre flowering stage and post podding stage. Plant protection measures were taken care to manage the biotic stress if any. To ascertain the extent and pattern of effective availability of Zn applied to the leaves of lentil crop. Treatment used was Zinc (0%) control, (Zn1) 0.025% (Zn2), 0.05% (Zn3) and 0.075% (Zn4). Data on number and dry weight of nodules/plant were recorded 60 and 90 DAS by digging five plants from each plot. Five plants were sampled 90 DAS for measuring shoot dry weight. Dry weight of the nodules and shoots were recorded by drying samples in an oven at 60˚C for 72 hrs. Similarly, chlorophyll contents were taken at 90 DAS. Chlorophyll contents were determined in young leaves (3^{rd} to 4^{th} leaf from the top) by the SPAD meter. At harvest five representative samples of each plot were collected and biometrical data were recorded and computed for plant height, shoot dry weight, root length, root dry weight, productive branch/plant, pod/plant, seed yield. Similarly 100-seed weight was also computed. Biomass and seed yield (kg/ha) were computed based on seed weight per plot and computed for ha.

3. RESULTS AND DISCUSSION

The plant height of lentil is significantly influenced by different levels of Zn (Fig. 1) in all the three cultivars. Maximum (49.3 cm) in WBL 77 and minimum (35.3 cm) in BM-8 plant height was recorded at harvest, with 0.08% Zn and control (0%) application of Zn, respectively (Fig. 1). In each cultivar plant height increased with increased zinc dose. Similar results were also observed earlier [3,12].

100-gain weight (g) was not influenced by of the levels of Zn as it is genetic characters and in general not influenced by management practices (Fig. 2) in all the three cultivars. Similar results were also observed earlier [13].

Numbers of primary branches not significantly influenced by different levels of Zn (Table 1). In all the three cultivars very negligible increase in number of primary branches was recorded at harvest, but there is relatively more increase in number of secondary branches with increase in zinc treatment. Maximum number of secondary branches 9.1 in WBL77 and 4.4 in Precoz was recorded in 0.04% Zn and control (0%) application of Zn, respectively (Table 1) Number of productive branches per plant is one of the primary yield contributing traits get influenced with the tested nutrient. Similar results in case of number of branches were observed [12,14,15].

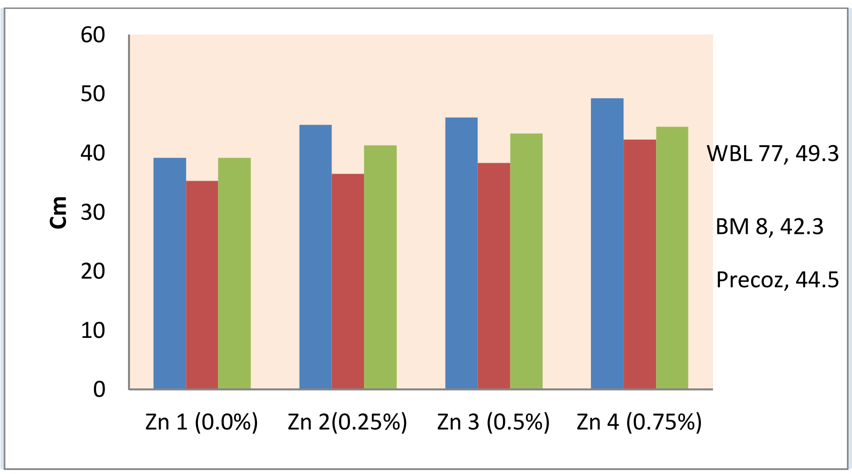

Fig. 1. Height of Lentil cultivars WBL77, BM 8, Precoz against four different zinc treatment

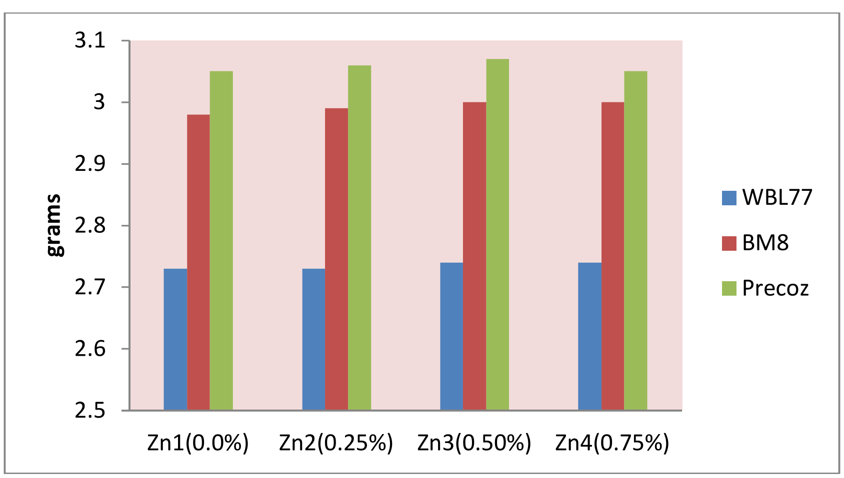

Fig. 2. 100 seed weight of Lentil cultivars WBL77, BM 8, Precoz against four different zinc treatment

Table 1. Effects of foliar application of zinc on Number of primary and secondary branches of different cultivars of lentil

Treatments	At harvest					
	Number of primary branches/plant			Number of secondary branches/plant		
	WBL 77	BM 8	Precoz	WBL 77	BM 8	Precoz
Zn1 (0.00%)	3.33	2.62	2.30	7.7	5.5	4.4
Zn2 (0.25%)	3.33	2.62	2.32	8.6	6.3	4.5
Zn3 (0.50%)	3.4	2.64	2.35	9.1	7.1	4.8
Zn4 (0.75%)	3.4	2.64	2.32	8.8	6.9	5.6
P=0.05	N.S	N.S	N.S	0.12	0.11	0.10

Table 2. Effects of foliar application of zinc on shoot dry weight (gm/plant) and total biomass (kg/ha) of different cultivars of lentil

Treatments	At harvest					
	Total biomass (kg/ha)			Shoot dry weight (gm/plant)		
	WBL 77	BM 8	Precoz	WBL77	BM8	Precoz
Control	2489.4	2134.1	2767.2	3.23	2.78	3.89
Zn1 (0.0%)	2676.3	2344.3	2898.3	3.73	2.99	4.13
Zn1 (0.0%)	2777.4	2404.5	2967.3	4.13	3.34	4.56
Zn1 (0.0%)	2823.1	2465.1	2978.2	4.11	3.23	4.50
P=0.05	81.3	80.7	82	0.16	0.13	0.18

Chlorophyll contents were measured at 90 DAS, significant increase in chlorophyll with increase Zn concentration were recorded up to highest concentration, though, maximum percentage increased was noticed in case of Zn2 over Zn1. Here we have taken SPAD values through SPAD meter (Fig. 3). Similar finding was also reported by Pandey and Gautam [7].

Shoot dry weight was increased with increasing concentration of foliar applied Zn mineral (Table 2). Minimum (2.78 g/plant) in BM-8 cultivar and maximum (4.56 g/plant) in Precoz shoot dry weight was recorded with application of Zn1 (0.0%) and Zn4 (0.08%), respectively. Similar stimulation of shoot dry weight was observed [16,12,15,17]. Total above ground biomass was also gets influenced significantly with applied zinc. Maximum (2978.2 kg/ha) in Precoz and minimum (2134.1 kg/ha) in BM-8 above ground biomass was recorded with the (0.08%) plot and (0.0%) zinc (Table 2). Similar findings were recorded in few species [7,18].

Highest lentil seed yield (1299.6 kg/ha) was recorded with (0.04%) Zn treatment whereas lowest yield (213.8 k/ha) was noticed with no application of (0.0%) Zn. Singh et al. [12] also reported similar result. Similar result was also reported [19].

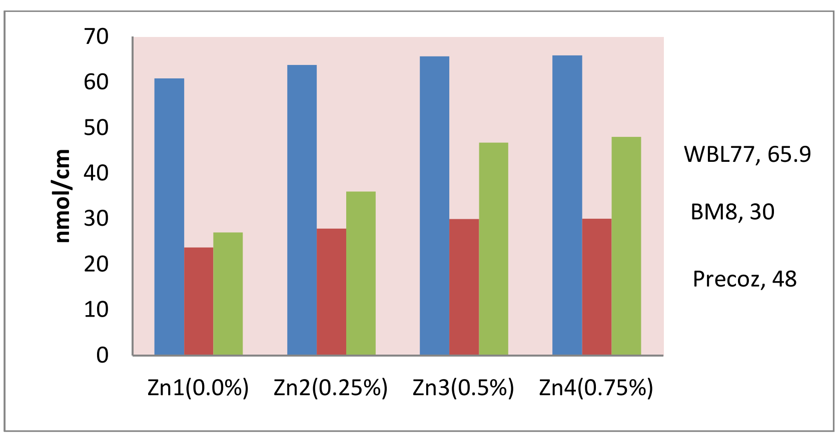

Fig. 3. SPAD value of leaves of Lentil cultivars WBL77, BM 8, Precoz against four different zinc treatment

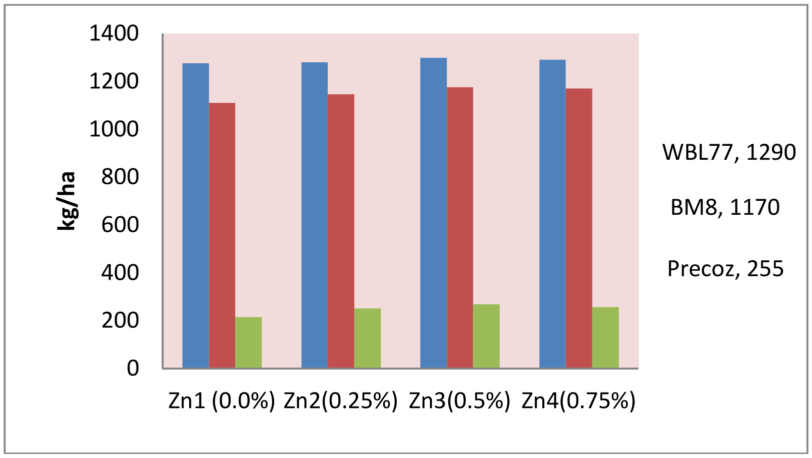

Fig. 4. Seed yield of Lentil cultivars WBL77, BM 8, Precoz against four different zinc treatments

4. CONCLUSION

It is concluded that foliar application of zinc improves lentil productivity and lentil production. Among the different zinc treatments Foliar application of zinc (0.04%) not only proved to be most beneficial but also economical for lentil production. Among the three lentil cultivars WBL77 found better in respect of production (Fig. 4) and other yield attributes. Though Precoz shown some good growth attributes but in production purpose in this specific experiment performance of this cultivar is very poor.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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