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LATE-SOWN LENTIL PERFORMANCE IN RESPONSE TO FOLIAR APPLICATION OF ZINC

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Abstract

Highest and lowest plant height at harvest was recorded with application of 0.08% Zn and in control treatment, respectively. Longest and shortest roots were recorded in the plots treated with 0.08% Zn and control respectively. Zn treatment of 0.04% produced maximum lentil seed whereas lowest was recorded under control.

India is world largest homeland of vegetarian population and world leader in pulses production and import to provide protean supplements (Ali and Gupta 2012). Lentil (*Lens culinaris* Medik.) is one of the most nutritious cool season food legumes and ranks next only to chickpea. It is one of the prominent sources of vegetable protein in the Indo-Gangetic plain (IGP) region, essentially grown as a rainfed crop on the residual soil moisture of preceding crop (rice in general) (Ali *et al.* 2012 and Joshi 1998). Zn deficiency is wide spread and very common in IGP, in the rice growing tract in general and rice-wheat and rice-lentil cropping system in particular (Joshi 1998 and Ali *et al.* 2012). Role of zinc is as multifaceted as the interface that reduces its availability. Physiologically its role 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 (Guilfoyle and Hagen 2001 and Liscum and Reed 2002). After flowering, high concentration of zinc in plant will enhance 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 (Jenik and Barton 2005, Pandey and Gautam 2009 and Reid *et al.* 2011). Foregone discussion outlined the role and importance of zinc in lentil crop production particularly under late sown conditions. This field experiment was undertaken, keeping in view the importance of zinc especially during sensitive phase may boost the performance of late sown lentil in the IGP region of India; with an objective to improve the lentil productivity and production by foliar supplementing of zinc to correlate and validate critical phase.

To evolve zinc management scheme, a field experiment was conducted at ICAR Research Complex for Eastern Region Patna during 2008-09 and 2009-10 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) Zn_1 (0.0%), Zn_2 (0.02%), Zn_3 (0.04%), Zn_4 (0.08%). 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 ($Zn\ SO_4.7H_2O$) which contains 21% Zn (active ingredient). Long duration (145 to 155 days) genotype Swarna Mansoori "MTU-7029" was chosen for rice crop. Tested lentil genotype was Pant Lentil 406 (PL-406), recommended for North and Eastern zone i.e. Indian IGP, where this field experiment was

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Conducted, as well as its performance even under late sown condition along with its medium maturity (125 - 135 days) are few features faovoured its selection. Sowing of lentil was performed on 10th of December 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, (Zn_1) 0.02% (Zn_2), 0.04% (Zn_3) and 0.08% (Zn_4).

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^{o}C for 72 hrs. Similarly, chlorophyll contents were taken at 90 DAS. Chlorophyll contents were determined in young leaves (3rd to 4th leaf from the top by the method described by Lichtenthaler and Wellburn (1983). 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. Seed yield were adjusted to 12% moisture.

The plant height of lentil is significantly influenced by different levels of Zn (Table 1). Maximum (42.2 cm) and minimum (32.8 cm) plant height was recorded at harvest, with 0.08% Zn and control (0%) application of Zn, respectively (Table 1). Similar results were also observed earlier (Ali *et al.* 2012 and Singh *et al.* 2011). Lentil root length at harvest also follows the same

Table 1. Effects of foliar application of zinc on growth and development of lentil.

Treatments	At harvest			Nodules/plant (no.)		Nodule dry wt. (mg/plant)		Chlorophyll content at 90 DAS (mg/g fresh wt. of leaves)
	Plant height (cm)	Root length (cm)	Root dry wt. (g/plant)	60 DAS	90 DAS	60 DAS	90 DAS	
Control	32.8	7.9	1.87				30.9	1.962
Zn_1 (0.0%)				10.6	14.9	27.3		
Zn_2 (0.02%)	38.7	10.2	2.01	12.7	15.2	31.9	33.4	2.329
Zn_3 (0.04%)	39.8	11.4	2.12	15.9	18.3	34.2	36.5	2.542
Zn_4 (0.08%)	42.2	12.1	2.34	17.4	21.8	37.1	41.3	2.654
p = 0.05	2.8	1.42	2.45	1.6	2.1	2.4	3.3	0.127

Fashion, longest (12.1 cm) and shortest (7.9 cm) root was recorded with 0.08% Zn and control application, respectively. Root dry weight did not fail to copy the pattern of response, as it was previously seen in case of root length. Highest root dry weight (2.45 g/plant) was noticed with 0.08% Zn (Table 1). Similar finding were also recorded by Pandey and Gautam 2009. Nodules/plant was recorded at two stages at 30 days interval starting with 60 DAS (Table 1). With increase in Zn concentration and advancement of growth stage, number of nodule increased significantly. This result is supported by Reid *et al.* (2011) and Van and Hartley (2000). Maximum (21.8 nodules at 90 DAS) and minimum (10.6 nodules at 60 DAS) were recorded with application of Zn_4 and control, respectively. Nodule dry weight (mg/plant) had shown alike trend as it was noticed in case of nodules count. Nodule dry weight was increased with the time and also influenced with incremental doses of Zn. Maximum (41.3 mg/plant at 90 DAS) and minimum (27.3 mg/plantat 60 DAS) were recorded with application of Zn_4 (0.08%) and Zn_1 (0.0%), respectively. Earlier similar results were recorded (Reid *et al.* 2011 and Singh *et al.* 2011). 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 Zn_2 over $Zn_{1.}$ Similar finding was also reported by Pandey and Gautam 2009.

Shoot dry weight was increased with increasing concentration of foliar applied Zn mineral (Table 2). Minimum (3.23 g/plant) and maximum (4.37 g/plant) shoot dry weight was recorded with application of Zn_1 (0.0%) and Zn4 (0.08%), respectively. Similar stimulation of shoot dry weight was observed (Van and Hartley, 2000, Singh *et al.* 2011, Somani 2008 and McVicar *et al.* **2**010). Number of productive branches per plant is one of the primary yield contributing traits get influenced with both the tested nutrients. Productive branches per plant had been recorded minimum (14) with no application of zinc whereas maximum (17) was obtained in case of Zn_3 (0.04%). Similar results in case of number of branches were observed (Singh *et al.* 2011, Singh and Bhatt 2013 and Somani 2008). Similarly, pod/plant were maximum (63.8) in plots fertilized foliar by application with Zn_4 0.08%) and minimum (45.9) with no application of zinc treatment. Identical results were observed by Pandey and Gautam 2009. Total above ground biomass was also gets influenced significantly with applied zinc. Maximum (2942.1kg/ha) and minimum (2537.5 kg/ha) above ground biomass was recorded with the (0.08%) plot and (0.0%) zinc (Table 2). Similar findings were recorded in few species (Pandey and Gautam 009 and Ramakrishna *et al.* 2000).

Table 2. Effects of foliar application of zinc on yield attributes and seed yield of lentil.

Treatments	Shoot dry weight (g/plant)	Branches/ plant	Pod / plant	Biomass (kg/ha)	Seed yield (kg/ha)	Harvest Index	1000-grain wt (g)
Control							
Zn_1 (0.0%)	3.23	14	45.9	2537.5	1063.1	0.40	24.7
Zn_2 (0.02%)	3.67	16	54.2	2825.6	1171.2	0.39	24.7
Zn_3 (0.04%)	4.11	17	58.0	2902.6	1238.6	0.39	24.8
Zn_4 (0.08%)	4.37	16	63.8	2942.1	1208.6	0.38	25.0
p = 0.05	0.18	2.0	8.6	87.5	35.2	NS	NS

Highest lentil seed yield (1238.6 kg/ha) was recorded with (0.04%) Zn treatment whereas lowest yield (1015 k/ha) was noticed with no application of (0.0%) Zn. 1000-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. Singh *et al.*(2011) also reported similar result. Harvest Index is also not influenced by any of the given treatment and this might be due to character, highly associated with genetic makeup of the crop. Similar result was also reported (Singh *et al.* 2011 and Thiyagarajan *et al.* 2003).

It is concluded that foliar application of zinc improves lentil productivity. Foliar application of zinc (0.04%) not only proved to be most beneficial but also economical for lentil production.

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