

## Effect of boron and zinc on growth, yield and economics of lentil (*Lens culinaris*) in New Alluvial Zone of West Bengal

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### ABSTRACT

A field experiment was conducted at District Seed Farm, Kalyani, Nadia, West Bengal, India, to study the effect of boron (B) and zinc (Zn) on growth, yield and economics of 'Moitree' lentil (*Lens culinaris* Medik.) during the winter (*rabi*) seasons of 2013–14 and 2014–15. Two micronutrients, viz. boron (B) and zinc (Zn), with variations in method and time of applications had significant effect on plant height, dry-matter (DM) production, and crop-growth rate (CGR) throughout the cropping season. The crop treated with T<sub>4</sub> [recommended dose of fertilizer (RDF) + soil application of B @ 1.0 kg/ha] resulted in the highest aerial dry-matter yield (132.7 g/m<sup>2</sup>) at 75 days after sowing (DAS) and crop-growth rate (3.23 g/m<sup>2</sup>/day) between 46 and 75 DAS compared to the other treatments used in the investigation. Although the foliar spray of both B @ 0.1% and Zn @ 0.25% twice at 40 and 60 DAS (T<sub>10</sub>) recorded the highest number of pods/plant (102.2) and seed yield (1.21 t/ha), single spraying of B @ 0.1% at 40 DAS (T<sub>9</sub>) to lentil recorded moderate yield (1.15 t/ha), maximum net return (₹27,009/ha) and benefit: cost ratio (1.86), which could be used for lentil crop during the winter season in New Alluvial Zone of West Bengal.

**Key words:** Boron, Economics, Lentil, Seed yield, Zinc

Lentil is an important winter (*rabi*) season pulse crop in India, whose cultivation is mainly confined to Northern and Central part of the country. In West Bengal, it is cultivated in 0.59 lakh ha of land with the production of 0.45 lakh tonnes and average productivity of 763 kg/ha (GoWB, 2009). Major lentil-growing districts in the state are Murshidabad, Nadia, Dakshin Dinajpur, North 24-Parganas, South 24-Parganas etc. Lentil production is largely influenced by the genotypic potential, agro-climatic conditions and cultivation practices. Among various edaphic factors, availability of adequate plant nutrients especially micronutrients are of prime importance for growth and yield of lentil (Singh and Kumar, 2009). Several studies reported that the deficiency of micronutrients in alluvial soil of Indo-gangetic plains and calcareous belts of eastern India is severe and thereby response of lentil and gram to added micronutrients such as zinc and boron is beneficial (Singh and Bhatt, 2013; Kumar *et al.*, 2006). Boron is very important in pod and seed formation and so,

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the reproductive growth (flowering, fruit and seed set) is more sensitive to B deficiency than vegetative growth. Zinc plays an important role in biosynthesis of plant hormone like indole acetic acid (Singh *et al.*, 2014) and protein, which helps in utilization of nitrogen and phosphorus in plants.

A field experiment was conducted during the winter (*rabi*) seasons (November to March) of 2013–14 and 2014–15 at District Seed Farm (22°93'N, 88°53'E and 9.75 m altitude) of the Bidhan Chandra Krishi Viswavidyalaya (BCKV) in New Alluvial Zone of West Bengal, India, to study the effect of boron (B) and zinc (Zn) on growth, yield and economics of lentil (cv. Moitree). The soil was sandy-loam (Inceptisol), neutral in reaction (pH 6.8), low in organic carbon (0.56%), available nitrogen (231.0 kg N/ha), phosphorus (30.0 kg P<sub>2</sub>O<sub>5</sub>/ha) and potassium (190.7 kg K<sub>2</sub>O/ha). The experiment was laid out in a randomized block design, consisting of 10 treatments, viz. T<sub>1</sub>, recommended dose of fertilizer (RDF) @ 20 kg N, 40 kg P<sub>2</sub>O<sub>5</sub> and 40 kg K<sub>2</sub>O/ha as basal; T<sub>2</sub>, T<sub>1</sub> + B (1 kg/ha) as basal soil application; T<sub>3</sub>, T<sub>1</sub> + Zn (5 kg/ha) as basal soil application; T<sub>4</sub>, T<sub>1</sub> + B (1 kg/ha) and Zn (5 kg/ha) as basal soil application; T<sub>5</sub>, T<sub>1</sub> + B (0.1%) as foliar spray at 40 days after sowing (DAS); T<sub>6</sub>, T<sub>1</sub> + Zn (0.25%) as foliar spray at 40 DAS; T<sub>7</sub>, T<sub>1</sub> + B (0.1%) and

Zn (0.25%) as foliar spray at 40 DAS;  $T_3$ ,  $T_1$  + B (0.1%) as foliar sprays at 40 and 60 DAS;  $T_9$ ,  $T_1$  + Zn (0.25%) as foliar sprays at 40 and 60 DAS; and  $T_{10}$ ,  $T_1$  + B (0.1%) and Zn (0.25%) as foliar sprays at 40 and 60 DAS. The sources of nutrients used in the experiment were urea (46% N), single superphosphate (16%  $P_2O_5$ ), muriate of potash (60%  $K_2O$ ), borax (11% B) for soil application; zinc sulphate monohydrate (33% Zn) for soil application, Solu-B (20% B) for foliar spray and Zincum-C or chelated zinc (12% Zn) for foliar spray.

Seeds of recently released (2008) lentil variety 'Moitree', collected from All India Coordinated Research Project (AICRP) on MULLaRP, BCKV, Nadia, West Bengal, were sown at 25 cm × 10 cm spacing in furrows after the rainy (*khari*) season rice on 27 November 2013 and 20 November 2014. Two hand-weedings at 25 and 45 DAS were done to keep the field under weed-free condition. Lentil was grown on residual soil moisture along with little rains (78.3 mm in 2013–14 and 27.6 mm in 2014–15) during the cropping periods, and 1 irrigation at pre-flowering stage (30–35 DAS). The growth attributes of lentil like plant height, dry-matter (DM) production and crop-growth rate (CGR) at different stages were noted. The yield components and seed yield were determined at maturity. The economics of cultivation was calculated at post-marketing period, and the data were analyzed using analysis of variance technique (ANOVA) as per standard statistical procedures.

Two micronutrients, viz. B and Zn, with variations in method and time of application had significant influence on plant height, DM and CGR of lentil throughout the cropping period during both the years (Table 1). The maximum plant height was noted with  $T_9$  treatment at harvesting (45.8 cm) but the minimum height with  $T_1$  (RDF @  $N_{20}P_{40}K_{40}$  kg/ha) throughout the life-cycle in the study. The crop treated with  $T_4$  (RDF + soil application of B @ 1.0 kg/ha + Zn @ 5.0 kg/ha) resulted in the highest aerial DM accumulation at 75 and 105 DAS compared to the other treatments. The CGR of lentil showed a steady phase between 46 and 75 DAS as well as between 76 and 105 DAS, which did

**Table 1.** Effect of boron and zinc on growth attributes, seed yield and economics of lentil (pooled data of 2013-14 and 2014-15)

Treatment	Plant height at harvest (cm)	Dry-matter production at 105 DAS (g/m <sup>2</sup> /day)	Crop-growth rate (g/m <sup>2</sup> /day)		Branches/plant	Pods/plant	1,000-seed weight (g)	Seed yield (t/ha)	Total cost of cultivation (×10 <sup>3</sup> ₹/ha)	Net returns (×10 <sup>3</sup> ₹/ha)	Benefit: cost ratio
			46–75 DAS	76–105 DAS							
$T_1$ , RDF ( $N_{20}P_{40}K_{40}$ kg/ha) as basal	41.9	179.1	2.62	2.21	5.5	89.0	18.70	1.03	29.8	22.7	1.76
$T_2$ , RDF + B @ 1 kg/ha as basal	44.2	190.5	3.11	2.10	5.8	90.3	18.87	1.06	33.9	20.3	1.60
$T_3$ , RDF + Zn @ 5 kg/ha as basal	45.5	194.5	3.20	2.09	6.0	92.7	18.73	1.07	31.8	22.8	1.72
$T_4$ , RDF + B @ 1 kg/ha + Zn @ 5 kg/ha as basal	44.5	197.4	3.23	2.16	6.2	94.2	18.72	1.11	35.7	20.7	1.58
$T_5$ , RDF (basal) + B @ 0.1% (40 DAS) as foliar spray	42.1	193.2	2.86	2.42	6.7	95.2	18.83	1.15	31.4	27.1	1.86
$T_6$ , RDF (basal) + Zn @ 0.25% (40 DAS) as foliar spray	45.7	185.0	2.76	2.21	6.7	95.7	19.42	1.17	36.0	23.6	1.66
$T_7$ , RDF (basal) + B @ 0.1% + Zn @ 0.25% (40 DAS) as foliar spray	44.6	190.1	2.79	2.38	6.3	99.0	19.20	1.14	37.5	21.0	1.56
$T_8$ , RDF (basal) + B @ 0.1% twice (40 and 60 DAS) as foliar spray	44.3	196.3	2.94	2.43	6.5	96.0	19.30	1.18	33.1	26.8	1.81
$T_9$ , RDF (basal) + Zn @ 0.25% twice (40 and 60 DAS) as foliar spray	45.8	191.3	3.08	2.15	6.7	100.7	19.77	1.19	42.3	18.1	1.43
$T_{10}$ , RDF (basal) + B @ 0.1% and Zn @ 0.25% (40 DAS) + B @ 0.1% and Zn @ 0.25% (60 DAS) as foliar spray	45.6	190.0	3.01	2.16	6.5	102.2	19.73	1.21	44.5	17.2	1.39
SEm±	0.39	0.82	0.03	0.05	0.11	1.37	0.19	0.03			
CD (P=0.05)	1.12	2.36	0.09	0.14	0.31	3.93	0.54	0.08			

B, Boron; Zn, zinc; RDF, recommended dose of fertilizer; SEm, standard error of means; CD, critical difference; DAS, days after sowing; cost of lentil seed, ₹ 68/kg (2013), ₹ 70/kg (2014); labour wages, ₹ 167/manday (2013), ₹ 193/manday (2014); rate of diesel, ₹ 52.27/litre (2013), ₹ 63.49/litre (2014); cost of urea, ₹ 6.5/kg (2013), ₹ 6/kg (2014); cost of single superphosphate, ₹ 8/kg (2013), ₹ 8/kg (2014); cost of muriate of potash, ₹ 12/kg (2013), ₹ 13/kg (2014); cost of borax, ₹ 320/kg (2013), ₹ 550/kg (2014); cost of zinc sulfate monohydrate, ₹ 110/kg (2013), ₹ 130/kg (2014); cost of solu-B, ₹ 350/kg (2013), ₹ 400/kg (2014); cost of zin cum-C (chelated zinc), 450/kg (2013), ₹ 500/kg (2014); rate of grain, ₹ 50/kg (2013), ₹ 52/kg (2014)

not follow the findings of Sen (2014). The combined application of B @ 1.0 kg/ha and Zn @ 5.0 kg/ha as basal ( $T_4$ ) recorded the highest CGR of lentil between 46 and 75 DAS (3.23 g/m<sup>2</sup>/day), while the foliar spray of B @ 0.25% twice at 40 and 60 DAS ( $T_8$ ) resulted in the maximum CGR between 76 and 105 DAS (2.43 g/m<sup>2</sup>/day). Thus, basal dressing of B @ 1 kg/ha or Zn @ 5.0 kg/ha or combined use of both B (1 kg/ha) and Zn (5 kg/ha) had positive effect on growth of lentil crop compared with foliar spray of these 2 micronutrients either once or twice at mid-early (40 DAS) or mid-growth stages (60 DAS). This could be attributed by the fact that either B or Zn or both applied basal could influence physiological response of lentil crop much earlier than the foliar applications about 40 and/or 60 DAS.

The foliar spray of B @ 0.1% at 40 DAS ( $T_5$ ) or Zn @ 0.25% at 40 DAS ( $T_9$ ) or Zn @ 0.25% twice at 40 and 60 DAS ( $T_9$ ) favoured the branching habit, which resulted in the maximum number of branches (6.7/plant) of lentil. On the other hand, foliar spray of both B @ 0.1% and Zn @ 0.25% twice at 40 and 60 DAS ( $T_{10}$ ) recorded the highest number of pods during 2013–14, 2014–15 and pooled over 2 years (102.2/plant). Among 10 treatments, the foliar spray of both B @ 0.1% and Zn @ 0.25% to lentil at 40 and 60 DAS ( $T_{10}$ ) recorded the highest seed yield during the first year (1.33 t/ha), second year (1.10 t/ha) (data not shown) and pooled values (1.21 t/ha); which was at par with  $T_9$ ,  $T_8$ ,  $T_6$ ,  $T_5$  and  $T_7$  treatments. The seed yield irrespective of treatments were found better in the first year (1.10–1.13 t/ha) than the second year (0.95–1.10 t/ha), probably owing to favourable weather conditions during 2013–14 (temperature 27.8°/12.3°C, rainfall 78.3 mm and bright sunshine 8.1 h) than 2014–15 (temperature 28.4°/14.0°C, rainfall 27.6 mm and bright sunshine 7.9 h).

Based on the estimated economics, the total cost of cultivation and gross returns obtained from the combined foliar spray of B @ 0.1% and Zn @ 0.25% twice at 40 and 60 DAS ( $T_{10}$ ) were the highest (₹44,510/ha and ₹61,752/

ha respectively) for the mean of 2 years; but lower net returns (₹17,242/ha) and benefit: cost ratio (B:C) (1.39) were noted due to greater cost involvement for repeated spraying of both micronutrients (B and Zn) in the investigation. Among 10 micronutrient-based treatments, foliar spraying of B @ 0.1% at 40 DAS ( $T_5$ ) appeared as best cost-effective owing to improved seed yield (1.15 t/ha), highest net returns (₹27,009/ha.) and benefit: cost ratio (1.86) in the study.

Thus, it could be concluded that the foliar spray of both B @ 0.1% and Zn @ 0.25% twice at 40 and 60 DAS resulted in the highest seed yield (1.21 t/ha) of lentil, the additional non-significant production could not be acceptable to the farmers due to greater cost involvement, lower net profit and B : C ratio. Based on 2-year study, single foliar spray of B @ 0.1% at 40 DAS could be used for lentil crop during the winter season for improved yield (1.15t/ha), maximum net return (27,009/ha) and B : C ratio (1.86) in lower gangetic alluvial region of West Bengal.

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