Growth and yield of lentil (*Lens culinaris* L.) as affected by Boron and Molybdenum application in lateritic soil.

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ABSTRACT

Field experiments were conducted during winter seasons of 2004-05 and 2005-06 at the RRSS, Sekahmpur, BCKV, to study the effect of B and Mo to the growth, and yield of lentil grown on inherently poor lateritic soil. The lentil (cv. B77) was raised with application of B and Mo either separately or in mixture through foliage or to soil along with NPK fertilizers. The leaf area index, above ground dry matter and crop growth rate increased with the application of B and Mo. Soil application of B coupled with foliar application of Mo enhanced the yield attributing characters and yield of the lentil crop. The study indicated that growing of lentil in lateritic soils depleted the nutrients particularly micronutrients which resulted in loss of yield and could be recovered, if the relevant micronutrients are supplemented through appropriate application methods and dosage.

Key words*:* Boron, CGR, molybdenum and LAI.

Lentil (*Lens culinaris* L.) is one of the commonly grown pulse crops in India. Pulse crops are generally grown in marginal and poorly fertile soils, almost exclusively under rain-fed condition without proper management practices. Among the major constraints affecting the production of pulses, lack of proper management practices assumes importance on account of continuous depletion of micronutrients due to over mining by way of intensive cropping and continuous application of major (NPK) nutrients only (Fageria *et al*., 2002). Mo is an essential component of nitrogenase and B is essential for the formation of nodules on legume roots (Yanni, 1992). It is, therefore, impending to include micronutrients in fertilization schedules for dry land lateritic tracts (Singh, 2001). Increases in seed yield of pulses from application of micronutrients are reported (Okaz, 1994; Singh, 2001) but the lentil crop has so far received scanty attention. In view of the limited information, this experiment was designed to ascertain the response of lentil crop to application of B and Mo.

MATERIALS AND METHODS

Field experiments were carried out at the RRSS, Sekhampur, Birbhum, Red and Laterite zone, Bidhan Chandra Krishi Viswavidyalaya during two successive winter seasons of 2004- 05 and 2005-06 to study the soil and foliar applications of B and Mo on growth, yield attributing characters and yield of lentil (cv. B77). The physico-chemical properties of the experimental soil are presented in table 1. The experiment consisted of seven treatments *i.e* T_1:control (no input); T_2 : 20:40:20 kg/ha NPK, T_3: T_2 + B (10 kg/ha borax) + Mo (1.5 kg/ha) ; T_4:T_2 + B (10 kg/ha) + Mo (0.2% as foliar at 45 and 65 DAS); T_5 :T_2 + B (10 kg/ha); T_6: T_2 + Mo (1.5 kg/ha); and T_7 :T_2 + Mo (0.2% as foliar at 45 and 65 DAS).The sources of N,P,K, B and Mo were urea, single superphosphate, muriatic of potash, borax and ammonium molybdate respectively. The experiment was laid out in a randomized block design with three replications. The seeds were sown on 2nd December 2004 and 5th December 2005 with a seed rate of 16 kg/ha with a spacing 30 x 10 cm in 5 x 4 m plots. Crop management practices were done as per schedule and necessity.

Representative plant samples were collected at 20, 40, 60, 90 and 120 (at harvest) DAS. The above ground portions were oven dried at 80^0 C for 48 h for dry weight. The CGR was calculated following the method of Brown (1984). The leaf area at 90 DAS was measured using leaf area meter and the LAI was calculated. Three plants from each plot were uprooted carefully at 70 DAS. The root nodules were counted and then oven dried at 50^0 C for 5 days to record the dry weights. Random samples from 10 plants, leaving two border rows, were taken from each plot at harvest and the plant height, number of pods/plant, 1000-seeds weight and seed yield were measured. Data were analyzed using SPSS (10.0.1version) statistical software and the treatment means were compared by Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

The above ground dry matter (AGDM) accumulated slowly up to 40 DAS and then rapidly till maturity (Fig 1). The T_4 treatment recorded higher dry matter than the other treatments. During the maximum dry matter accumulation at 120 DAS, the treatments in which B and Mo were used either singly or in combination applied to soil or foliage recorded statistically similar values that of the exclusive NPK

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fertilizers (T_2) treatment. A marginal increase in dry matter could be observed in the T_6 treatment (13.18 g/plant) where Mo was applied foliarly than the soil application (T_7, 12.67 g/plant). In general, irrespective of the treatments, the peak CGR occurred during 60-90 DAS corresponding to the pod development stage of lentil (Fig. 2). The maximum CGR at 60-90 DAS was registered with T_4 treatment (0.25 g/plant/day) although not statistically different from treatments - T_5 (0.186 g/plant/day), T_3 (0.182 g/plant/day), T_7 (0.180 g/plant/day) and T_6 (0.179 g/plant/day). However, the exclusive NPK fertilizers treatment (T_2) although showed lower CGR values, but statistically similar to the treatments T_3, T_6 and T_7. Increased CGR in the treatments inclusive of B and Mo is indicative of enhanced physiological growth condition of a crop which enables to produce higher seed yield (Karim and Fattah, 2007). A linear relationship ($R^2 = 0.807$) between CGR and seed yield was indicated in this study (Fig. 3), as also observed by Mondal and Fattah (1997) in rapeseed.

The plots treated with NPK fertilizers plus soil application of B and foliar application of Mo (T_4 treatment) showed higher LAI (5.28) at 90 DAS, although not statistically different from the other treatments, except the control treatment (2.98) which registered the significantly lowest LAI (Table 2). The relationship between LAI and seed yield of lentil was positive and linear ($R^2 = 0.99$) (Fig. 4). Similar relationship was also obtained by Motior *et al*. (1997). The plant height recorded at 75 DAS did not vary much between the treatments consisting of both macro and micronutrients (Table 2). The control treatment produced the shortest plants (32.8 cm). The T_4 treatment produced maximum number of pods/plant (48), followed by T_3 (43) and T_5 (41) treatments. The number of nodules/plant showed notable variation among the treatments. The T_4 treatment (23) was responsible for maximum number of nodule / plant (23) but was not statistically different from the T_3 treatment (18). Application of B and Mo either singly or in mixture enhanced the production of nodules than the exclusive NPK fertilizer treatment (T_2) but the increases were marginal. Foliar application of Mo (T_7 treatment) was slightly better than soil application (T_6 treatment) in increasing the nodule number/plant. The nodule dry weight/plant ranged from 123 mg (control), to 218 mg (T_4) (Table 2). Soil application of NPK+B+Mo (T_3 treatment) showed statistically higher nodule dry weight/plant as compared to the exclusive NPK fertilizers treatment (T_2). The 1000-seeds weight was not affected much by the treatments. The application of NPK fertilizers (T_2) increased the lentil seed yield by 32 % over the control treatment. On an average, the NPK+ micronutrients application treatments (T_3, T_4, T_5, T_6 & T_7) manifested 61 and 21% increase in seed yield over control and NPK fertilizer treatments respectively. These might be due to enhanced the photosynthesis process and translocation of photosynthetic products to the seeds as a result of increased enzymatic and other biological activities, as also indicated by Zeidan *et al*. (2006). The seed yield in plots lacking in one of the micronutrients (T_5, T_6 and T_7 treatments) showed losses, while not statistically different from the treatments T_3 and T_4 where both B and Mo were applied. On the other hand, when Mo was either applied as foliar along with soil application of B or applied singly to soil, the increase in seed yield was marginal. The results are in harmony with the work conducted by Okaz *et al*. (1994). Sharief and Said (1998) found that foliar application with micronutrients either separately or in mixture significantly increased the seed yield of lentil. Yang *et al*. (2009) reported that application of B fertilizer to sandy soil increased the seed yield by 46% compared to control. The combined application of B with Mo or Zn resulted in higher seed yield than their single applications.

The results of the present experiments suggested that micronutrient application along with macronutrients could prove advantageous in increasing the seed yield of lentil in the resource poor soils of the dry land lateritic tracts.

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Table 1 : Physico-chemical properties of the experimental soil

Properties	Value
Sand (%)	62
Silt (%)	24
Clay (%)	24
pH	5.2
Organic carbon (%)	0.62
Total N (%)	0.48
Available P (kg/ha)	12
Available K (kg/ha)	212
B (ppm)	0.46
Mo (ppm)	0.18

Table 2 : Effect of different treatments on growth parameters and seed yield of lentil.

Treatment	Plant height (cm)	Leaf area index (90 DAS)	Pods/ plant	Nodule no. /plant	Nodule Dry weight/ plant (mg)	1000-Seed weight (g)	Seed yield (q/ha)
T_1	32.8 b	2.98 b	21 c	6 d	123 e	21.6 a	7.4 c
T_2	37.2 a	3.87 a	35 b	10 cd	172 d	23.4 a	9.8 b
T_3	39.7 a	4.93 a	43 ab	18 ab	202 b	23.8 a	12.4 ab
T_4	40.8 a	5.28 a	48 a	23 a	218 a	24.7 a	13.6 a
T_5	38.2 a	4.75 a	41 ab	16 bc	193 bc	23.5 a	11.8 ab
T_6	37.5 a	4.13 a	37 b	12 c	184 cd	22.7 a	10.7 ab
T_7	38.2 a	4.32 a	39 b	14 bc	195 bc	22.1 a	11.1 ab

Note: Values followed by the same alphabet in a vertical column do not differ significantly at 5% level.
T_1: control (no input); T_2 : 20:40:20 kg/ha NPK, T_3: T_2 + B (10 kg/ha borax) + Mo (1.5 kg/ha) ;
T_4:T_2 + B (10 kg/ha) + Mo (0.2% as foliar at 45 and 65 DAS); T_5 :T_2 + B (10 kg/ha);
T_6: T_2 + Mo (1.5 kg/ha); and T_7 :T_2 + Mo (0.2% as foliar at 45 and 65 DAS)

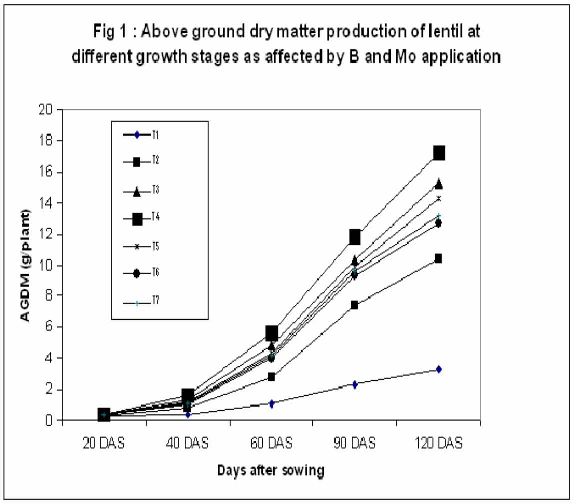

Fig 1 : Above ground dry matter production of lentil at different growth stages as affected by B and Mo application

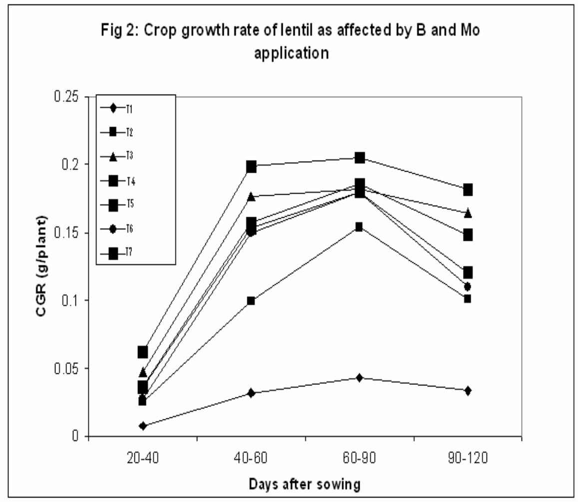

Fig 2: Crop growth rate of lentil as affected by B and Mo application

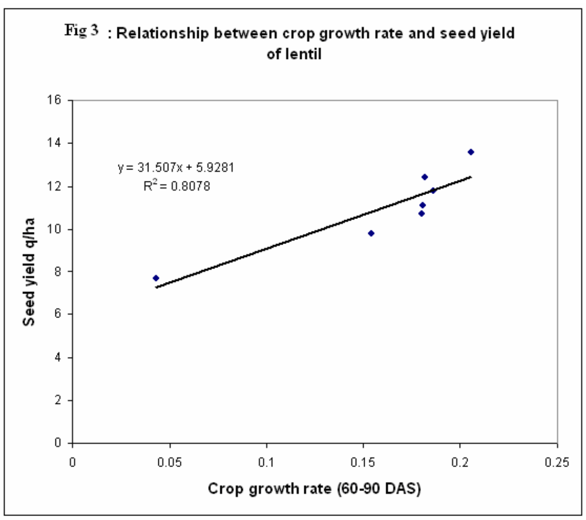

Fig 3 : Relationship between crop growth rate and seed yield of lentil

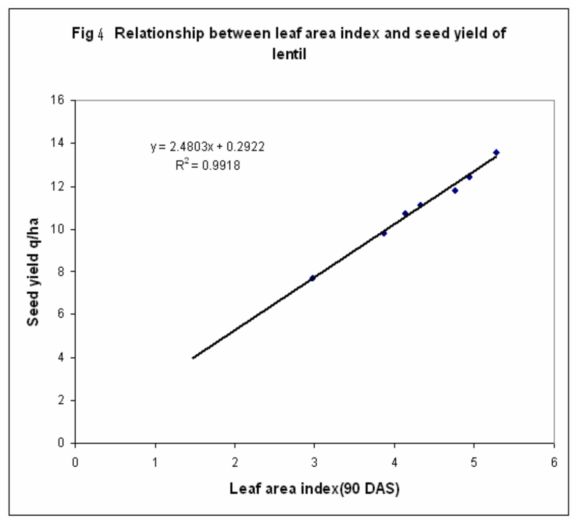

Fig 4 Relationship between leaf area index and seed yield of lentil