Annals of Plant and Soil Research 17(4): 385-387 (2015)

EFFECT OF BORON ON YIELD, QUALITY AND UPTAKE OF NUTRIENTS BY LENTIL

DHARVENDRA SINGH*, ARCHANA KHARE[1], REENA SHARMA AND SUKHVIR SINGH CHAUHAN

RVSKVV, Krishi Vigyan Kendra, Morena (M.P.) - 456002
Recived: June, 2015; revised Accepted: October 2015

ABSTRACT

A field experiment was conducted on an alluvial soil to study the effect of boron on yield, quality and uptake of nutrients in lentil crop during rabi season 2010-12 at farmers field, at Jeegani, Morena (M.P.). The experiment was laid out in randomized block design with five levels of boron (0, 0.5, 1.0, 1.5 and 2.0 kg ha^{-1}) with four replications. Application of boron up to 1.0 kg B ha^{-1} significantly increased the grain and straw yields of lentil by 20.4 and 16.2%, respectively, whereas at higher boron level (2.0 kg B ha^{-2}) the yields tended to decline. Boron application increased the uptake of N,P,K and S up to 1.0 kg B ha^{-1} and that of B up to 1.5 kg B ha^{-1}. The maximum value of protein content (22.0%) and yield (350.2 kg ha^{-1}) in grain were recorded with 2.0 and 1.0 kg boron ha^{-1}, respectively. Lentil crop gave maximum net profit (Rs 52023 ha^{-1}) and B/C ratio (4.32) with 1.0 kg B ha^{-1}. The apparent recovery of boron was influenced by its level with maximum (0.30%) at 0.5 kg B ha^{-1}. The boron use efficiency decreased with its increasing levels and minimum use efficiency was recorded at 2.0 kg B ha^{-1} application.

Keywords: Boron, yield, quality, nutrient uptake, lentil.

INTRODUCTION

Lentil (Lens culinaris Medik) is traditionally cultivated under rain fed condition during rabi season. It is generally grown in poor soils with little or no fertilizers, leading to low productivity. There are many agro-ecological, biological and management related constraints that are responsible for lower productivity of lentil. There is a lot of scope for increasing its production through application of required nutrients especially boron. The demand for boron by legumes is more as compared to most of the field crops. Boron being a less mobile element in the phloem, its deficiency usually appears on young growth. Boron plays a vital role in transport of carbohydrates as well as in cell wall metabolism, permeability and stability of cell membranes and phenol metabolism, with primary role in lignin biosynthesis. Deficiency of boron restricts stomata opening and transpiratory water loss and also leads to enhanced leakage of solutes across the plasma membrane. In addition it has an important role in improving the quality of produce (Mahajan *et al.* 1994, Noor *et al.* 1997). The application of boron through soil or foliar application was found to be beneficial in stimulating plant growth and yield (Nagula *et al.* 2015). Since, the area-specific information on different aspects of nutritional requirement of lentil is not adequately available. The present investigation was, therefore, undertaken to study the variability in the response of lentil crop to boron application in alluvial soil of Morena Madhya Pradesh.

MATERIALS AND METHODS

The study was carried out during rabi seasons of 2010-11 and 2011-12 at farmer field, at Jeegani, Morena (Madhya Pradesh). The pH, EC, organic carbon and HWS-B of the soil at the initial stage (before sowing) were 8.0, 0.20 dSm^{-1}, 4.2 g kg^{-1} and 0.50 mg kg^{-1}, respectively. The soil was low in available N (170 kg ha^{-1}), P (9.5 kg ha^{-1}) and medium in K (176 kg ha^{-1}). Boron was applied to soil at the rate of 0, 0.5, 1.0, 1.5 and 2.0 kg B ha^{-1}. Lentil (Var.) was sown on November 25, in both the years. Randomized block design was followed with four replications. A basal application of 25 kg N, 60 kg P_2O_5 and 60 kg K_2O ha^{-1} was given to lentil through urea di ammonium phosphate and muriate of potash, respectively. The lentil crop was harvested at maturity and yields were recorded. Grain and straw samples were drawn and processed for chemical analysis taking special care against boron concentration. The samples were digested in di-acid mixture (HNO_3 and $HClO_4$, 5:1) and boron concentration was determined by carmine method (Hatcher and Wilcox 1950). Nitrogen in grain and straw was determined by Kjeldahl method, phosphorus in di-acid extrat by ammonium molybdate venadate yellow colour method, (Jackson 1973), potassium by flame-photometer and sulphur by turbidimetric method (Chesnin and Yien 1951). The uptake of nutrients in grain and straw was worked out by multiplying content values with yield data. Economics of various treatments was calculated on the basis of prevailing market prices of inputs and produce.

RESULTS AND DISCUSSION

Yield

The result distinctly indicated that lentil crop responded markedly to boron application (Table 1). In general, each additional dose up to 1.0 kg B ha^{-1} increased significantly the grain and straw yields and thereafter a decreasing trend was observed. A level of 1.0 kg B ha^{-1} appeared to be the optimum dose under the experimental conditions. The yield of lentil grain ranged from 13.22 q ha^{-1} with control to 15.92 q ha^{-1} at 1.0 kg. The corresponding range of straw yield was from 24.79 to 28.82 q ha^{-1}. The grain and straw yield increased by 20.4 and 16.2 percent with 1.0 kg B ha^{-1} over control, respectively. This may be because boron takes part in active photosynthesis, which ultimately helps towards increase in quality and yields of lentil crop. Rajani and Meitei (2004) and Kumar *et al.* (2009) also reported that boron improved the yield of French bean and lentil over control, respectively.

Protein

The protein content of lentil crop increased with increasing levels of boron up to 2.0 kg B ha^{-1}. Increases in protein content in grain and straw were from 21.3 to 22.0% and 3.8 to 4.1%, respectively with 2 kg B ha^{-1}. The increase in protein content with boron application might be attributed to increase in the activity of enzymes involved in protein synthesis on its addition. Kumar *et al.* 2009 reported similar results. The protein yield increased with boron application and maximum values of protein yield (350.2 kg ha^{-1}) was noted at 1.0 kg B ha^{-1} level. This increase in protein yield may be attributed to greater production of grain and improvement in protein content due to boron addition. The highest level of B (2.0 kg B ha^{-1}) could not improve the protein production in lentil crop over 1.0 kg B ha^{-1} due to poor grain yield. The increase in protein yield with boron application has been reported by Sinha and Chatterjee (2003) and Kumar *et al.* (2009).

Table 1: Effect of boron levels on yield quality and economics of lentil (mean of two years)

Boron (kg ha^{-1})	Grain Yield (q ha^{-1})	% Response	Straw yield (t ha^{-1})	Protein content (%)		Protein Yield (kg ha^{-1})	Net return (Rs ha^{-1})	B/C Ratio
				Grain	Straw			
0	13.22	-	24.79	21.3	3.8	281.6	40380	3.25
0.5	14.57	10.2	26.00	21.6	3.9	314.7	47357	4.00
1.0	15.92	20.4	28.82	22.0	4.0	350.2	52023	4.32
1.5	15.45	16.9	28.28	22.1	4.1	341.4	47265	3.96
2.0	14.50	9.7	26.00	22.0	4.1	319.0	46830	3.60
CD (P=0.05)	1.35		1.70	0.38	0.11	28.4		

Economics

The monetary advantage (Table 1) indicated that the lentil crop gave higher benefits with boron application over control. The maximum net return (Rs, 52023 ha^{-1}) was obtained by lentil with 1.0 kg B ha^{-1}. Similarly, the maximum value of B/C ratio in lentil (4.32) was obtained with 1.0 kg B ha^{-1}. The minimum values of net returns (Rs, 40380 ha^{-1}) and B:C ratio (3.25) were recorded in no boron (control) treatment. The pooled data showed that application of 1 kg B ha^{-1} resulted in significantly higher lentil grain yield and also proved economically beneficial with highest net returns and benefit: cost ratio. This could be attributed to higher yield with this treatment. Kumar *et al.* (2006) and Kumar *et al.* (2009) also showed that the B/C ratio was significantly superior with the application of boron in gram and lentil respectively.

Nutrient uptake

A perusal of the data (Table 2) indicated that different levels of boron had significant effect in comparison to control on uptake of nutrients i.e. N, P, K, S and B in both grain and straw. The uptake values of all the nutrients commensurate with grain and straw yield under different boron treatments. The mean N uptake increased significantly up to 1.0 kg B ha^{-1}, thereafter, a declining trend was observed at 2 kg B ha^{-1}. Higher values of N uptake with boron addition are apparently the result of favorable effect of this element on N absorption coupled with grater grain and straw production (Kumar *etal.* 2009). Phosphorus uptake increased significantly up to 1.0 kg B ha^{-1} in grain and straw. Phosphorus uptake by grain ranged between 3.7 and 5.2 kg ha^{-1} and by straw from 2.2 to 4.2 kg ha^{-1}, which shows that grain removed more P than straw. Potassium uptake in grain and straw increased up to 1.0 kg B ha^{-1}, and thereafter decreased significantly at 2.0 kg B ha^{-1} (Noor *et al.* 1997) Uptake of sulphur increased up to 1.0 kg B ha^{-1} in grain and straw. The mean sulphur uptake by grain and straw ranged from 2.6 to 3.5 and 2.5 to 3.4 kg ha^{-1}, respectively. The grain removed more S than straw, which shows that B plays an important role in grain formation. The boron uptake increased upto 2.0 kg

B ha^{-1} in grain and straw. The mean increases in boron uptake by lentil grain and straw were from 39.7 to 85.1 and 52.6 to 133.1 g ha^{-1}, respectively with rising B levels. The control plot recorded lower uptake of nutrients compared to boron applied treatments. An increase in B removel in grain and straw of lentil is obvious as B application had significantly increased available B in the soils.Similar results were reported by Sakal *et al.* (1998) and Kumar *et al.* (2006) in gram.

Table 2: Effect of boron levels on uptake of N, P, K, S kg ha^{-1} and B g ha^{-1}) by lentil (mean of two years)

Boron (kg ha^{-1})	Nitrogen		Phosphorus		Potassium		Sulphur		Boron		PAR (%)	BUE (Kg produce/ kg boron)
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw		
0	45.1	15.1	3.7	2.2	10.6	43.6	2.6	2.5	39.7	52.6	-	-
0.5	50.2	16.1	4.2	3.4	11.6	46.0	3.0	2.9	53.9	80.6	0.028	27.0
1.0	55.9	18.4	4.9	3.7	12.6	50.7	3.5	3.4	71.9	111.0	0.030	27.0
1.5	54.7	18.6	5.2	4.2	12.2	49.5	3.1	3.1	78.7	126.1	0.026	14.8
2.0	51.0	16.9	4.8	3.6	11.3	45.0	2.6	2.6	85.1	133.1	0.022	6.4
CD(P=0.05)	2.80	0.81	0.62	0.43	0.68	2.90	0.55	0.37	7.15	10.5	-	-

Efficiency indicates

The maximum values of apparent recovery of boron by lentil crop was 0.3% at 1.0 kg B ha^{-1} and minimum at 2.0 kg B ha^{-1} level. Thus, percent apparent recovery declined with increase in the rates of boron application (Table 2). The boron use efficiency (kg produce / kg B) declined with increase in the rates of boron application (Table 2). The response in kg produce / kg boron showed a decline with increasing levels of B from 27 kg grain / kg B at 0.5 and 1.0 kg B ha^{-1} to 6.4 kg grain / kg B at 2.0 kg B ha^{-1}. Thus, better boron use efficiency was obtained with 0.5 or 1.0 kg B ha^{-1} recording 27.0 kg grain per kg boron application.

From the present investigation, it may be inferred that application of 1 kg B ha^{-1} in lentil resulted in higher yields and uptake of nutrients. Therefore, it may be concluded that application of 1 kg B ha^{-1} appears to be the best dose for obtaining higher yield and utilization of nutrients in lentil under agro-climatic condition of Morena (M.P.).

REFERENCES

Hatcher, J.T. and Wilcox, L.V. (1950) Colorimertric determination of boron using carmine, *Analytical Chemistry*. **22**: 567-569.

Jackson, M.L. (1973) *Soil Chemical Analysis*. Prentice Hall of India, Pvt.Ltd., New Delhi.

Kumar, Ashok, Prasad, Shambhu and Kumar, S.B (2006) Effect of boron and sulphur on performance of gram (*Cicer arietinum*). *Indian Journal of Agronomy* **51**: 57-59.

Kumar, S., Singh, V. and Solanki, V.P.S (2009) Effect of boron and phosphorus application on yield and uptake of nutrients in lentil. *Annals of Agricultural Research. New Series* **30**:108-110.

Mahajan, T.S., Chavan, A.S. and Dongale, J.H. (1994) Effect of boron on yield and quality of groundnut (*Arachis hyogaea*) on lateritic soil. *Indian Journal of Agricultural Sciences* **64**: 532-535.

Nagula, S., Joseph, B. and Gladis, R. (2015) Effect of silicon and boron on nutrient status and yield of rice in laterite soils. *Annals of Plant and Soil Research* **17** 93): 299-302.

Noor, S., Hnnan, M.A. and Islam, M.S. (1997) Effect of molybdenum and boron on the growth and yield to ground nut. *Indian Journal of Agricultural Research* **31**(1): 51-58.

Rajani, K. and Meitri, W.I. (2004) Effect of boron and zinc on growth and yield of French bean (*Phaseolus vulgaris* L.) Environment and Ecology **22**: 83-85.

Sakal, R., Sinha, R.B., Singh, A.P. and Bhigal, N.S. (1998) Response of some rabi pulses to boron, zinc and sulphur application in farmers field. *Fertilizer News* **43**: 37-40.

Singh, A., Singh, B.B. and Patel, C.S. (1992) Response of vegetable pea (*Pisum sativam)* to zinc, boron and molybdenum in an acid Alfisol of Meghalaya. *Indian Journal of Agronomy* **37**(3):615-616.

Sinha, Pratima and Chatterjee, C. (2003) Influence of low boron on yield and seed quality of soybean. *Indian Journal of Agricultural Research* **34**: 193-198.