Reprint **ISSN 1923-7766 (Web Version)**

International Journal of Experimental Agriculture

(Int. J. Expt. Agric.)

Volume: 4	Issue: 3	September 2014

Int. J. Expt. Agric. 4(3): 1-6 (September 2014)

EFFECT OF SEED TREATMENT WITH BORON AND MOLYBDENUM ON THE YIELD AND SEED QUALITY OF CHICKPEA

M.S. RAHMAN, M.N. ISLAM, M.R. SHAHEB, M.A. ARAFAT, P.C. SARKER AND M.H. SARKER

An International Scientific Research Publisher

Green Global Foundation©

Web address: http://ggfjournals.com/e-journals archive

E-mails: editor@ggfjournals.com and editor.int.correspondence@ggfjournals.com

ISSN-1923-7766 (Online)
Int. J. Expt. Agric. 4(3):1-6(September 2014)

EFFECT OF SEED TREATMENT WITH BORON AND MOLYBDENUM ON THE YIELD AND SEED QUALITY OF CHICKPEA

M.S. RAHMAN[1a], M.N. ISLAM[1b], M.R. SHAHEB[2*], M.A. ARAFAT[1c], P.C. SARKER[1d] AND M.H. SARKER[3]

[1a]Principal Scientific Officer & [1b&c]Scientific Officer (SO), and [1d]Senior Scientific Officer (SSO), Seed Technology Division,
[3]SO, Farm Division, Bangladesh Agricultural Research Institute (BARI), Gazipur, Bangladesh;
[2]SSO, On Farm Research Division, BARI, Sylhet, Bangladesh.

*Corresponding author & address: Md. Rayhan Shaheb, E-mail: smrayhan@bari.gov.bd
Accepted for publication on 5 August 2014

ABSTRACT

Rahman MS, Islam MN, Shaheb MR, Arafat MA, Sarker PC, Sarker MH (2014) Effect of seed treatment with boron and molybdenum on the yield and seed quality of chickpea. *Int. J. Expt. Agric.* 4(3), 1-6.

Micronutrients are vital for plant growth and human health. Soil and foliar applications are the most prevalent methods of micronutrient addition but the cost involved and difficulty in obtaining high quality micronutrient fertilizers are major concerns with these in developing countries. Seed treatments with micronutrient, which include seed priming and seed coating, are an attractive and easy alternative. The experiment was conducted at the farming systems research and development site, Chabbishnagar, Barind, Rajshahi, Bangladesh during *rabi* (winter) season 2009-2011 to evaluate the influence of seed treatment with boron (B) and molybdenum (Mo) on the yield and seed quality of chickpea. Sixteen treatments combinations from four doses *viz*. each of B 0.0, 1.0, 2.0 and 4.0 $gKg^{-1}$and Mo 0.0, 0.5, 1.0 and 1.5 gKg^{-1} seed were used in the form of boric acid and ammonium molybdate, respectively and mixed with seed prior to sowing. Results revealed that seed yield and yield contributing characters showed significant difference when the seeds were treated with 1.0 to 2.0 g of B and 0.5-1.0 g of Mo. Seed treatment with 2.0 g B and 1.0 g Mo along with 40-30-40-20-2 kg N-P-K-S and $Znha^{-1}$ can be used for higher seed yield (1109.61 $Kgha^{-1}$) and quality (96.0% germination) seed production of chickpea. However, there were no significant influence of seed treatment on the quality and protein content of seed.

Key words: *seed treatment, boron, molybdenum, chickpea, seed yield, seed quality*

INTRODUCTION

Chickpea (*Cicer arietinum* L.) commonly known as gram, is a major pulse crop in Bangladesh stands 5th in respect of area (19000 acre) and production (77000 ton) among the pulse crop (BBS 2012). The average yield of chickpea (750 $Kgha^{-1}$) is low and almost stagnant over the years (BBS 2004) while in neighboring country like Myanmar the average yield increased from 600-1000 $Kgha^{-1}$ in the recent years (ICRISAT 2003). For the last few years, Botrytis Grey Mold (BGM) disease incidence is the main concern for chickpea production. Due to this, many farmers of the major chickpea growing areas like Faridpur and Pabna are shifting to *boro* rice cultivation from chickpea. Almost all the local and high yielding varieties (HYV) of chickpea are susceptible to BGM. BARI has identified a new line CCL 87322, an open canopy type, tolerant to BGM. Its open canopy type, that can pass more light and air through the plants than that of creeping and bushy type traditional varieties, which restricts the fungal growth of BGM.

Balanced fertilization with micronutrients can enhance the chickpea production to a considerable extent. Micronutrients play an important role in increasing the yield of pulse and oilseed legumes through their effects on plant itself and on the nitrogen fixing symbiotic process. Gaur *et al.* (2010) reported that intensive cropping without application of micronutrients, limited or no application of organic fertilizers and leaching losses lead to deficiency of one or more micronutrients in the soil. The important micronutrients for chickpea include; Sulphur (S), Zinc (Zn), Iron (Fe), Boron (B) and Molybdenum (Mo). The soils of different parts of Bangladesh are more or less deficient in B and Mo. B is very important in cell division, regulate carbohydrates metabolism, involved in protein synthesis and play role in pod and seed formation synthesis (FRG 2012; Dell and Huang, 1997; Tanaka and Fujiwar, 2008). Salam (2005) observed that seed yield of chickpea (cv. BARI Chola 5) increased significantly due to application of 1.0 to 1.5 Kg Bha^{-1}. Bihari *et al.* (2002) reported that seed yield of chickpea increased with the application of B @ 2.5 $Kgha^{-1}$.

In comparison, the response of the crop to the application of B is higher in chickpea than in some cereals (Wankhade *et al.* 1996). B deficiency can be caused by high pH in the soil and the availability of B decreases when the pH is larger than 6.5-7.0 (Sims 2000), which occur in highly leached sandy soils or in low organic matter soils. Soil application of 1.0-2.5 Kg Borax ha^{-1} or foliar application of 0.25 Kg Borax ha^{-1} helps in correcting B deficiency.

Mo is required for the formation of nitrate reductase enzyme (FRG 2012) and it plays an additional role in the symbiotic nitrogen fixation in the legumes. The nitrogen fixing enzyme, nitrogenase is composed of Mo and Fe and without adequate quantities of these elements nitrogen fixation cannot occur. Mo is related directly to N fixation by legumes (Roy *et al*. 2006). The availability of Mo increases as the pH of the soil approaches neutrality (pH 7.0) or is higher than neutral (Sims 2000). Mahler (2005) reported that a rate of 1 pound per acre of Mo should apply to the soil at pH less than 5.7. Seed treatment with 3.5 g sodium molybdate has been found to have beneficial effect in chickpea and the response to molybdenum was greater when applied along with P and Rhizobium inoculation (Gaur *et al*. 2010). Effects of Mo and B on different grain legumes have been reported by many Scientists (Bhuiya *et al.* 1998; Verma *et al.* 1988; Tiwari *et al*. 1989 and Zaman *et al.* 1996). Shil (2007) reported that a combination of 2.5 Kg B with 1.0 to 1.5 Kg Mo ha^{-1} produced significantly higher seed yield of chickpea in both calcareous and non-calcareous flood plain soils in Bangladesh with blanket dose of NPK and 5 tons cowdung ha^{-1}. The micronutrient B may cause yield losses up to 100% and the availability of Mo is low in acidic soils (Ahlawat *et al*. 2007). B, in acidic soils, has been shown to be a major reducer of chickpea yields in some regions (Srivastava *et al*. 1997). In our country, so far different agronomic and fertilizer management efforts like bio-fertilizer were made to enhance chickpea production but little efforts have so far been made to see the performance of micronutrients against chickpea specially by treating the seed with micronutrients where very small amount of micronutrients are required compared to soil application thereby less chance of soil toxicity and economic loss. Seed treatment is a recognized method especially for micronutrient which ensure better and healthy initial plant population and ultimately results in better economic yield. With this view in mind, the experiment was conducted at Chabbishnagar, Rajshahi, Bangladesh by treating the chickpea seeds prior to sowing with boron and molybdenum to observe the performance in the field in respect of yield and seed quality.

MATERIALS AND METHODS

The experiment was conducted at the farming system research and development (FSRD) site, Chabbishnagar, High Barind Tract, Rajshahi, Bangladesh during *rabi* (winter) season of two consecutive years 2009-2010 and 2010-2011. The initial soil nutrient status is presented in Table 1.

Table 1. Initial nutrient status of the experimental site Chabbishnagar, Rajshahi, Bangladesh

Properties	**pH**	**K meq/100g**	**Ca meq/100g**	**P µg/g**	**B µg/g**	**Mo µg/g**	**Total N (%)**
Value	5.6	0.17	1.27	21.0	0.17	-	0.041
Critical level	-	0.20	2.0	14.0	0.20	-	0.12
Interpretation	Acidic soil	low	Low	High	Low		Low

The experiment was laid out in a factorial randomized complete block design with three replications having sixteen treatment combinations from four doses each of B and Mo. The doses of B and Mo @e 0, 1.0, 2.0, 4.0, and 0, 0.5, 1.0 and 1.5 gKg^{-1} seed were applied in the form of boric acid and ammonium molybdate, respectively. The micronutrients were mixed with drops of water to make paste and then mixed with the seed coat of the seed prior to sowing. After mixing, the seeds were dried in air under shade for one hour. The seeds were sown in 40cm x 10cm line on 24 November in 3m x 2m unit plot. All the fertilizers such as urea, TSP, MP, gypsum and zinc sulphate were applied as basal following the blanket dose @ 40-30-40-20-2 kg N-P-K-S and Zn ha^{-1}, respectively during the final land preparation. After germination, data on emergence and prior to flowering, data on nodules were recorded. At harvest, data on plant population, plant height, number of branches per plant, number of pods per plant and number of seeds per pod were taken carefully. After harvest, 100 seed weight and plot wise seed yield were recorded and then converted into per hectare of seed yield. Seeds were tested for germination and vigour to ascertain the seed quality and also for protein content. Data were analyzed into ANOVA using MSTATC programme and the means were compared by DMRT (Gomez and Gomez., 1984). Seed germination and vigour index were calculated on the basis of the following formula:

$$i)\ \textit{Seed germination (\%)} = \frac{\textit{No. of seed germinated}}{\textit{Total seed}} \times 100 \ ....(A)$$

$$ii)\ \textit{Vigour index (VI)} = ASDW \times PG \ ....(B)$$

Where,
VI = Vigour index;
ASDW = Average seedling dry weight;
PG = Percentage germination.

RESULTS AND DISCUSSION

The agronomic characters of chickpea like seedling emergence, nodule number, plant height and plant population showed significant variation due to the combined effect of B and Mo (Table 2). From the study it was observed that chickpea seeds treated with 2.0 g B along with 1.0 g Mo influenced the seed germination and highest emergence (89.63%). It is evident that both the micronutrients exerted significant effect on the emergence of plant. Excessive amount of B and Mo had comparatively less influence on seedling emergence. Among the agronomic characters, only nodule number failed to show any significant effect due to the application of micronutrients either in single on in combination. The results is partially agreed with Yanni (1992), who reported that chickpea responded to the soil application of sodium molybdate along with sodium borate increased nodule dry weight, plant dry weight and N-content 60 days after sowing and seed yield, seed size and N and P contents of seed. Plant height indicates the ability of the plants to use the resources within their vicinity. In the study, treating the seeds with boron and molybdenum jointly influenced the growth of plants and the highest plant height (49.21 cm) was observed, when 2.0 g B along with 1.5 g Mo were used for treating the seeds before sowing (Table 2). Identical results were also obtained from the treatment where B was used in combination with Mo. Interaction was observed between Mo and B, interpreted as indicating that Mo can counteract the effect of B application. In Mo deficient chickpea, the flowers produced are fewer in number, smaller in size and many of them fail to open or to mature leading to lower seed yield (Roy *et al*. 2006).

Table 2. Agronomic characters of chickpea as influenced by seed treatment with Boron and Molybdenum

Treatments	**Field emergence (%)**	**Nodule plant^{-1} (nos.)**	**Plant height (cm)**	**Plants m^{-2} (nos.)**
T_1 ($B_0Mo_{0.0}$)	86.44bc	11.3	46.87bc	21.00bc
T_2 ($B_0Mo_{0.5}$	81.63cd	10.8	47.80b	21.33bc
T_3 ($B_0Mo_{1.0}$)	79.22de	10.2	45.60c	20.00c
T_4 ($B_0Mo_{1.5}$)	80.83d	9.9	44.47cd	21.16bc
T_5 ($B_{1.0}Mo_{0.0}$)	82.33cd	11.4	48.22ab	23.82ab
T_6 ($B_{1.0}Mo_{0.5}$	79.28de	11.3	48.30ab	24.00a
T_7 ($B_{1.0}Mo_{1.0}$)	87.67ab	10.9	49.15a	24.18a
T_8 ($B_{1.0}Mo_{1.5}$)	85.66bc	10.6	48.67ab	22.10b
T_9 ($B_{2.0}Mo_{0.0}$)	80.00d	10.6	47.62b	22.00b
T_{10} ($B_{2.0}Mo_{0.5}$	74.67e	11.0	48.90ab	21.33bc
T_{11} ($B_{2.0}Mo_{1.0}$)	89.63a	11.0	49.10a	23.88ab
T_{12} ($B_{2.0}Mo_{1.5}$)	87.36ab	10.7	49.21a	22.78b
T_{13} ($B_{4.0}Mo_{0.0}$)	77.88de	10.3	47.61b	21.90b
T_{14} ($B_{4.0}Mo_{0.5}$)	81.88cd	10.0	48.33ab	21.83b
T_{15} ($B_{4.0}Mo_{1.0}$)	86.66bc	9.9	45.22c	22.00b
T_{16} ($B_{4.0}Mo_{1.5}$)	83.33c	10.3	46.87bc	23.22ab
CV (%)	11.16	6.72	13.36	8.69
Level of significance	*	NS	*	*

Plant population was also significantly influenced by the application of B and Mo as seed treatment. Treating with 1.0 g B along with 0.5 to 1.0 g Mo Kg^{-1} seed produced the highest number of plants (24 and 24.18) per unit area. From the result, it was observed that B played significant role than that of Mo since treating the seeds with 1.0 kg B gave the statistically identical result to that of the highest value in this regard. However, the lowest plant population was observed in treatments where B was not used in the experimental plot.

The yield and yield contributing characters of the new chickpea line showed significant difference due to the seed treatment with B and Mo except for the case of number of pods per plant and 100 grain weight (Table 3). Since, branch bears the pod so it has a direct influence on the grain or seed yield of chickpea. In the study, the seeds treated with 2.0 g B and 1.0 g Mo produced the highest number of branches per plant (3.60). Excess amount of B and Mo from seed treatment may have some toxic effect and there by showed negative effect on plant growth. Highest number of pods per plant (44.67) was found when seeds were treated with 4.0 g B and 0.5 g Mo Kg^{-1} of seed. However, this was followed by 4.0 g B and 1.0 to 1.5 g of Mo Kg^{-1} seed that produced the statistically similar pod numbers of chickpea (Table 3). Pod number was the lowest where neither B nor Mo was used as treating material.

Table 3. Yield and yield attributes of Chickpea as influenced by seed treatment with Boron and Molybdenum

Treatments	**Branches plant^{-1} (nos.)**	**Pods plant^{-1} (nos.)**	**Seed pod^{-1} (nos.)**	**100 grain weight (g)**
T_1 ($B_0Mo_{0.0}$)	2.80c	32.66d	1.60	15.74
T_2 ($B_0Mo_{0.5}$	2.80c	35.62cd	1.50	15.56
T_3 ($B_0Mo_{1.0}$)	2.70cd	36.67cd	1.50	15.50
T_4 ($B_0Mo_{1.5}$)	2.90bc	39.66bc	1.50	15.66
T_5 ($B_{1.0}Mo_{0.0}$)	3.00bc	40.21 b	1.50	16.23
T_6 ($B_{1.0}Mo_{0.5}$	3.10bc	38.36c	1.60	16.11
T_7 ($B_{1.0}Mo_{1.0}$)	3.30ab	41.16b	1.50	15.81
T_8 ($B_{1.0}Mo_{1.5}$)	3.20ab	41.67b	1.60	16.00
T_9 ($B_{2.0}Mo_{0.0}$)	3.40ab	38.83c	1.60	16.10
T_{10} ($B_{2.0}Mo_{0.5}$	3.50ab	40.72b	1.60	16.20
T_{11} ($B_{2.0}Mo_{1.0}$)	3.60a	40.96b	1.60	16.12
T_{12} ($B_{2.0}Mo_{1.5}$)	3.40ab	42.33ab	1.70	16.00
T_{13} ($B_{4.0}Mo_{0.0}$)	3.00bc	44.0a	1.60	15.81
T_{14} ($B_{4.0}Mo_{0.5}$)	2.90c	44.67a	1.50	15.81
T_{15} ($B_{4.0}Mo_{1.0}$)	3.00bc	42.16ab	1.60	16.32
T_{16} ($B_{4.0}Mo_{1.5}$)	3.40ab	42.17ab	1.70	16.13
CV (%)	8.73	11.37	5.22	4.32
Level of significance	*	*	NS	NS

Hundred grain weights is an inherent character controlled by the genetic make up of the plants and very hard to have any impact on this character by applying any process or treatment. Likewise here, the two micronutrients did not exibit any effect on this character. Seed yield is the resultant effect of yield contributing character and in this study the highest seed yield (1109.61 Kgha^{-1}) was obtained when the chickpea seeds were treated with 2.0 g B along with 1.0 g Mo which is identical with the treatments when seeds were treated with 2.0 g B and 0.5 to 1.5 g of Mo (Fig. 1). Regression and correlation co-efficient between seed treatment with B and Mo and seed yield of chickpea were studied and the results also revealed that associations between seed treatment and seed yield showed highly significant positive correlation (r^2= 0.555). Seeds treated with only 2.0 to 4.0 g of B also produced the satisfactory grain yield indicating its indispensability for chickpea production in the area. Farooq *et al. (*2012) reported that micronutrient application through seed treatments improves the stand establishment, advances phenological events, and increases yield and micronutrient grain contents in most cases. They also stated that being an easy and cost effective method of micronutrient application, seed treatments offer an attractive option for resource-poor farmers. The results are also agreed with the findings of Valenciano *et al.* (2010) who reported that Zn, B and Mo applications improved seed yield, mainly due to the number of pods per plant. This was the yield component that had the most influence on, and the most correlation with seed yield. The highest seed yield (4 g plant^{-1}) was obtained from the Zn, B and Mo @ 4, 2 and 2 mg treatment, respectively while the lowest was obtained from the Zn0×B0×Mo0 treatment (2.31 g plant^{-1}). Srivastava *et al.* (1997) reported that B deficiency also causes flower drop and, subsequently, poor podding of chickpeas and poor yields. In Mo-deficient chickpea, the flowers produced are less in number, smaller in size and many of them fail to open or to mature, consequently this leads to lower seed yield (Ahlawat *et al.* 2007). Kumar *et al.* (2008) reported increased plant height, fruiting and pod yield, when seeds were primed in 0.5% B solution with a concomitant reduction in days to 50% flowering. Kumar Rao *et al.* (2004), in a pot study on chickpea, reported a yield increase of 27% by seed priming with Mo (0.5 g l^{-1} solution of sodium molybdite) for 8 hours compared with Mo soil application. However in a field trial, the yield increase in chickpea was 20% from the same treatment (Khanal *et al.* 2005). Thus, it might be evident that seed treatment with micronutrients might have the potential to meet crop micronutrient requirements and improve seedling emergence and stand establishment, yield, and grain micronutrient enrichment in chickpea.

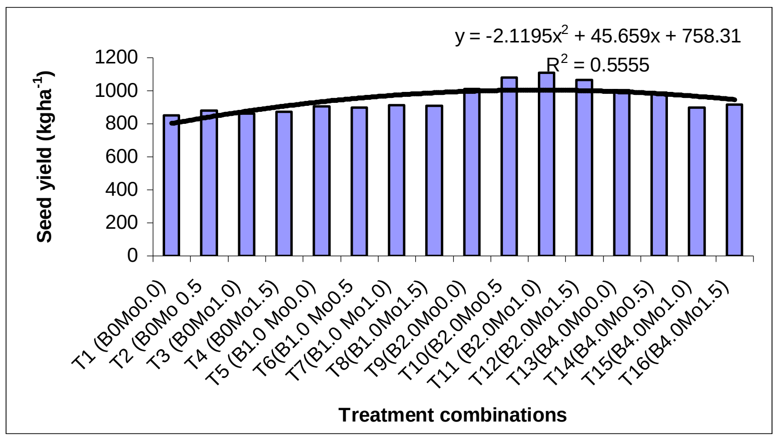

Fig. 1. Seed yield of chickpea as influenced by seed treatment with Boron and Molybdenum

Table 4. Seed quality character of chickpea as influenced by Boron and Molybdenum micronutrient seed treatment

Treatment	**Moisture content at harvest (%)**	**Germination (%)**	**Seedling dry weight plant^{-1} (g)**	**Vigour index**	**Protein content (%)**
T_1 ($B_0Mo_{0.0}$)	16.16	96.0	1.96	188.16	19.22
T_2 (B_0Mo $_{0.5}$	16.83	94.0	1.95	183.30	19.14
T_3 ($B_0Mo_{1.0}$)	17.02	94.0	1.95	183.30	19.74
T_4 ($B_0Mo_{1.5}$)	16.78	95.0	2.0	190.0	20.02
T_5 ($B_{1.0}Mo_{0.0}$)	15.96	93.0	1.96	182.28	19.44
T_6 ($B_{1.0}Mo_{0.5}$	15.92	96.0	1.96	186.10	19.63
T_7 ($B_{1.0}Mo_{1.0}$)	16.71	97.0	1.96	192.06	19.0
T_8 ($B_{1.0}Mo_{1.5}$)	17.02	97.0	1.98	192.06	20.0
T_9 ($B_{2.0}Mo_{0.0}$)	17.0	95.0	1.95	185.25	20.0
T_{10} ($B_{2.0}Mo_{0.5}$	16.12	94.0	1.96	184.24	19.66
T_{11} ($B_{2.0}Mo_{1.0}$)	16.36	96.0	2.0	192.0	19.43
T_{12} ($B_{2.0}Mo_{1.5}$)	17.03	96.0	2.0	192.0	20.10
T_{13} ($B_{4.0}Mo_{0.0}$)	15.88	95.0	1.98	188.1	20.10
T_{14} ($B_{4.0}Mo_{0.5}$)	16.03	94.0	2.0	188.0	19.76
T_{15} ($B_{4.0}Mo_{1.0}$)	15.77	94.0	2.0	188.0	19.44
T_{16} ($B_{4.0}Mo_{1.5}$)	16.01	95.0	1.98	188.1	19.10
CV (%)	7.11	4.28	3.84	4.07	7.16
$LSD_{0.05}$	NS	NS	NS	NS	NS

Post harvest seed quality status showed in the table 4 indicates no effect of micronutrient on the qualitative development of chickpea seed. Since seed quality is an inherent character and is very difficult to change it by any management practices, thereby in the present study seed quality of chickpea was not influenced by micronutrient seed treatment. Protein content status also remains unaffected due to seed treatment with molybdenum and boron.

CONCLUSION

As final conclusions, this study shows that both B and Mo applications as seed treatment with acidic soils at high Barind tract, Rajshahi region, Bangladesh increase total dry matter and seed yield of chickpea due to an increase in the number of pods per plant, principally. The combined application of B and Mo provides a beneficial effect on seed yield. Finally, the number of pods per plant is the most influential yield component and the yield component that is most closely correlated with seed yield. Therefore, the findings of the study may be concluded that seed treatment with 2.0 g B and 1.0 g Mo along with blanket doses of fertilizers @ 40-30-40-20-2 Kg N-P-K-S and Zn ha^{-1} might be suitable for higher yield and quality seed production of chickpea.

REFERENCES

Ahlawat IPS, Gangaiah B, Zadid MA (2007) Nutrient management in chickpea. In: Chickpea breeding and management (Yadav S.S., Redden R., Chen W., Sharma B., eds). *CAB International*, Wallingford, Oxon, United Kingdom, 213-232.

BBS (2004) The year book of Agril. statistics of Bangladesh. Bangladesh Bureau of Statistics, Ministry of Planning, Govt. of the peoples Republic of Bangladesh.

BBS (2012) Statistical year book of Bangladesh. Bangladesh Bureau of Statistics, Ministry of Planning, Govt. of the peoples Republic of Bangladesh.

Bhuiyan AH, Khanam D, Khatun MR, Hasem MS (1998) Effect of molybdenum, boron and Raizobium on nodulation, growth and yield of chickpea *Bull. Inst. Trop. Agric*. 21, 1-7.

Bihari N, Murtoza M, Sing AP (2002) Effect of boron rhizobium relationship on yield, ritrogem and boron nutrition of chickpea. *J. Res. Birsa agric. Univ*. 14(2), 175-179.

Dell B, Huang L (1997) Physiological responses of plants to boron. *Plant Soil.* 193, 103-120.

Farooq M, Wahid A, Siddique KHM (2012) Micronutrient application through seed treatments - a review, *J. Soil Sci. Plant Nutr.* 12(1), 125-142. http://dx.doi.org/10.4067/.

FRG (2012) Fertilizer Recommendation Guide 2012. Published by Bangladesh Agricultural Research Council (BARC), Dhaka, Bangladesh.

Gaur PM, Tripathi S, Gowda CLL, Ranga Rao GV, Sharma HC, Pande S, Sharma M (2010) *Chickpea Seed Production Manual*. Patancheru 502 324, Andhra Pradesh, India: ICRISAT, 28.

Gomez KA, Gomez AA (1984) Statistical procedures for Agricultural Research. 2nd edn. John Wiley and Sons, New York, 194.

ICRISAT (2003) In: annual report International crop Research Institute for the semi-- Arid Tropics. Patancheru, Andrapradesh, India, 12.

Khanal N, Joshi D, Harris D, Chand SD (2005) Effect of micronutrient loading, soil application, and foliar sprays of organic extracts on grain legumes and vegetable crops under marginal farmers' conditions in Nepal. In: P. Andersen, J.K. Tuladhar, K.B. Karki, S.L. Maskey (eds.). *Micronutrients in South and South East Asia, 121-132. Proceedings of an International Workshop* held in Kathmandu, Nepal, 8-11 September, 2004.

Kumar R, Kumar SS, Pandey AC (2008) Effect of seed soaking in nitrogen, phosphorus, potassium and boron on growth yield of garden pea *(Pisum sativum* L.). *Ecol. Environ. Conserv.* 14, 383-386.

Kumar Rao, JVDK, Harris D, Johansen C, Musa AM (2004) Low cost provision of molybdenum (Mo) to chickpeas grown in acid soils. *In: Proceedings of the Zvarevashe, CARE Stakeholder Workshop,* Report IDG/00/18, Silsoe Research Institute, Bedford, UK.

Mahler RL (2005) University of Ldaho, Northern Ldaha, USA. *Fertilizer guide, chickpeas CIS,* 1085.

Roy RN, Finck A, Blair GJ, Tandon HLS (2006) Plant nutrition for food security. A guide for integrated nutrient management. FAO Fertilizer and Plant Nutrition Bulletin 16. Food and Agriculture Organization of the United Nations, Rome, Italy, 368. S0718-95162012000100011.

Salam B (2005) Requirement of Boron for mustard, wheat and chickpea based Cropping- Pattern. *Ph.D thesis*. Department of Soil Science, BAU, Mymensingh, 124.

Shil NC, Noor S, Hossain MA (2007) Effects of Boron and molybdenum on the yield of chickpea. *J. Agric and Rural Dev*. 5 (1&2), 17-24.

Sims TT (2000) Soil fertility evaluation. In: Handbook of soil science (Summer M.E., ed). CRC Press LLC, Boca Raton, Florida, USA, 113-154.

Srivastava SP, Yadav CR, Rego TJ, Johansen C, Saxena NP (1997) Diagnosis and alleviation of boron deficiency causing flower and pod abortion in chick pea (*Cicer arietinum* L.) in Nepal. In: Boron in soils and plants. Developments in Plant and Soil Sciences 76 (Bell R.W., Rerkasem B., eds). Kluwer Academic Publishers, Dordrecht, The Netherlands, 95-99.

Tanaka M, Fujiwar T (2008) Physiological roles and transport mechanisms of boron: perspectives from plants. *Pflügers Arch. European J. Physiol*. 456, 671-677.

Tiwari VN, Lehri LK, Pathak AN (1989) Rhizobium inoculation of legumes as influenced by phosphorus and molybdenum fertilization. *J. Indian Soc.. Soil. Sci.* 37, 712-716.

Valenciano JB, Boto JA, Marcelo V (2010) Response of chickpea (*Cicer arietinum* L.) yield to zinc, boron and molybdenum application under pot conditions. *Spanish J. Agril. Res.* 8(3), 797-807.

Verma LP, Ram PC, Maurya BR (1988) Response of chickpea to phosphorus and molybdenum in alluvium of Eastern Utter Pradesh. *Inlt. Chickpea Newsletter*. 18, 31-33.

Wankhade SG, Dakhore RC, Wanjari SS, Patil DB, Potdukhe NR, Ingle RW (1996) Response of crops to micronutrients. *Indian J Agric Res*. 30, 164-168.

Yanni YG (1992) Performance of chickpea, lentil and lupine nodulated with indigenous on inoculated micronutrients under nitrogen, boron, cobalt and molybdenum fertilization schedules. *World J. Microb. and Biotechnol.,* 607-613.

Zaman AKM, Alam MS, Biswas BK, Roy B, Beg AH (1996) Effect of B and Mo application on mungbean. *Bangladesh J. Agril. Res.* 21, 115-124.