EFFECT OF BORON AND MOLYBDENUM ON GROWTH AND YIELD OF BARI MOTORSHUTI-1

MD. SUJAN ALI SHAIKH

DEPARTMENT OF SOIL SCIENCE
SHER-E-BANGLA AGRICULTURAL UNIVERSITY
DHAKA-1207

JUNE, 2014

EFFECT OF BORON AND MOLYBDENUM ON GROWTH AND YIELD OF BARI MOTORSHUTI-1

BY

MD. SUJAN ALI SHAIKH

REG. NO. : 08-02792

A Thesis
Submitted to the Faculty of Agriculture
Sher-e-Bangla Agricultural University, Dhaka
in partial fulfilment of the requirements
for the degree
of

MASTER OF SCIENCE (MS)
IN
SOIL SCIENCE

SEMESTER: JANUARY-JUNE, 2014

APPROVED BY:

Prof. Mst. Afrose Jahan
Supervisor

Prof. Dr. Alok Kumar Paul
Co-Supervisor

Dr. Mohammad Issak
Chairman
Examination Committee

DEDICATED

TO

MY BELOVED PARENTS

DEPARTMENT OF SOIL SCIENCE

Sher-e-Bangla Agricultural University

Sher-e-Bangla Nagar, Dhaka-1207

CERTIFICATE

This is to certify that the thesis entitled **'Effect of Boron and Molybdenum on Growth and Yield of BARI Motorshuti-1'** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfilment of the requirements for the degree of **Master of Science** in **Soil Science**, embodies the result of a piece of bonafide research work carried out by **Md. Sujan Ali Shaikh**, Registration number: **08-02792** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that any help or source of information, received during the course of this investigation has duly been acknowledged.

Dated:
Dhaka, Bangladesh

Prof. Mst. Afrose Jahan
Department of Soil Science
Sher-e-Bangla Agricultural University
Dhaka-1207

ACKNOWLEDGEMENT

All praises to Almightly and Kindfull faith on to "Omnipotent Allah" for His never-ending blessing. The author deems it a great pleasure to express his profound gratefulness to his respected parents, who entiled much hardship inspiring for prosecuting his studies, receiving proper education.

The author likes to express his deepest sense of gratitude to his respected supervisor Professor Mst. Afrose Jahan, Department of Soil Science, Sher-e-Bangla Agricultural University (SAU), Dhaka, for her scholastic guidance, support, encouragement, valuable suggestions and constructive criticism throughout the study period and gratuitous labor in conducting and successfully completing the research work and in the preparation of the manuscript writing including data analysis.

The author also expresses his gratefulness to his respected Co-Supervisor Professor Dr. Alok Kumar Paul Department of Soil Science, SAU, Dhaka for his scholastic guidance, helpful comments and constant inspiration, inestimatable help, valuable suggestions throughout the research work and in preparation of the thesis.

The author expresses his sincere gratitude towards the sincerity of the Chairman, Dr. Mohammad Issak, Associate Professor, Department of Soil Science, SAU, Dhaka for his valuable suggestions and cooperation during the study period. The author also expresses heartfelt thanks to all the teachers of the Department of Soil Science, SAU, for their valuable suggestions, instructions, cordial help and encouragement during the period of the study.

The author expresses his sincere appreciation to his brother, sisters, relatives, well wishers and friends especially Maruf, Rizvi and Prince for their inspiration, help and encouragement throughout the study period.

The Author

ABSTRACT

The experiment was conducted at the farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh during the period from November 2012 to March, 2013 to study the effect of boron and molybdenum on growth and yield of BARI motorshuti-1. The experiment comprised of two factors-Factor A: Levels of boron (4 levels); B_0: 0 (control), B_1: 1.0, B_2: 1.5 and B_3: 2.0 kg B ha^{-1}; Factors B: Levels of molybdenum (3 levels)- Mo_0: 0 (control), Mo_1: 1.0 and Mo_2: 1.5 kg Mo ha^{-1}. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. For boron at 25, 35, 45, 55 and at harvest, the tallest plant (16.23, 38.54, 63.09, 76.60 and 82.54 cm, respectively) was recorded from B_3, whereas the shortest plant (14.42, 36.24, 57.97, 72.67 and 75.56 cm, respectively) from B_0. The longest pod (8.29 cm) was observed from B_3, while the shortest pod (7.31 cm) from B_0. The highest seed yield (7.61 t ha^{-1}) was observed from B_3 and the lowest (6.28 t ha^{-1}) from B_0. The highest stover yield (13.08 t ha^{-1}) was found from B_3, whereas the lowest (10.38 t ha^{-1}) from B_0. The maximum concentration in seed for N (0.451%), P (0.308%), K (0.370%), B (0.0348%) and Mo (0.0133%) was found from B_3, while the minimum concentration in seed for N (0.374%), P (0.228%), K (0.307%), B (0.0261%) and Mo (0.0104%) from B_0. For molybdenum, at 25, 35, 45, 55 DAS and at harvest, the tallest plant (15.63, 38.70, 62.55, 77.50 and 82.32 cm, respectively) was found from Mo_2, while the shortest plant (14.71, 36.08, 59.12, 72.95 and 78.14 cm, respectively) from Mo_0. The longest pod (8.38 cm) was recorded from Mo_2 (1.5 kg Mo ha^{-1}) and the shortest pod (7.39 cm) from Mo_0. The highest seed yield (7.35 t ha^{-1}) was recorded from Mo_2 (1.5 kg Mo ha^{-1}), whereas the lowest (6.59 t ha^{-1}) from Mo_0. The highest stover yield (12.69 t ha^{-1}) was observed from Mo_2, while the lowest (11.03 t ha^{-1}) from Mo_0. The maximum concentration in seed for N (0.452%), P (0.299%), K (0.365%), B (0.0356%) and Mo (0.0131%) was observed from Mo_2 (1.5 kg Mo ha^{-1}) and the minimum concentration in seed for N (0.380%), P (0.234%), K (0.316%), B (0.0259%) and Mo (0.0106%) from Mo_0. Due to the interaction effect of boron and molybdenum at 25, 35, 45, 55 DAS and at harvest, the tallest plant (17.31, 40.57, 65.49, 80.34 and 85.58 cm, respectively) was recorded from B_3Mo_2 and the shortest plant (13.22, 34.79, 57.01, 68.67 and 71.19 cm, respectively) from B_0Mo_0. The longest pod (8.94 cm) was recorded from B_3Mo_2, whereas the shortest pod (7.05 cm) from B_0Mo_0. The highest seed yield (8.29 t ha^{-1}) was found from B_3Mo_2, while the lowest seed yield (6.14 t ha^{-1}) from B_0Mo_0. The highest stover yield (14.51 t ha^{-1}) was observed from B_3Mo_2 and the lowest (10.14 t ha^{-1}) from B_0Mo_0. The maximum concentration in seed for N (0.0497%), P (0.384%), K (0.419%), B (0.0409%) and Mo (0.0151%) was observed from B_3Mo_2, whereas the minimum concentration in seed for N (0.350%), P (0.223%), K (0.305%), B (0.0252%) and Mo (0.0093%) was found from B_0Mo_0. Combination of 1.5 kg B ha^{-1} & 1.0 kg Mo ha^{-1} can be more beneficial for the farmers to get maximum yield and as well as economic return from the cultivation of BARI Motorshuti-1.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER I

INTRODUCTION

Pea (*Pisum sativum* L.) locally known as Motorshuti belongs to the family *Fabaceae* is one of the important vegetables crops and ranks fourth among the pulses in the world with a cultivated area of 6.33 million hectares of land (FAOSTAT, 2013). It is one of the world's oldest domesticated crops and generally cultivated before 10th and 9th millennia BC (Zohary and Hopf, 2000). Peas are cultivated for the fresh green seeds, tender green pods, dried seeds and foliage (Duke, 1981). It is commonly used in human diet throughout the world and rich in protein (21-25 %), carbohydrates, vitamin A and vitamin C, Ca, phosphorous and has high levels of amino acids like lysin and trypophan (Bhat *et al*., 2013). Its cultivation maintains soil fertility through biological nitrogen fixation in association with symbiotic rhizobium prevalent in nodules and thus plays a vital role in fostering sustainable agriculture (Negi *et al.*, 2006).

The acreage of pea cultivation in Bangladesh is decreasing due to increase in area under boro rice, maize and potato cultivation (BBS, 2013). In Bangladesh in the year 2013, the area for pea cultivation was 36,132 acres and the production was 11,842 metric tons but in the year 2007 it was 37,145 acres and 12,610 metric tons (BBS, 2013). In Bangladesh most of the pea varieties are generally inbred type and the average mature yield of pea is below 1.0 t ha^{-1} (BBS, 2013), whereas the average world yield of pea dry seed is around 1.70 t ha^{-1} (FAO, 2012). Seed yield of garden pea is very low in Bangladesh and such low yield however is not an indication of low yielding potentiality of this crop, but may be attributed to a number of reasons, viz., unavailability of seeds of high yielding varieties with indicative quality, delayed sowing, fertilizer management especially micronutrients, disease and insect infestation, modern cultivation and improper or limited irrigation facilities. Among different factor micronutrients especially boron and molybdenum application are also the most important factor.

Among the 17 essential elements, some elements required in relatively high amounts, are called macronutrients and some in trace amounts are called micronutrients. Micronutrients play an important role in increasing yield of pulses and oilseed through their effects on the plant and on the nitrogen fixing symbiotic process. While micronutrients are required in relatively smaller quantities for plant growth, they are as important as macronutrients for the plants and if any element is lacking in the soil or not adequately balanced, growth suppression or even complete inhibition may result (Mengel *et al.*, 2001). Most importantly, micronutrients are involved in the key physiological processes such as photosynthesis and respiration and their deficiency can impede vital physiological processes thus limiting yield (Marschner, 1995).

Boron is one of the essential micronutrients required for plant growth and productivity. It plays an important role in cell wall synthesis, RNA metabolism, and root elongation as well as phenol metabolism, pollen growth and also yield (Marschner, 1995; Srivastava and Gupta, 1996; Fageria *et al*., 2007). Application of boron resulted increase in the plant height, relative growth rate, net assimilation rate and leaf area index, number of pods branches^{-1}, increased the number of seeds plant^{-1} and yield plant^{-1} (Kalyani *et al*., 1993; Sakal *et al*., 1995). Photosynthetic activity and metabolic activity are also enhanced with application of boron (Lalit Bhott *et al.*, 2004, Sathya *et al.*, 2009). Boron's involvement in hormone synthesis and translocation, carbohydrate metabolisms and DNA synthesis probably contributed to growth and yield (Ratna Kalyani *et al*., 1993). Born is essential for normal growth of pollen grains, sugar translocation and movement of growth regulators within the plant (Hamasa and Putaiah, 2012). Deficiency of B causes severe reduction in crop yield, due to severe disturbances in B-involving metabolic processes, such as metabolism of nucleic acid, carbohydrate, protein and indole acetic acid, cell wall synthesis, membrane integrity and function, and phenol metabolism (Dell and Huang, 1997; Tanaka and Fujiwar, 2008). The critical level of boron with reference to crops in general was reported to be 0.15 to 0.20 ppm depending on soil types (BARC, 2005).

Molybdenum is an essential micronutrient and required for the formation of the nitrate reductase enzyme and in legume is directly involved in symbiotic nitrogen fixation (Williams and Fraustoda Silva, 2002; Roy *et al.*, 2006). It is an important co-factor component of key enzymes of assimilatory nitrogen metabolism, nitrogen fixation, nitrate uptake (Gupta and Lipsett, 1981; Campbell, 1999). Moreover, Mo is an element that is translocated with low mobility inside plants, which is the main reason for its low utilization by plant organs during the period of starvation (Gupta and Lipsett, 1981). Application of molybdenum into the soils has increased the contents of potassium, phosphorus and crude protein (Anon., 2005). Molybdenum is required for growth of most biological organisms including plants (Graham and Stangoulis, 2005). Molybdenum has a positive effect on yield quality and nodules formation in legume crops and molybdenum increased plant height, number of branches and pods plant^{-1}, number of seeds plant^{-1} and seeds yield (Togay *et al.*, 2008). Effects of molybdenum and boron on legumes have been reported by many scientists (Bhuiyan *et al.*, 1998; Verma *et al.*, 1988; Tiwari *et al.*, 1989; Zaman *et al.*, 1996 etc.).

Considering the above all context and situation the present experiment was conducted with different levels of boron and molybdenum on motorshuti with the following objectives:

a. To assess the effect of B and Mo on growth and yield of motorshuti;
b. To optimize the suitable dose of B and Mo as micronutrients on growth and yield of motorshuti;
c. To determine the growth and yield of motorshuti due to the interaction effect of B and Mo;
d. To assess the concentration of different nutrients in pods and stover due to the application of different levels of B and Mo.

CHAPTER II

REVIEW OF LITERATURE

Motorshuti or Garden pea is an important vegetable as well as pulse crop in many countries of the world. The crop has been grown normally without/minimum care or following minimum modern management practices. There is a very limited research on the effect of micronutrient on the growth and yield of motorshuti in context in our country although an influential effect of micronutrients already proved and it is also necessary for improving motorshuti growth and yield. But research works related to micronutrients especially boron and molybdenum are limited in world and as well as Bangladesh context. However, some of the important and informative works and research findings related to the boron and molybdenum so far been done at home and abroad on other related crops have been reviewed in this chapter under the following headings-

2.1 Boron on growth and yield of pea and other related crops

Singh and Singh (1984) conducted an experiment and reported that the uptake of N, Na and B by grain and straw increased significantly with the application of boron in barley. Dutta *et al.* (1984) found that application of 1 Kg B ha^{-1} increased in leaf area ratio, leaf area index, number of branches $plant^{-1}$, number of pods $plant^{-1}$ in mustard.

Sakal *et al*. (1988) reported that application of 2.0 and 2.5 kg B ha^{-1} increased grain yields of black gram and chickpea by 63 and 38%, respectively and a synergistic relationship between B and K was found in black gram.

The possible effects of B on nitrate reductase (NR) activity were found via the metabolism of nucleic acids and proteins (Kastori and Petrovic, 1989). Yang *et al*. (1989) reported from their findings that application of B, N and K promoted growth, CO_2 assimilation, NR activity in rape seed leaves.

Luo *et al.* (1990) observed that B fertilizer application increased branches plant^{-1}, pods plant^{-1} in groundnut. On the contrary, uptake of Ca, K, P decreased with B application in wheat (Singh *et al.*, 1990).

Lin and Deng, (1992) applied B fertilizers at transplanting and observed that NR activity in leaves of tobacco was increased. Nitrate reductase activity was lower when there was a B deficiency, especially when NO_3 was present in the medium.

Boron has a beneficial effect on morphological characters in different crop plants. Sinha *et al.* (1994) conducted an experiment on the effect of B, Zn and Mo on morphological characters in lentil and showed that primary branch plant^{-1} and pods plant^{-1} increased significantly due to application of B. Srivastava (1994) reported that application of B increased the number of pods plant $^{-1}$ and grain yield in a susceptible chickpea variety, Kalika.

Saha *et al*. (1996) carried out a field trial in pre-*Kharif* seasons at Pundibari, India with given 0, 2.5 or 5.0 kg borax and 0, 1 or 2 kg/ha of sodium molybdate was applied in soil, 66% soil + 33% foliar or foliar applications and the residual effects were studied on summer green gram [*Vigna radiata*]. In both years green gram seed yield was highest with a combination of 5 kg borax + 2 kg sodium molybdate.

Srivastava *et al*. (1997) reported that application of 0.5 kg B ha^{-1} optimally corrected the deficiency of B and they found from a field experiment that at B-deficient soil, where no fertilizers, complete or the complete fertilizer minus each of the trace elements were applied flower abortion was the highest and no seed was produced in the treatment of without B.

Verma and Mishra (1999) conducted a pot experiment with mungbean cv. PDM 54, boron was applied for seed treatment as soil application (basally or at flowering) or foliar spraying. It increased yield and growth parameters with the best results in terms of seed yield/plant when the equivalent of 5 kg borax/ha was applied at flowering stage.

Srivastava *et al*. (1999) observed that the average grain yield of chickpea and other legume crops was 0.1 t ha^{-1} when B was not applied while the yield was 1.4 t ha^{-1} 0.5 kg ha^{-1} by the application of B. Further, flowering and fruit development were also restricted by a shortage of B (Tisdale *et al*., 1999).

Liu *et al*. (2000) conducted an experiment on the effect of B and Mo stress on NR activity in leaves of three soybean cultivars at different stages of growth and showed that NR activity was reduced due to boron and molybdenum deficiency.

Consequently two field experiments was conducted by Rizk and Abdo (2001) at Giza Experimental Station, ARC, Egypt to investigate the response of mungbean (*Vigna radiata*) with some micronutrients. Zn (0.2 or 0.4 g/l), Mn (1.5 or 2.0 g/l), B (3.0 or 5.0 g/l) and a mixture of Zn, Mn, and B (0.2, 1.5 and 3.0 g/l, respectively) and distilled water as control were sprayed once at 35 days after sowing (DAS). Among all treatments of micronutrients, B gave the highest percentage of crude protein.

Banu (2003) reported that boron deficiency was established as the dominant nutritional problem causing flower and pod abortion. No pods or grains were formed in the absence of B in chickpea.

An experiment carried out by Moghazy *et al*. (2014) to study the influence of a foliar application with boron and five levels of combinations between compost manure and mineral nitrogen fertilizer as well as their interaction on growth, yield and chemical composition of pea. The vegetative growth traits of green pea, i.e., plant length, number of leaves, number of branches, fresh weight per plant, relative growth rate, yields and its components had high significant values by foliar spraying with boron. It could be concluded that foliar spray with boron (boric acid 17% B) at 50 ppm with application of nitrogen fertilizer in compost form at 2.5 ton fed^{-1} and inorganic N-fertilizer at 60 kg fed^{-1} in pea field were the most effective treatment for improving quality and increasing yield.

2.2 Molybdenum on growth and yield of pea and other related crops

According to FAO (1983) application of molybdenum at the rate of 0.4 kg/ha is sufficient for the maximum nodulation in legumes on acid soils. Total molybdenum content of most agricultural soils lies between 0.6 and 3.5 ppm with an average available content of 0.2 ppm molybdenum occurs in soil mainly as molybdenum (MoO_4). This particular minor element is an essential component of two major enzymes nitrogenous and nitrate as pointed out by Mengel and Kirkby (1982).

Sheudzhen *et al*. (1985) conducted an experiment with basal application of 120 kg N + 90 kg P_2O_5 + 60 kg K_2O/ha with 0.05% molybdenum. Highest yields were achieved with 0.05% Mo (7.46 t/ha) compared to (6.14 t/ha) zero trace element. Molybdenum treatment gave rise to the greatest N and P uptake by the plants.

Padma *et al*. (1989) conducted an experiment on French bean with the application of N (20 kg/ha), P (50 kg/ha) and K (50 kg/ha). Mo (as sodium molybdate) at 75 or150 ppm were applied, individually and in combination, as foliar sprays 20 days after sowing and again 40 days after sowing. Control plants were sprayed with distilled water. The greatest plant height (35.0 cm), number of leaves/plant (14.6), number of branches/plant (4.3), tap root length (20.4 cm), leaf area/plant (941.2 cm), leaf area index (0.60) and DM production (62.8 g/plant) were obtained with the 75 ppm Mo+2.5 ppm B treatment.

Sarkar and Banik (1991) conducted an experiment on green gram and observed the molybdenum application significantly increased pods/plant; seed/pod 1000 seed weight, seed yield and straw yield. They also reported that application of molybdenum at the rate of 0 and 0.25 kg/ha gave 11.45 q/ha straw yield, 19.25 and 20.18 pods/plant, respectively.

Singh *et al*. (1992) reported that application of molybdenum at the rate 1 kg/ha increased the grain yield of chickpea significantly. Further increase in molybdenum level had no effect on the yield.

Muralidharan and Jose (1994) stated that combined application of Zn, Mn, B, Cu, Mo, S and Mg increased the yield, while application of B and Mn only in cultivar joyti, produced yield about 2.31 and 2.09 t/ha, respectively compared with the control yield (2.07 t/ha). The treatment in rabi season gave grain yields of 2.96 and 3.01 t/ha, respectively compared to control (2.81 t/ha).

Wang *et al.* (1995) showed that the application of molybdenum increased the yield of wheat by 11.45% and 45%, respectively at low level of N (0.05g N/kg soil) and high level of N (0.2g N/kg soil). The fresh weight of wheat seedlings by 18.6-80.1% and dry weight by 23.7-80.6% increased respectively compare to control. The activity of nitrate reductase in wheat with molybdenum treatment was greater than that of control. They also pointed out that molybdenum also increased the efficiency of nitrogen fertilizer utilization.

Tej *et al.* (1995) reported that molybdenum application @ 1 kg ha^{-1} had marked beneficial effect on the number of filled grains per pod and grain yield of mungbean. He cited that due to the omission of molybdenum, the number of filled grains pod^{-1} was 10.2 as compared to 12.4 for treatment with molybdenum.

Li and Gupta (1995) conducted an experiment in USA and observed that application of molybdenum (2 mg soil) increased leaf nitrogen and shoot, root and nodule dry weight but did not significantly increase mean photosynthesis, nodule nitrogenase activity and chlorophyll content in soybean.

Berger *et al.* (1995) reported that application of 20 g Mo ha^{-1} at sowing and a further foliar application of 20 g Mo ha^{-1} at 25 days after emergence had a greater effect when French bean plants were grown on poorer soil.

Zaman *et al.* (1996) conducted an experiment on mungbean and found that and found that 1 kg Mo ha^{-1} produced 40.49% higher plant height, 44.6% higher root length, 97% higher nodule number and 180% higher nodule weight over control. They also reported 89% higher branches $plant^{-1}$ with 2 kg Mo ha^{-1} over control.

Lopez *et al.* (1996) grew *Phaseolus vulgaris cv*. In Buenos Aires in nutrient solution containing 1, 5 or 10 mg Mo/litre Mo content in roots, stems and leaves increased over time. Root Absorption Index (Mo in roots/Mo in nutrient solution) was highest in 1 mg Mo/litre. This concentration provided the plant growth with Mo requirement, but there was no visible damage caused by higher Mo concentrations.

Rodrigues (1996) conducted an experiment with *P. vulgaris* cultivars given 0, 40, 80 or 120 g Mo/ha to the leaves at 25 days after emergence. They gave the highest seed yields (1.62-1.93 t/ha) in all seasons. Only in the dry summer/autumn season there was no response to Mo; in the rainy summer season and autumn/winter the response of seed yield to Mo was quadratic with highest yields corresponding 76-81 g Mo/ha. Application of all doses of Mo significantly increased pod number/plant, harvest index and 100-seed weight in all seasons. It is suggested that increasing rates of applied foliar Mo beyond 20-40 g/ha, as commonly practiced and should result in economically viable yield increases.

Hazra and Tripathi (1998) observed that molybdenum application at the rate of 1.5 kg/ha increased forage and seed yields in calcareous soil.

Andrade *et al.* (1999) reported that the growth and yield of bean were influenced by molybdenum fertilization. In their trial foliar applications of 0, 30, 60, 90 or 120 g Mo/ha were used. There were no significant effects of Mo rates or rate x cultivar interaction on yield or yield components. There were significant differences among the cultivars for height of first pod, seed number per pod, 100-seed weight and yield.

Manga *et al.* (1999) reported that the growth and yield of French bean were influenced by phosphorus and molybdenum fertilization. In their trail, the crop received 0, 13 or 26 kg P and 0, 0.5 or 1.0 kg ammonium molybdate/ha. Phosphorus application significantly increased the number of pods per plant, number of seeds per pod and shelling percentage. The seed yield was increased by

43.2 and 73.32% (averaged over years) when 13 and 26 kg P/ha were applied, respectively. Molybdenum application increased the number of pods per plant, number of seeds per pod and seed yield. The seed yield increase was 15.7 and 25.9% when 0.5 and 1.0 kg ammonium molybdate/ha respectively were applied.

Kushwaha (1999) conducted a field study during the winter seasons of 1991-93 at Kanpur, Uttar Pradesh on sandy loam soil to study the effect of zinc, boron and molybdenum on the growth and yield of French bean (*Phaseolus vulgaris cv.* PDR 14), 25 kg $ZnSO_4$, 10 kg borax and 1 kg sodium molybdate/ha were applied individually or in all combinations. All trace elements generally increased seed and haulm yield. Mean seed yield was 1736 kg/ha in controls and the highest 2459 kg with borax alone.

Pessoa *et al*. (2000) investigated the effects of molybdenum (Mo) leaf application in beans. Levels of Mo were 0, 40, 80 and 120 g ha^{-1}, using ammonium molybdate applied to the leaves 25 days after emergence. There was a quadratic response due to increasing doses of Mo application, on the leaf and grain concentrations of Mo, total N and organic N. Leaf Mo increased from 0.49 mg kg^{-1} (control) up to o.95 mg kg^{-1}, where improved N utilization resulting in higher leaf and grain concentrations of total N and organic N, better plant growth and darker green leaves.

Nasreen and Farid (2003) conducted a field experiment during the winter (rabi) seasons to study the effect of different nutrients on yield, yield components and nutrient uptake by garden pea cv. BARI Motorsuti-1 grown in Grey Terrace soil. Application of different nutrients caused significant increases in yield and nutrient uptake. The highest fresh pod yield and protein content were achieved by the treatment of $N_{30}P_{50}K_{40}S_{20}Mo_1B_1$ and it was not significantly different from the $N_{30}P_{50}K_{40}S_{20}N_{30}P_{50}K_{40}S_{20}Mo_1$ and $N_{30}P_{50}K_{40}S_{20}Mo_1B_1Zn_1$ treatments. Uptake of N, P, K, S, and Zn by shoot and seed was also highest under the treatment N_{30} P_{50} K_{40} S_{20} Mo_1 B_1 and not significantly different from $N_{30}P_{50}K_{40}S_{20}Mo_1$ and $N_{30}P_{50}K_{40}S_{20}Mo_1B_1Zn_1$. Addition of Mo, B and Zn with NPKS did not show any significant change in pod yield. Application of $N_{30}P_{50}K_{40}S_{20}Mo_1$,$N_{30}P_{50}K_{40}S_{20}$ Mo_1B_1 and $N_{30}P_{50}K_{40}S_{20}Mo_1B_1Zn_1$ kg/ha were not economical, but treatment N30 $P_{50}K_{40}S_{20}$ kg/ha proved to be the most economically profitable for garden pea production.

Pires *et al*. (2004) conducted an experiment to study the effects of the foliar application of Mo on the yield of common bean (*P. vulgaris*). The treatments consisted of a control (without Mo), 80 g Mo ha^{-1} applied at 15 days after emergence (DAE), 40 g Mo ha^{-1} applied at 15 and 20 DAE, 40 g Mo ha^{-1} applied at 15 and 25 DAE, 40 g Mo ha^{-1} applied at 15 and 30 DAE, 80 g Mo ha^{-1} applied at 20 DAE, 40 g Mo ha^{-1} applied at 20 and 25 DAE, 40 g Mo ha^{-1} applied at 20 and 30 DAE, 80 g Mo ha^{-1} applied at 25 DAE, and 40 g Mo ha^{-1} applied at 25 and 30 DAE. Mo foliar spray increased the yield and harvest index in summer-autumn cultivation when started at 15 or 20 DAE, but not at DAE. Rate partitioning did not significantly increase the yields. In winter-spring cultivation, all treatments increased the yields.

The role of molybdenum (Mo) and copper (Cu) in regulation the activities of the enzymes involved in primary nitrogen assimilation in particular the nitrate reductase (EC 1.6.6.1) and glutamine synthetase (EC 6.3.1.2) was examined by Hristozkova (2006). Pea plants were grown in a phytotron chamber at 12 h photoperiod, day /night temperature 25/18 oC and photon flux density of 95 μmol m-1 s-1 until 21-st day. Plants were grown at full strength Helriegel nutrient solution competed with micronutrients as in Hoagland and Arnon and reduced Mo and Cu concentrations. Although only extremely small amounts of Mo and Cu are required for normal plant growth, reduced supply with Mo and Cu to the growth medium decreased activities of the enzymes (nitrate reductase and glutamine synthetase) involved at initial steps of nitrate assimilation, fresh weight, and plastid pigment content (total chlorophyll and carotenoids). Accumulation of nitrates in plant tissues enhanced, especially in the variants with restrictive Cu concentration.

A field experiment was conducted by Shil *et al*. (2007) on chickpea (cv. BARI Chola-5) during the rabi season. The objective was to find out the optimum dose of boron and molybdenum for yield maximization. Four levels each of boron (0, 1, 2 and 2.5 kg/ha) and molybdenum (0, 1, 1.5 and 2 kg/ha) along with a blanket dose of $N_{20}P_{25}K_{35}S_{20}$ Zn_2 kg/ha & cowdung 5 t/ha were applied in this study. The combination of $B_{2.5}Mo_{1.5}$ kg/ha and $B_{2.5}Mo_1$ kg/ha produced significantly higher yield in both the years of study at Jessore and Rahmatpur, respectively. The said treatments produced the highest mean yields of 2.10 and 1.49 t/ha for Jessore and Rahmatpur, respectively, which was around 53% higher over control (B M_0). The combined application of both boron and molybdenum were found superior to their single application even though boron played major role in augmenting the yield. However, from the regression analysis, the optimum treatment combination was calculated as $B_{2.34}Mo_{1.44}$ kg/ha for Jessore and $B_{2.20}Mo_{1.29}$ kg/ha for Rahmatpur.

Two field experiments were carried out by Nadia and Abd El-Moez (2013) to evaluate the effect of different levels of molybdenum on nodules efficiency, growth, yield quantity and quality of cowpea plants. The experiments were conducted at Research and Production station, National Research Centre, EL-Nobaria site, Beheara Governorate, Delta Egypt, under drip irrigation system during 2011 and 2012 seasons. Molybdenum enhance cowpea root nodules efficiency, growth, minerals composition, yield quantity and quality compared with control plants. Molybdenum at 16 ppm resulted in maximum growth, nodules number and weight, nitrogenase activity, pods and seeds yield as well as nutritional and chemical content. Increasing molybdenum levels more than 16 ppm decreased the molybdenum promotive effect on cowpea.

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted during the period from November 2012 to March, 2013 to study the effect of boron and molybdenum on growth and yield of BARI motorshuti-1. This chapter includes materials and methods i.e. experimental period, description of experimental site, climate condition and soil of the experimental plot, materials used, design of the experiment, data collection procedure and procedure of data analysis that were used in conducting the experiment are presented below under the following headings:

3.1 Description of the experimental site

3.1.1 Experimental period

The experiment was conducted during the period from November 2012 to March, 2013.

3.1.2 Description of experimental site

The experiment was conducted at the farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh. The experimental site is situated between $23^0 74^/$N latitude and $90^0 35^/$E longitude and at an elevation of 8.4 m from sea level (Anon., 1989).

3.1.3 Climatic condition

The climate of experimental site is subtropical, characterized by three distinct seasons, the monsoon from November to February and the pre-monsoon period or hot season from March to April and the monsoon period from May to October. The monthly average temperature, humidity and rainfall during the crop growing period were collected from Weather Yard, Bangladesh Meteorological Department, and presented in Appendix I. During the experimental period the maximum temperature (31.7^0C) was recorded in the month of March 2013 while the minimum temperature (12.8^0C) in the month of January 2013. The highest humidity (78%) was recorded in the month of November, 2012, whereas the highest rainfall (39 mm) was recorded in the month of February 2013.

3.1.4 Characteristics of soil

The soil of the experimental field belongs to the Tejgaon series under the Agroecological Zone, Madhupur Tract (AEZ- 28) and the General Soil Type is Deep Red Brown Terrace Soils. A composite sample was made by collecting soil from several spots of the field at a depth of 0-15 cm before the initiation of the experiment. The collected soil was air-dried, grind and passed through 2 mm sieve and analyzed at Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka for some important physical and chemical properties. The soil was having a texture of sandy loam with pH and Cation Exchange capacity 5.6 and 2.64 meq 100 g soil^{-1}, respectively. The results showed that the soil composed of 27% sand, 43% silt, 30% clay and organic matter 0.78%, which have been presented in Appendix II.

3.2 Experimental details

3.2.1 Treatments of the experiment

The experiment comprised of two factors

Factor A: Levels of boron (4 levels)

- i) B_0: 0 kg B ha^{-1} (control)
- ii) B_1: 1.0 kg B ha^{-1}
- iii) B_2: 1.5 kg B ha^{-1}
- iv) B_3: 2.0 kg B ha^{-1}

Factors B: Levels of molybdenum (3 levels)

- i) Mo_0: 0 kg Mo ha^{-1} (control)
- ii) Mo_1: 1.0 kg Mo ha^{-1}
- iii) Mo_2: 1.5 kg Mo ha^{-1}

There were in total 12 (4×3) treatment combinations such as B_0Mo_0, B_0Mo_1, B_0Mo_2, B_1Mo_0, B_1Mo_1, B_1Mo_2, B_2Mo_0, B_2Mo_1, B_2Mo_2, B_3Mo_0, B_3Mo_1 and B_3Mo_2.

3.2.2 Planting material

The variety BARI Motorshuti-1 was used as the test crops and the seeds were collected from the Agronomy Division of Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur. It was the released variety of Motorshuti, which was recommended by the national seed board. Green pod of this variety may harvest within 70-75 days as green pods and highest pod yield of 10-12 t ha^{-1} may be harvest if cultivated following modern technology.

3.2.3 Land preparation

The land was first opened with the tractor drawn disc plough. Ploughed soil was brought into desirable fine tilth by ploughing and cross-ploughing, harrowing and laddering. The stubble and weeds were removed. The first ploughing and the final land preparation were done on 15^{th} and 24^{th} November, 2013, respectively. Experimental land was divided into unit plots following the experimental design.

3.2.4 Fertilizer application

Urea, Triple super phosphate (TSP), Muriate of potash (MoP), gypsum, zinc sulphate, boric acid and sodium molybdate were used as a source of nitrogen, phosphorous, potassium, gypsum, sulphur, zinc, boron and molybdenum, respectively. Urea, Triple super phosphate (TSP), Muriate of potash (MoP), gypsum and zinc sulphate were applied at the rate of 90, 60, 60, 40 and 2.0 kg $hectare^{-1}$, respectively following the BARI recommendation but boron and molybdenum were applied as per treatment. All of the fertilizers except urea were applied during final land preparation.

3.2.5 Experimental design and layout

The two factors experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. An area of 25.5 m × 11.5 m was divided into blocks. The two varieties were assigned in the main plot and five supplementary treatments in sub-plot. The size of the each unit plot was 2.5 m × 1.5 m. The space between two blocks and two plots were 1.0 m and 0.5 m, respectively. The layout of the experiment is shown in Figure 1.

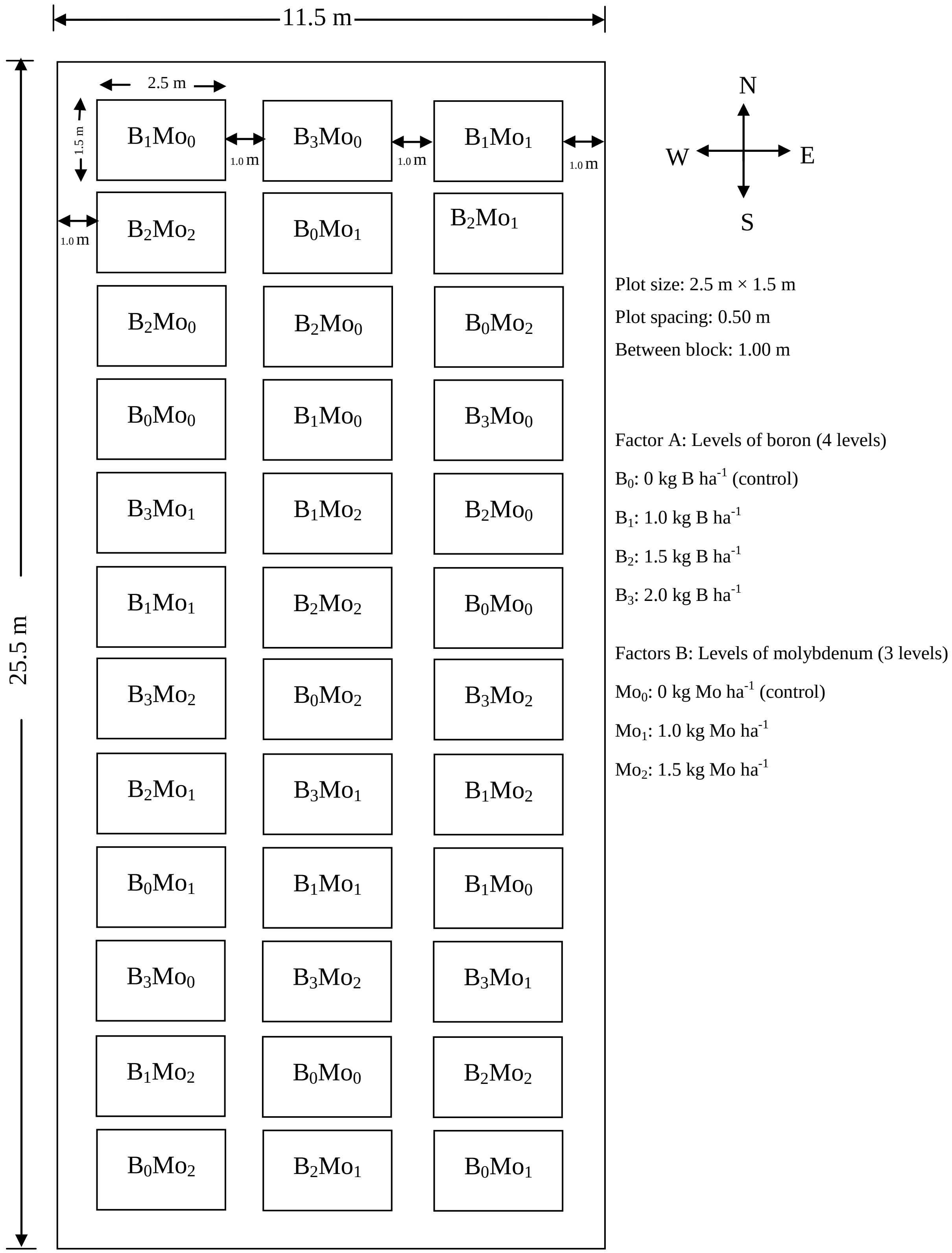


Figure 1. Layout of the experimental plot

3.3 Growing of crops

3.3.1 Sowing of seeds in the field

The seeds of motorshuti were sown on November 24, 2013 in solid rows in the furrows having a depth of 2-3 cm and row to row distance was 40 cm.

3.3.2 Intercultural operations

3.3.2.1 Thinning

Seeds started germination of four Days After Sowing (DAS). Thinning was done two times; first thinning was done at 8 DAS and second was done at 15 DAS to maintain optimum plant population in each plot.

3.3.2.2 Irrigation and weeding

Irrigation was provided before 30 and 45 DAS for optimizing the vegetative growth of motorshuti for the all experimental plots equally. The crop field was weeded as per necessary.

3.3.2.3 Protection against insect and pest

At early stage of growth few worms (*Agrotis ipsilon*) infested the young plants and at later stage of growth pod borer (*Maruca testulalis*) attacked the plant. Ripcord 10 EC was sprayed at the rate of 1 mm with 1 litre water for two times at 15 days interval after seedlings germination to control the insects.

3.4 Crop sampling and data collection

Five plants from each treatment were randomly selected and marked with sample card. Plant height and number of branches were recorded from selected plants at an interval of 10 days started from 25 DAS (days after sowing) to 55 DAS and final harvesting of pod at 72 DAS.

3.5 Harvest and post harvest operations

Harvesting was done when 90% of the pods became mature**.** The matured pods were collected by hand picking from a pre demarcated area of 6.4 m^2 at the center of each plot.

3.6 Data collection

The following data were recorded

i. Plant height (cm)
ii. Number of branches plant^{-1}
iii. Days required for sowing to harvest
iv. Number of pods plant^{-1}
v. Pod length (cm)
vi. Number of seeds pod^{-1}
vii. Weight of 100 seeds (g)
viii. Seed yield (t ha^{-1})
ix. Stover yield (t ha^{-1})
x. N, P, K, B and Mo concentration of seed and stover sample
xi. pH, organic matter, available B and Mo in post harvest soil

3.7 Procedure of data collection

3.7.1 Plant height

The plant height was measured at 25, 35, 45, 55 DAS and at harvest with a meter scale from the ground level to the top of the plants and the mean height was expressed in cm.

3.7.2 Number of branches plant^{-1}

The total number of branches plant^{-1} was counted from each selected plant. Data were recorded as the average of 5 plants selected at random of each plot at 25, 35, 45, 55 DAS and at harvest

3.7.3 Days required for sowing to harvest

Each plant of the experiment plot was kept under close observation to count days to harvest of Motorshuti. Total number of days from the date of sowing to the harvest was recorded.

3.7.4 Pod length

Pod length was taken from randomly selected ten pods and the mean length was expressed on pod^{-1} basis.

3.7.5 Number of pods $plant^{-1}$

Numbers of total pods of selected plants from each plot were counted and the mean numbers were expressed as $plant^{-1}$ basis. Data were recorded as the average of 10 plants selected at random from the inner rows of each plot.

3.7.6 Number of seeds pod^{-1}

The number of seeds $pods^{-1}$ was recorded from randomly selected 10 pods at the time of harvest. Data were recorded as the average of 10 pods from each plot.

3.7.7 Weight of 100 seeds

One hundred cleaned, dried seeds were counted from each harvest sample and weighed by using a digital electric balance and weight was expressed in gram (g).

3.7.8 Seed yield $hectare^{-1}$

The seeds collected from 3.75 (2.5 m ×1.5 m) square meter of each plot were cleaned. The weight of seeds was taken and converted the yield in t ha^{-1}.

3.7.9 Stover yield $hectare^{-1}$

The stover collected from 3.75 (2.5 m ×1.5 m) square meter of each plot was sun dried properly. The weight of stover was taken and converted the yield in t ha^{-1}.

3.8 Chemical analysis of seeds and stover samples

3.8.1 Collection of samples

Seeds and stover samples were collected after threshing and finely ground by using a Wiley-Mill with stainless contact points to pass through a 60-mesh sieve. The samples were stored in plastic vial for analyses of N, P, K, B and Mo.

3.8.2 Preparation of samples

The samples were dried in an oven at 70^0C for 72 hours and then ground by a grinding machine to pass through a 20-mesh sieve. The seeds and stover samples were analyzed for N, P, K, B and Mo concentrations as follows:

3.8.3 Digestion of samples with sulphuric acid for N

For the determination of nitrogen an amount of 0.2 g oven dry, ground sample were taken in a micro kjeldahl flask. 1.1 g catalyst mixture (K_2SO_4: $CuSO_4$. $5H_2O$: Se in the ratio of 100: 10: 1), and 5 ml conc. H_2SO_4 were added. The flasks were heating at 120^0C and added 2.5 ml 30% H_2O_2 then heated was continued at 180^0C until the digests became clear and colorless. After cooling, the content was taken into a 100 ml volumetric flask and the volume was made up to the mark with de-ionized water. A reagent blank was prepared in a similar manner. Nitrogen in the digest was estimated by distilling the digest with 10 N NaOH followed by titration of the distillate trapped in H_3BO_3 indicator solution with 0.01N H_2SO_4.

3.8.4 Digestion of samples with nitric-perchloric acid for P, K, B and Mo

A sub sample weighing 0.5 g was transferred into a dry, clean 100 ml digestion vessel. Ten ml of di-acid (HNO_3: $HClO_4$ in the ratio 2:1) mixture was added to the flask. After leaving for a while, the flasks were heated at a temperature slowly raised to 200^0C. Heating were stopped when the dense white fumes of $HClO_4$ occurred. The content of the flask were boiled until they were became clean and colorless. After cooling, the content was taken into a 100 ml volumetric flask and the volume was made up to the mark with de-ionized water. P, K, B and Mo were determined from this digest.

3.8.5 Determination of P, K, B and Mo from samples

3.8.5.1 Phosphorus

Phosphorus was digested from the plant sample (grain and straw) with 0.5 M $NaHCO_3$ solutions, pH 8.5 (Olsen *et al.*, 1954). Phosphorus in the digest was determined by using 1 ml for grain sample and 2 ml for straw sample from 100 ml extract was then determined by developing blue color with reduction of phosphomolybdate complex and the color intensity were measured colorimetrically at 660 nm wavelength and readings were calibrated with the standard P curve (Page *et al*., 1982).

3.8.5.2 Potassium

Five milli-liter of digest sample for the grain and 10 ml for the straw were taken and diluted 50 ml volume to make desired concentration so that the absorbance of sample were measured within the range of standard solutions. The absorbance was measured by atomic absorption flame photometer.

3.8.5.3 Boron

For B, the extractant of $CaH_4(PO_4)_2$, HCl and phenol was used (Hunter, 1980). Boron concentration was measured by adding 2 ml Curcumin solution plus 0.5 ml concentrated H_2SO_4 and 15 ml Methanol (Meth: water = 3:2) solution before taking reading. The concentration in the extract was read at 555 nm wave length in a double beam spectrophotometer (Model No. 200-20, Hitachi, Japan).

3.8.5.4 Molybdenum

For Mo, the extractant of $CaH_4(PO_4)_2$, HCl and phenol was used (Hunter, 1980). Molybdenum concentration was measured by adding 2 ml Curcumin solution plus 0.5 ml concentrated H_2SO_4 and 15 ml Methanol (Meth: water = 3:2) solution before taking reading. The concentration in extract was read at 555 nm wave length in a double beam spectrophotometer (Model No. 200-20, Hitachi, Japan).

3.9 Post harvest soil sampling

After harvest of crop soil samples were collected from each plot at a depth of 0 to 15 cm. Soil samples of each plot was air-dried, crushed and passed through a two mm (10 meshes) sieve. The soil samples were kept in plastic container to determine the physical and chemical properties of soil.

3.10 Soil analysis

Soil samples were analyzed for both physical and chemical characteristics viz. pH, organic matter B and Mo contents. The soil samples were analyzed by the following standard methods as follows:

3.10.1 Soil pH

Soil pH was measured with the help of a glass electrode pH meter, the soil water ratio being maintained at 1: 2.5 as described by Page *et al.*, 1982.

3.10.2 Organic matter

Organic carbon in soil sample was determined by wet oxidation method. The underlying principle was used to oxidize the organic matter with an excess of 1N $K_2Cr_20_7$ in presence of conc. H_2SO_4 and conc. H_3PO_4 and to titrate the excess $K_2Cr_20_7$ solution with 1N $FeSO_{4.}$ To obtain the content of organic matter was calculated by multiplying the percent organic carbon by 1.73 (Van Bemmelen factor) and the results were expressed in percentage (Page *et al.*, 1982).

3.10.3 Available Boron

For available B, the extractant composed of $CaH_4(PO_4)_2$, HCl and phenol was used (Hunter, 1980). Boron concentration was measured by adding 2 ml Curcumin solution plus 0.5 ml concentrated H_2SO_4 and 15 ml Methanol (Meth: water = 3:2) solution before taking reading. The concentration in the soil extract was read at 555 nm wave length in a double beam spectrophotometer (Model No. 200-20, Hitachi, Japan).

3.10.4 Available Molybdenum

Available Mo content was determined by extracting the soil with $BaCl_2$ solution as described by Page *et al*., 1982. The digested Mo was determined by developing turbidity by adding $BaCl_2$ solution. The intensity of turbidity was measured by spectrophotometer at 420 nm wavelengths (Hunter, 1984).

3.11 Statistical analysis

The data obtained for different parameters were statistically analyzed to find out the significant difference of different levels of boron and molybdenum. The mean values of all the characters were calculated and analysis of variance was performed by the 'F' (variance ratio) test. The significance of the difference among the treatment means was estimated by the Least Significant Difference (LSD) at 5% level of probability (Gomez and Gomez, 1984).

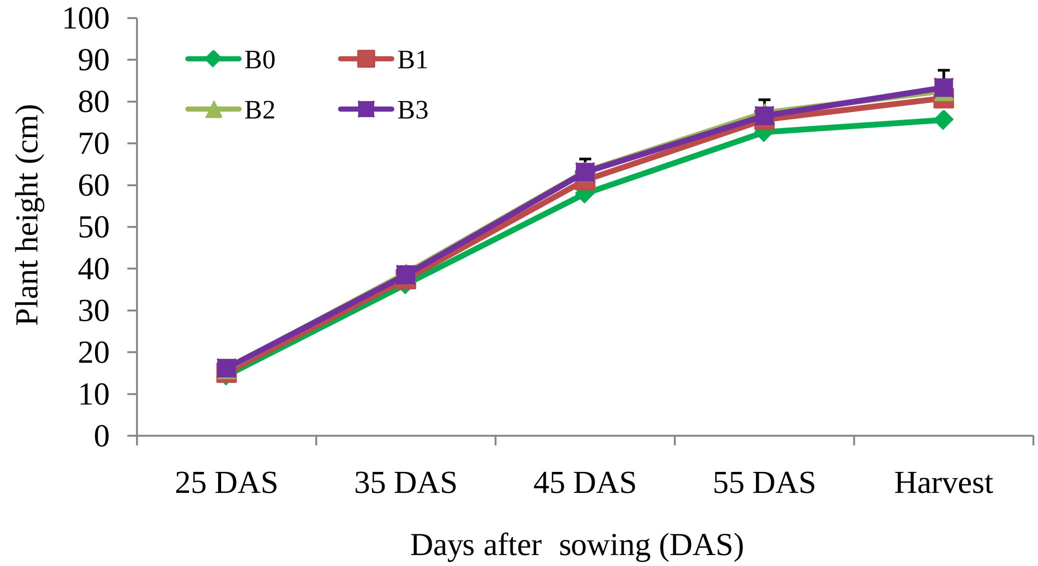
CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted to study the effect of boron and molybdenum on growth and yield of BARI motorshuti-1. Data on different growth parameter, yield, nutrient concentration in pods and stover and characteristics of post harvest soil was recorded. The analyses of variance (ANOVA) of the data on different recorded parameters are presented in Appendix III-VIII. The findings of the experiment have been presented and discusses with the help of table and graphs and possible interpretations were given under the following headings:

4.1 Plant height

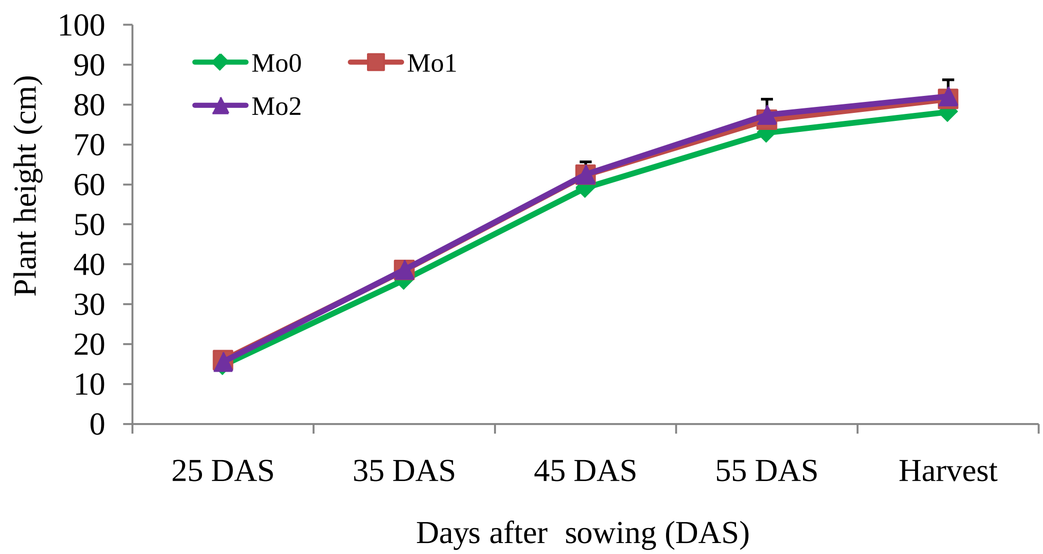
Plant height of BARI motorshuti-1 showed statistically significant variation due to different levels of boron at 25, 35, 45, 55 days after sowing (DAS) and at harvest (Appendix III). Data revealed that at 25, 35, 45, 55 and at harvest, the tallest plant (16.23, 38.54, 63.09, 76.60 and 82.54 cm, respectively) was recorded from B_3 (2.0 kg B ha^{-1}), which were statistically similar (16.03, 38.84, 63.26, 77.26 and 83.32 cm, respectively) with B_2 (1.5 kg B ha^{-1}), whereas the shortest plant (14.42, 36.24, 57.97, 72.67 and 75.56 cm, respectively) was found from B_0 (0 kg B ha^{-1}) (Figure 2). Micronutrients play an important role in increasing growth of pulses with making availability of other nutrients for the plant. From the recorded data it was observed that with the increase of boron fertilizer, plant height of motorshuti increased upto the highest level of boron that was applied under the present trial. Marschner, 1995 reported that micronutrients are involved in the key physiological processes of photosynthesis and respiration that helps for the enongation of plants. Kalyani *et al*., 1993 reported that application of boron resulted increase in the plant height. Togay *et al*., 2008 reported that molybdenum increased plant height. Moghazy *et al*. (2014) reported that plant length had high significant values by foliar spraying with boron.



B_0: 0 kg B ha^{-1} (control) B_1: 1.0 kg B ha^{-1}

B_2: 1.5 kg B ha^{-1} B_3: 2.0 kg B ha^{-1}

Figure 2. Effect of different levels of boron on plant height of BARI motorshuti-1



Mo_0: 0 kg Mo ha^{-1} (control) Mo_1: 1.0 kg Mo ha^{-1}

Mo_2: 1.5 kg Mo ha^{-1}

Different levels of molybdenum differed significantly in terms of plant height of BARI motorshuti-1 at 25, 35, 45, 55 DAS and at harvest (Appendix III). At 25, 35, 45, 55 DAS and at harvest, the tallest plant (15.63, 38.70, 62.55, 77.50 and 82.32 cm, respectively) was found from Mo_2 (1.5 kg Mo ha^{-1}) which were statistically identical (16.00, 38.55, 62.44, 76.21 and 81.40 cm, respectively) with Mo_1 (1.0 Mo ha^{-1}), while the shortest plant (14.71, 36.08, 59.12, 72.95 and 78.14 cm, respectively) was observed from Mo_0 (0 kg Mo ha^{-1}) (Figure 3). Hazra and Tripathi (1998) observed that molybdenum application at the rate of 1.5 kg/ha increased forage in calcareous soil.

Interaction effect of different levels of born and molybdenum showed statistically significant variation on plant height of BARI motorshuti-1 at 25, 35, 45, 55 DAS and at harvest (Appendix III). At 25, 35, 45, 55 DAS and at harvest, the tallest plant (17.31, 40.57, 65.49, 80.34 and 85.58 cm, respectively) was recorded from B_3Mo_2 (2.0 kg B ha^{-1} and 1.5 kg Mo ha^{-1}) and the shortest plant (13.22, 34.79, 57.01, 68.67 and 71.19 cm, respectively) was observed from B_0Mo_0 (0 kg B ha^{-1} and 0 kg Mo ha^{-1}) treatment combination (Table 1).

4.2 Number of branches plant^{-1}

Statistically significant variation was recorded in terms of number of branches plant^{-1} of BARI motorshuti-1 due to different levels of boron at 25, 35, 45, 55 days after sowing (DAS) and at harvest (Appendix IV). At 25, 35, 45, 55 and at harvest, the maximum number of branches plant^{-1} (3,50, 4.41, 5.62, 7.58 and 7.77, respectively) was observed from B_3 (2.0 kg B ha^{-1}), which were statistically similar (3.39, 4.48, 5.58, 7.46 and 7.72, respectively) with B_2 (1.5 kg B ha^{-1}), while the minimum number of branches plant^{-1} (2.44, 3.66, 5.11, 6.24 and 6.68, respectively) was recorded from B_0 (0 kg B ha^{-1}) (Figure 4). Togay *et al*., 2008 reported that molybdenum increased number of branches. Moghazy *et al*. (2014) reported that number of branches had high significant values by foliar spraying with boron.

Table 1. Interaction effect of boron and molybdenum on plant height of BARI motorshuti-1

Treatment	Plant height (cm) at				
	25 DAS	35 DAS	45 DAS	55 DAS	Harvest (72 DAS)
B_0Mo_0	13.22 d	34.79 d	57.01 d	68.67 c	71.19 c
B_0Mo_1	15.38 bc	37.85 abc	59.05 cd	73.80 abc	76.80 bc
B_0Mo_2	14.67 c	36.08 cd	57.84 cd	75.55 ab	78.68 ab
B_1Mo_0	14.89 c	35.78 cd	59.39 bcd	74.37 abc	79.62 ab
B_1Mo_1	15.38 bc	38.21 abc	62.38 abc	76.16 ab	81.45 ab
B_1Mo_2	15.03 c	38.49 abc	61.72 abcd	76.48 ab	81.37 ab
B_2Mo_0	15.89 bc	36.66 cd	60.63 abcd	76.38 ab	82.87 ab
B_2Mo_1	16.70 ab	40.20 a	63.99 ab	77.77 ab	84.21 a
B_2Mo_2	15.52 bc	39.67 ab	65.14 a	77.62 ab	82.89 ab
B_3Mo_0	14.85 c	37.09 bcd	59.43 bcd	72.36 bc	78.88 ab
B_3Mo_1	16.53 ab	37.95 abc	64.36 a	77.12 ab	83.15 ab
B_3Mo_2	17.31 a	40.57 a	65.49 a	80.34 a	85.58 a
$LSD_{(0.05)}$	1.259	2.433	4.287	5.923	6.182
Significance level	0.05	0.05	0.05	0.05	0.05
CV(%)	4.81	5.80	4.13	4.63	7.53

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

B_0: 0 kg B ha^{-1} (control)

B_1: 1.0 kg B ha^{-1}

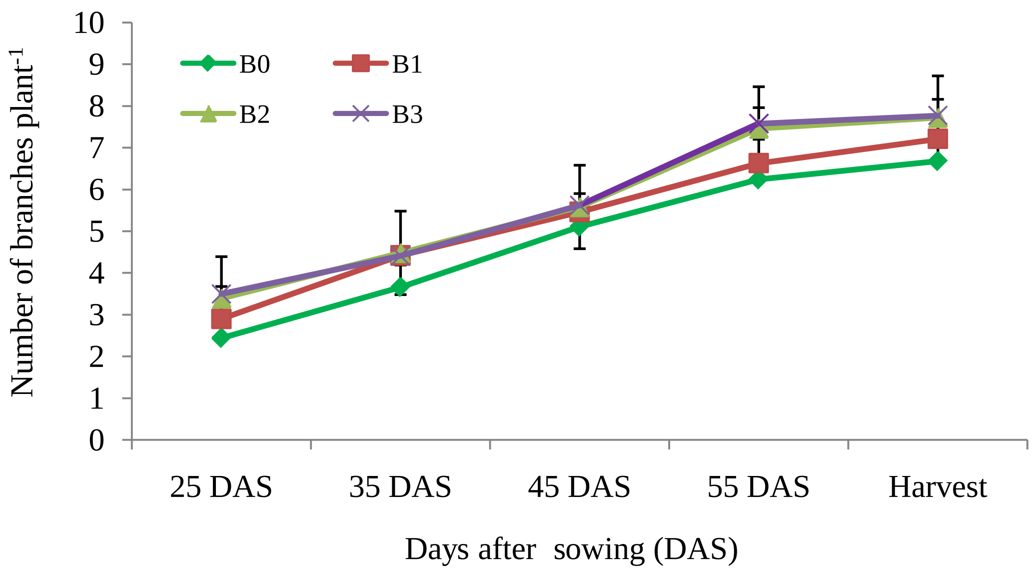
B_2: 1.5 kg B ha^{-1}

B_3: 2.0 kg B ha^{-1}

Mo_0: 0 kg Mo ha^{-1} (control)

Mo_1: 1.0 kg Mo ha^{-1}

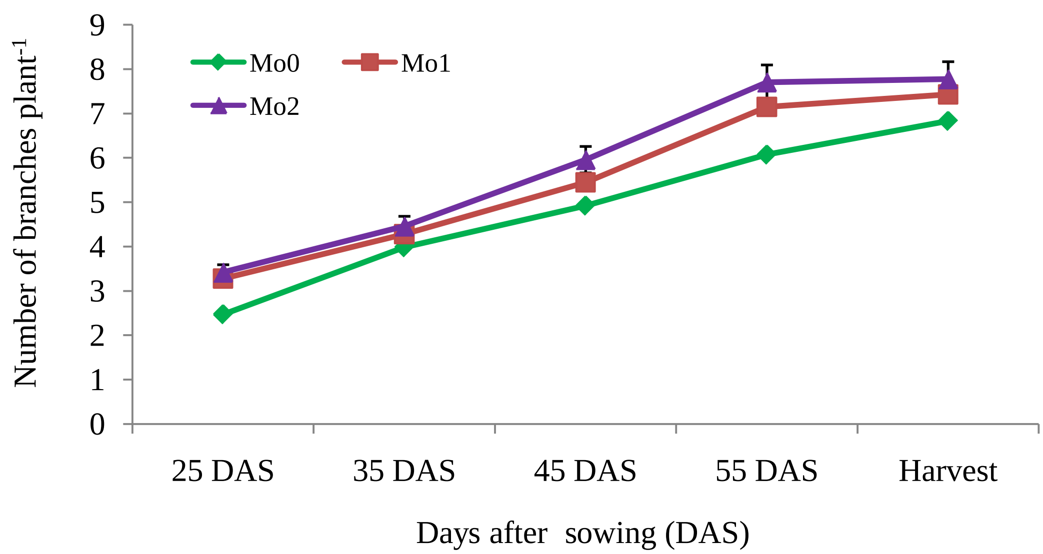
Mo_2: 1.5 kg Mo ha^{-1}



B_0: 0 kg B ha^{-1} (control) B_1: 1.0 kg B ha^{-1}

B_2: 1.5 kg B ha^{-1} B_3: 2.0 kg B ha^{-1}

Figure 4. Effect of different levels of boron on number of branches $plant^{-1}$ of BARI motorshuti-1



Mo_0: 0 kg Mo ha^{-1} (control) Mo_1: 1.0 kg Mo ha^{-1}

Mo_2: 1.5 kg Mo ha^{-1}

Number of branches plant^{-1} of BARI motorshuti-1 varied significantly due to different levels of molybdenum at 25, 35, 45, 55 DAS and at harvest (Appendix IV). At 25, 35, 45, 55 DAS and at harvest, the maximum number of branches plant^{-1} (3.42, 4.46, 5.96, 7.71 and 7.78, respectively) was attained from Mo_2 (1.5 kg Mo ha^{-1}) which were statistically similar (3.28, 4.28, 5.45, 7.15 and 7.43, respectively) with Mo_1 (1.0 Mo ha^{-1}) and the minimum number (2.47, 3.98, 4.92, 6.07 and 6.83, respectively) was observed from Mo_0 (0 kg Mo ha^{-1}) (Figure 5). Hazra and Tripathi (1998) observed that molybdenum application at the rate of 1.5 kg/ha increased forage yields in calcareous soil.

Number of branches plant^{-1} of BARI motorshuti-1 at 25, 35, 45, 55 DAS and at harvest showed statistically significant differences due to the interaction effect of different levels of born and molybdenum (Appendix IV). At 225, 35, 45, 55 DAS and at harvest, the maximum number of branches plant^{-1} (3.90, 4.87, 6.52, 8.33 and 8.40, respectively) was recorded from B_3Mo_2 (2.0 kg B ha^{-1} and 1.5 kg Mo ha^{-1}), while the minimum number (2.10, 3.43, 4.50, 5.33 and 6.40, respectively) from B_0Mo_0 (0 kg B ha^{-1} and 0 kg Mo ha^{-1}) treatment combination (Table 2).

4.3 Days required for sowing to harvest

Days required for sowing to harvest of BARI motorshuti-1 showed statistically significant variation due to different levels of boron (Appendix V). The minimum days required for sowing to harvest (71.00) was found from B_3 (2.0 kg B ha^{-1}), which were statistically identical (72.11 and 73.33) with B_2 (1.5 kg B ha^{-1}) and B_1 (1.0 kg B ha^{-1}), while the maximum days required for sowing to harvest (76.78) was observed from B_0 (0 kg B ha^{-1}) (Figure 6).

Different levels of molybdenum varied significantly in terms of days required for sowing to harvest of BARI motorshuti-1 (Appendix V). The minimum days required for sowing to harvest (71.58) was observed from Mo_2 (1.5 kg Mo ha^{-1}) which were statistically similar (73.50) with Mo_1 (1.0 kg Mo ha^{-1}), whereas the maximum days required for sowing to harvest (74.83) was recorded from Mo_0 (0 kg Mo ha^{-1}) (Figure 7).

Table 2. Interaction effect of boron and molybdenum on number of branches plant^{-1} of BARI motorshuti-1

Treatment	Number of branches plant^{-1} at				
	25 DAS	35 DAS	45 DAS	55 DAS	Harvest (72 DAS)
B_0Mo_0	2.10 e	3.43 d	4.50 e	5.33 h	6.40 e
B_0Mo_1	2.43 d	3.63 cd	5.23 cd	6.20 fgh	6.53 de
B_0Mo_2	2.80 c	3.90 c	5.60 bc	7.20 bcde	7.10 bcde
B_1Mo_0	2.37 de	4.37 b	5.24 cd	6.03 gh	6.67 cde
B_1Mo_1	3.17 b	4.50 b	5.47 bcd	6.87 defg	7.37 abcde
B_1Mo_2	3.17 b	4.40 b	5.67 bc	7.00 cdef	7.60 abcd
B_2Mo_0	2.63 cd	4.33 b	5.17 cde	6.77 efg	7.47 abcde
B_2Mo_1	3.70 a	4.43 b	5.53 bc	7.67 bcd	7.70 abc
B_2Mo_2	3.83 a	4.67 ab	6.03 ab	7.93 ab	8.00 ab
B_3Mo_0	2.77 c	3.80 c	4.79 de	6.17 fgh	6.80 cde
B_3Mo_1	3.83 a	4.57 ab	5.55 bc	7.87 abc	8.10 ab
B_3Mo_2	3.90 a	4.87 a	6.52 a	8.33 a	8.40 a
$LSD_{(0.05)}$	0.312	0.317	0.638	0.803	0.968
Significance level	0.05	0.01	0.05	0.05	0.05
CV(%)	6.02	4.42	6.92	6.79	7.78

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

B_0: 0 kg B ha^{-1} (control)

B_1: 1.0 kg B ha^{-1}

B_2: 1.5 kg B ha^{-1}

B_3: 2.0 kg B ha^{-1}

Mo_0: 0 kg Mo ha^{-1} (control)

Mo_1: 1.0 kg Mo ha^{-1}

Mo_2: 1.5 kg Mo ha^{-1}

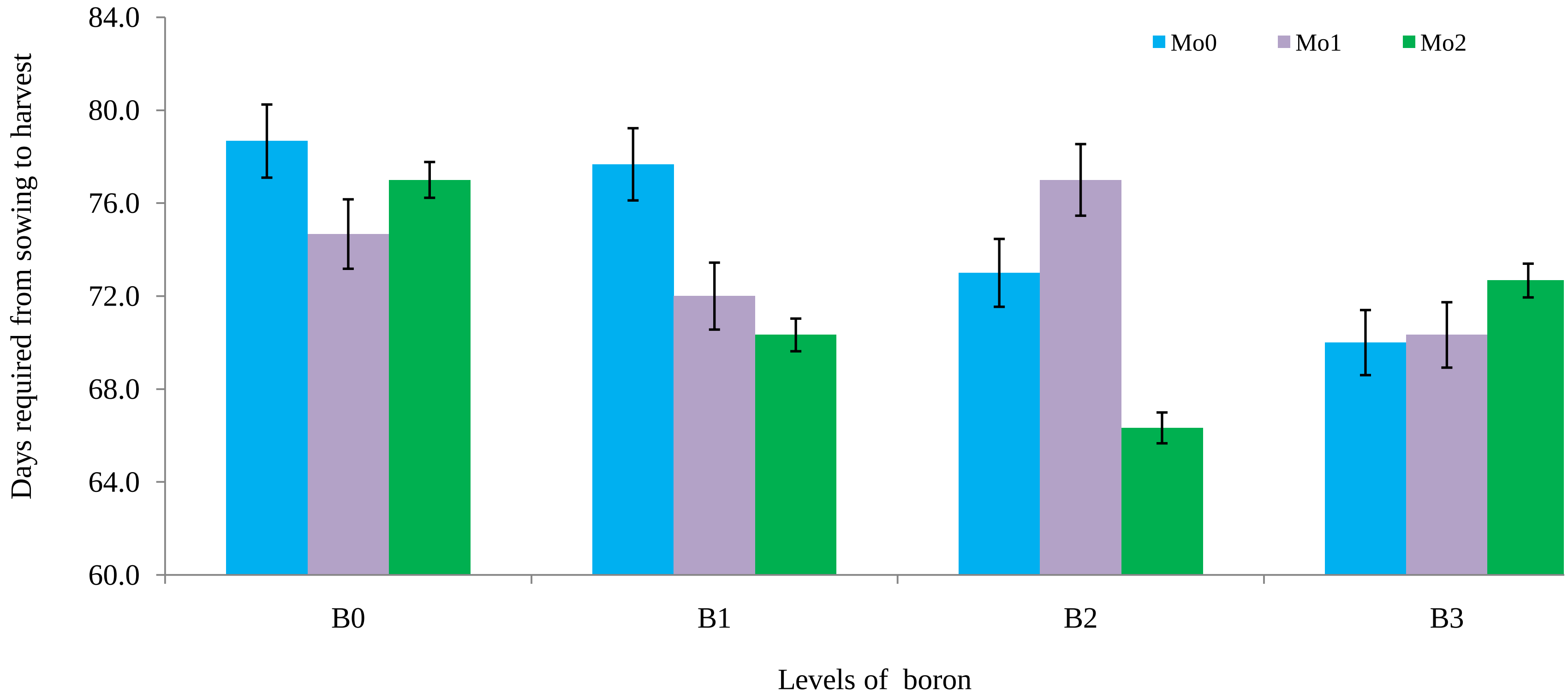
Statistically significant variation was recorded due to the interaction effect of different levels of born and molybdenum on days required for sowing to harvest of BARI motorshuti-1 (Appendix V). The minimum days required for sowing to harvest (66.33) was found from B_2Mo_2 (1.5 kg B ha^{-1} and 1.5 kg Mo ha^{-1}), again the maximum days required for sowing to harvest pod (78.67) was found from B_0Mo_0 (0 kg B ha^{-1} and 0 kg Mo ha^{-1}) treatment combination (Figure 8).

4.4 Number of pods plant^{-1}

Different levels of boron showed statistically significant variation on number of pods plant^{-1} of BARI motorshuti-1 (Appendix V). The maximum number of pods plant^{-1} (25.97) was recorded from B_3 (2.0 kg B ha^{-1}), which were statistically identical (25.57 and 24.94) with B_2 (1.5 kg B ha^{-1}) and B_1 (1.0 kg B ha^{-1}), whereas the minimum number (23.27) was attained from B_0 (0 kg B ha^{-1}) (Table 3). Kalyani *et al.*, 1993 reported that application of boron resulted increase in the number of pods branches^{-1}. Togay *et al.*, 2008 reported that molybdenum increased pods plant^{-1}.

Number of pods plant^{-1} BARI motorshuti-1 varied significantly due to different levels of molybdenum (Appendix V). The maximum number of pods plant^{-1} (26.67) was recorded from Mo_2 (1.5 kg Mo ha^{-1}) which were statistically similar (25.74) with Mo_1 (1.0 kg Mo ha^{-1}), while the minimum number (22.39) from Mo_0 (0 kg Mo ha^{-1}) (Table 3). Manga *et al.* (1999) reported that molybdenum application increased the number of pods per plant

Interaction effect of different levels of born and molybdenum varied significantly in terms of number of pods plant^{-1} of BARI motorshuti-1 (Appendix V). The maximum number of pods plant^{-1} (28.73) was found from B_3Mo_2 (2.0 kg B ha^{-1} and 1.5 kg Mo ha^{-1}) and the minimum number (20.47) was found from B_0Mo_0 (0 kg B ha^{-1} and 0 kg Mo ha^{-1}) treatment combination (Table 4).



B_0: 0 kg B ha^{-1} (control) B_1: 1.0 kg B ha^{-1} Mo_0: 0 kg Mo ha^{-1} (control) Mo_1: 1.0 kg Mo ha^{-1}

B_2: 1.5 kg B ha^{-1} B_3: 2.0 kg B ha^{-1} Mo_2: 1.5 kg Mo ha^{-1}

Figure 8. Interaction effect of different levels of boron and molybdenum on days required from sowing to harvest of BARI motorshuti-1. Vertical bars represent LSD value.

Table 3. Effect of boron and molybdenum on yield contributing characters and yield of BARI motorshuti-1

Treatment	Number of pods per plant	Number of seeds pod^{-1}	Weight of 100 seeds (g)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})
Levels of boron					
B_0	23.27 b	6.59 c	19.57 b	6.28 c	10.38 c
B_1	24.94 a	7.08 b	21.43 a	6.90 b	11.84 b
B_2	25.57 a	7.34 ab	21.98 a	7.45 a	12.86 a
B_3	25.97 a	7.50 a	22.21 a	7.61 a	13.08 a
$LSD_{(0.05)}$	1.232	0.368	1.188	0.428	0.710
Significance level	0.01	0.01	0.01	0.01	0.01
Levels of molybdenum					
Mo_0	22.39 b	6.46 c	20.26 b	6.59 b	11.03 b
Mo_1	25.74 a	7.30 b	21.61 a	7.24 a	12.40 a
Mo_2	26.67 a	7.63 a	22.03 a	7.35 a	12.69 a
$LSD_{(0.05)}$	1.067	0.319	1.029	0.371	0.615
Significance level	0.01	0.01	0.01	0.01	0.01
CV(%)	5.05	5.29	5.71	6.20	7.03

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

B_0: 0 kg B ha^{-1} (control)
B_1: 1.0 kg B ha^{-1}
B_2: 1.5 kg B ha^{-1}
B_3: 2.0 kg B ha^{-1}

Mo_0: 0 kg Mo ha^{-1} (control)
Mo_1: 1.0 kg Mo ha^{-1}
Mo_2: 1.5 kg Mo ha^{-1}

Table 4. Interaction effect of boron and molybdenum on yield contributing characters and yield of BARI motorshuti-1

Treatment	Number of pods per plant	Number of seeds pod^{-1}	Weight of 100 seeds (g)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})
B_0Mo_0	20.47 e	6.20 f	18.32 e	6.14 f	10.14 e
B_0Mo_1	24.27 cd	6.63 def	20.45 cde	6.26 ef	10.30 e
B_0Mo_2	25.07 cd	6.93 cde	19.94 cde	6.43 def	10.71 e
B_1Mo_0	23.80 d	6.57 def	21.48 bcd	6.56 cdef	11.01 de
B_1Mo_1	24.60 cd	7.07 cd	20.82 bcd	7.00 bcde	12.09 cd
B_1Mo_2	26.43 bc	7.60 bc	21.99 abc	7.13 bcd	12.42 c
B_2Mo_0	23.83 d	6.77 def	21.67 bcd	7.28 bc	12.42 c
B_2Mo_1	26.40 bc	7.63 bc	22.13 abc	7.53 ab	13.05 bc
B_2Mo_2	26.47 bc	7.63 bc	22.13 abc	7.55 ab	13.10 bc
B_3Mo_0	21.47 e	6.30 ef	19.55 de	6.38 def	10.57 e
B_3Mo_1	27.70 ab	7.87 ab	23.04 ab	8.16 a	14.17 ab
B_3Mo_2	28.73 a	8.33 a	24.05 a	8.29 a	14.51 a
$LSD_{(0.05)}$	2.133	0.638	2.058	0.742	1.229
Significance level	0.01	0.05	0.05	0.05	0.01
CV(%)	5.05	5.29	5.71	6.20	7.03

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

B_0: 0 kg B ha^{-1} (control)

B_1: 1.0 kg B ha^{-1}

B_2: 1.5 kg B ha^{-1}

B_3: 2.0 kg B ha^{-1}

Mo_0: 0 kg Mo ha^{-1} (control)

Mo_1: 1.0 kg Mo ha^{-1}

Mo_2: 1.5 kg Mo ha^{-1}

4.5 Pod length

Statistically significant variation was recorded due to different levels of boron in terms of pod length of BARI motorshuti-1 (Appendix V). The longest pod (8.29 cm) was observed from B_3 (2.0 kg B ha^{-1}), which were statistically identical (8.24 cm and 7.94 cm) with B_2 (1.5 kg B ha^{-1}) and B_1 (1.0 kg B ha^{-1}), while the shortest pod (7.31 cm) was found from B_0 (0 kg B ha^{-1}) (Figure 9).

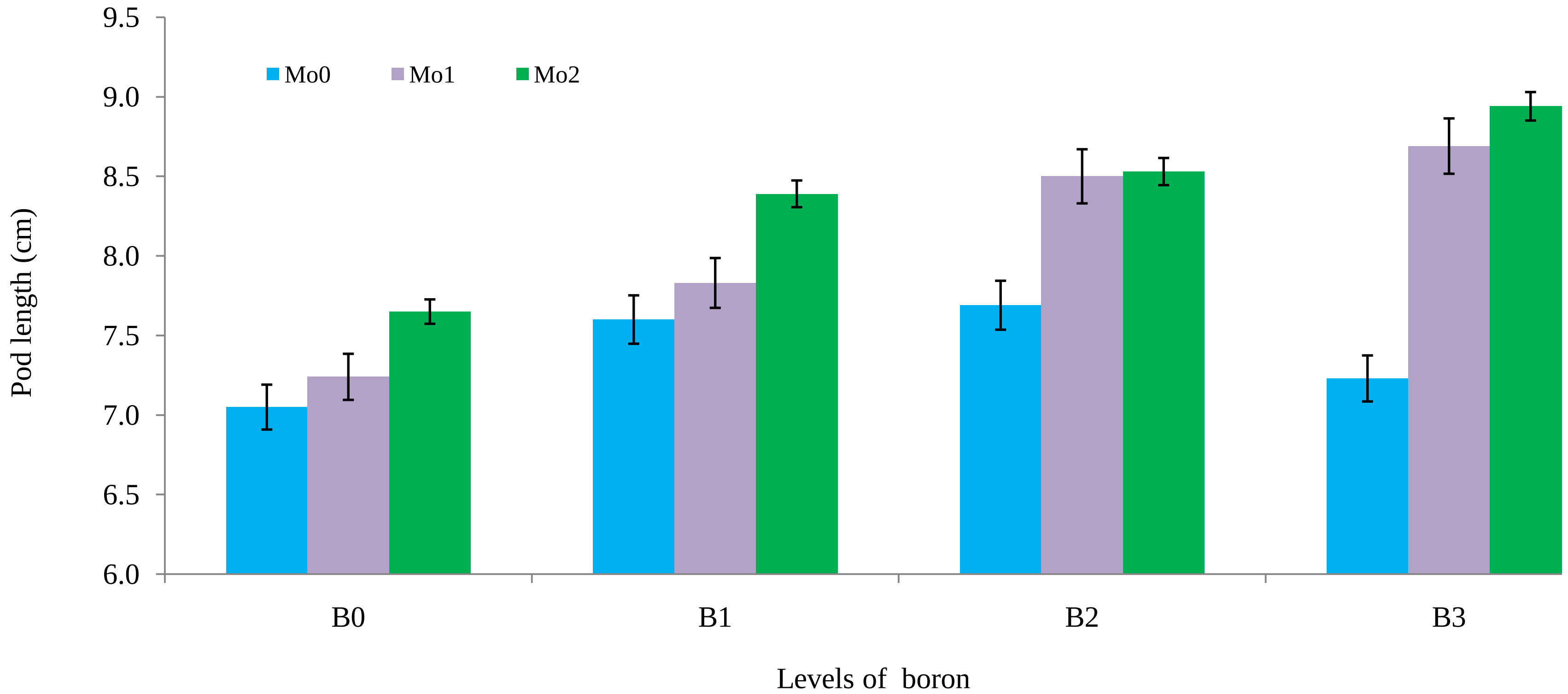
Different levels of molybdenum varied significantly in terms of pod length of BARI motorshuti-1 (Appendix V). The longest pod (8.38 cm) was recorded from Mo_2 (1.5 kg Mo ha^{-1}) which were statistically similar (8.06 cm) with Mo_1 (1.0 kg Mo ha^{-1}) and the shortest pod (7.39 cm) from Mo_0 (0 kg Mo ha^{-1}) (Figure 10).

Pod length of BARI motorshuti-1 showed statistically significant variation due to the interaction effect of different levels of born and molybdenum (Appendix V). The longest pod (8.94 cm) was recorded from B_3Mo_2 (2.0 kg B ha^{-1} and 1.5 kg Mo ha^{-1}), whereas the shortest pod (7.05 cm) was found from B_0Mo_0 (0 kg B ha^{-1} and 0 kg Mo ha^{-1}) treatment combination (Figure 11).

4.6 Number of seeds pod^{-1}

Different levels of boron showed statistically significant variation on number of seeds pod^{-1} of BARI motorshuti-1 (Appendix V). The maximum number of seeds pod^{-1} (7.50) was found from B_3 (2.0 kg B ha^{-1}), which were statistically identical (7.34) with B_2 (1.5 kg B ha^{-1}) and followed (7.08) by B_1 (1.0 kg B ha^{-1}), while the other hand, the minimum number (6.59) from B_0 (0 kg B ha^{-1}) (Table 3). Togay *et al*., 2008 reported that molybdenum increased number of seeds $plant^{-1}$.

Number of seeds pod^{-1} of BARI motorshuti-1 varied significantly due to different levels of molybdenum (Appendix V). The maximum number of seeds pod^{-1} (7.63) was recorded from Mo_2 (1.5 kg Mo ha^{-1}) which were statistically similar (7.30) with Mo_1 (1.0 kg Mo ha^{-1}), while the minimum number (6.46) from Mo_0 (0 kg Mo ha^{-1}) (Table 3). Sarkar and Banik (1991) observed the molybdenum application significantly increased seed pod^{-1}.



B_0: 0 kg B ha^{-1} (control) B_1: 1.0 kg B ha^{-1} Mo_0: 0 kg Mo ha^{-1} (control) Mo_1: 1.0 kg Moha^{-1}

B_2: 1.5 kg B ha^{-1} B_3: 2.0 kg B ha^{-1} Mo_2: 1.5 kg Mo ha^{-1}

Figure 11. Interaction effect of different levels of boron and molybdenum on pod length of BARI motorshuti-1. Vertical bars represent LSD value.

Statistically significant variation was recorded due to the interaction effect of different levels of born and molybdenum on number of seeds pod^{-1} of BARI motorshuti-1 (Appendix V). The maximum number of seeds pod^{-1} (8.33) was observed from B_3Mo_2 (2.0 kg B ha^{-1} and 1.5 kg Mo ha^{-1}) and the minimum number (6.20) was found from B_0Mo_0 (0 kg B ha^{-1} and 0 kg Mo ha^{-1}) treatment combination (Table 4).

4.7 Weight of 100 seeds

Weight of 100 seeds of BARI motorshuti-1 varied significantly due to different levels of boron under the present trial (Appendix V). The highest weight of 100 seeds (22.21 g) was observed from B_3 (2.0 kg B ha^{-1}), which were statistically identical (21.98 g and 21.43 g) with B_2 (1.5 kg B ha^{-1}) and B_1 (1.0 kg B ha^{-1}), while the lowest weight (19.57 g) was attained from B_0 (0 kg B ha^{-1}) (Table 3). Moghazy *et al*. (2014) reported that its components had high significant values by foliar spraying with boron.

Statistically significant variation was recorded in terms of weight of 100 seeds of BARI motorshuti-1 due to different levels of molybdenum (Appendix V). The highest weight of 100 seeds (22.03 g) was found from Mo_2 (1.5 kg Mo ha^{-1}) which were statistically similar (21.61 g) with Mo_1 (1.0 kg Mo ha^{-1}), again the lowest weight (20.26 g) from Mo_0 (0 kg Mo ha^{-1}) (Table 3). Sarkar and Banik (1991) observed the molybdenum application significantly increased 1000 seed weight.

Interaction effect of different levels of born and molybdenum showed statistically significant variation in terms of weight of 100 seeds of BARI motorshuti-1 (Appendix V). The highest weight of 100 seeds (24.05 g) was observed from B_3Mo_2 (2.0 kg B ha^{-1} and 1.5 kg Mo ha^{-1}), whereas the lowest weight (18.32 g) was attained from B_0Mo_0 (0 kg B ha^{-1} and 0 kg Mo ha^{-1}) treatment combination (Table 4).

4.8 Seed yield hectare^{-1}

Seed yield hectare^{-1} of BARI motorshuti-1 varied significantly due to different levels of boron (Appendix V). The highest seed yield (7.61 t ha^{-1}) was observed from B_3 (2.0 kg B ha^{-1}), which were statistically identical (7.45 t ha^{-1}) with B_2 (1.5 kg B ha^{-1}) and closely followed (6.90 t ha^{-1}) by B_1 (1.0 kg B ha^{-1}). On the other hand, the lowest seed yield (6.28 t ha^{-1}) was observed from B_0 (0 kg B ha^{-1}) (Table 3). Kalyani *et al*. (1993) reported that application of boron resulted increase in the yield. Togay *et al*. (2008) reported that molybdenum increased seeds yield. Moghazy *et al*. (2014) reported that yields and its components had high significant values by foliar spraying with boron. Verma and Mishra (1999) reported that increased yield and growth parameters with the best results in terms of seed yield/plant when the equivalent of 5 kg borax/ha was applied at flowering stage. Sarkar and Banik (1991) observed the molybdenum application significantly increased seed yield. Manga *et al.* (1999) reported that the seed yield increase was 15.7 and 25.9% when 0.5 and 1.0 kg ammonium molybdate/ha respectively were applied.

Levels of molybdenum varied significantly in terms of seed yield hectare^{-1} of BARI motorshuti-1 (Appendix V). The highest seed yield (7.35 t ha^{-1}) was recorded from Mo_2 (1.5 kg Mo ha^{-1}) which were statistically similar (7.24 t ha^{-1}) with Mo_1 (1.0 kg Mo ha^{-1}), whereas the lowest seed yield (6.59 t ha^{-1}) from Mo_0 (0 kg Mo ha^{-1}) (Table 3). Sheudzhen *et al*. (1985) reported highest yield with 0.05% Mo (7.46 t/ha) compared to (6.14 t/ha) zero trace element. Hazra and Tripathi (1998) observed that molybdenum application at the rate of 1.5 kg/ha increased seed yields.

Statistically significant variation was recorded due to the interaction effect of different levels of born and molybdenum on seed yield hectare of BARI motorshuti-1 (Appendix V). The highest seed yield (8.29 t ha^{-1}) was found from B_3Mo_2 (2.0 kg B ha^{-1} and 1.5 kg Mo ha^{-1}), while the lowest seed yield (6.14 t ha^{-1}) was found from B_0Mo_0 (0 kg B ha^{-1} and 0 kg Mo ha^{-1}) treatment combination (Table 4).

4.9 Stover yield hectare^{-1}

Different levels of boron varied significantly on stover yield hectare^{-1} of BARI motorshuti-1 (Appendix V). The highest stover yield (13.08 t ha^{-1}) was found from B_3 (2.0 kg B ha^{-1}), which were statistically identical (12.86 t ha^{-1}) with B_2 (1.5 kg B ha^{-1}) and closely followed (11.84 t ha^{-1}) by B_1 (1.0 kg B ha^{-1}), whereas the lowest stover yield (10.38 t ha^{-1}) from B_0 (0 kg B ha^{-1}) (Table 3).

Stover yield hectare^{-1} of BARI motorshuti-1 varied significantly due to different levels of molybdenum (Appendix V). The highest stover yield (12.69 t ha^{-1}) was observed from Mo_2 (1.5 kg Mo ha^{-1}) which were statistically similar (12.40 t ha^{-1}) with Mo_1 (1.0 kg Mo ha^{-1}), while the lowest stover yield (11.03 t ha^{-1}) was recorded from Mo_0 (0 kg Mo ha^{-1}) (Table 3). Sarkar and Banik (1991) observed the molybdenum application significantly increased straw yield.

Interaction effect of different levels of born and molybdenum showed statistically significant variation in terms of stover yield hectare of BARI motorshuti-1 (Appendix V). The highest stover yield (14.51 t ha^{-1}) was observed from B_3Mo_2 (2.0 kg B ha^{-1} and 1.5 kg Mo ha^{-1}) and the lowest stover yield (10.14 t ha^{-1}) from B_0Mo_0 (0 kg B ha^{-1} and 0 kg Mo ha^{-1}) treatment combination (Table 4).

4.10 N, P, K, B and Mo concentration in seed

Significant variation was found for N, P, K, B and Mo concentration in seed due different levels of boron (Appendix VI). The maximum concentration in seed for N (0.451%), P (0.308%), K (0.370%), B (0.0348%) and Mo (0.0133%) was found from B_3 (2.0 kg B ha^{-1}), while the minimum (0.374%), P (0.228%), K (0.307%), B (0.0261%) and Mo (0.0104%) was found from B_0 (0 kg B ha^{-1}) (Table 5).

N, P, K, B and Mo concentration in seed showed statistically significant variation due to different levels of molybdenum (Appendix VI). The maximum concentration in seed for N (0.452%), P (0.299%), K (0.365%), B (0.0356%) and Mo (0.0131%) was observed from Mo_2 (1.5 kg Mo ha^{-1}) and the minimum concentration in seed for N (0.380%), P (0.234%), K (0.316%), B (0.0259%) and Mo (0.0106%) was recorded from Mo_0 (0 kg Mo ha^{-1} (Table 5).

Table 5. Effect of boron and molybdenum on N, P, K, B and Mo concentrations in seeds of BARI motorshuti-1

Treatment	Concentration (%) in seeds				
	N	P	K	B	Mo
Levels of boron					
B_0	0.374 c	0.228 d	0.307 d	0.0261 c	0.0104 c
B_1	0.419 b	0.255 c	0.331 c	0.0299 b	0.0112 bc
B_2	0.441 ab	0.282 b	0.355 b	0.0339 a	0.0120 b
B_3	0.451 a	0.308 a	0.370 a	0.0348 a	0.0133 a
$LSD_{(0.05)}$	0.031	0.010	0.010	0.003	0.0010
Significance level	0.01	0.01	0.01	0.01	0.01
Levels of molybdenum					
Mo_0	0.380 b	0.234 c	0.316 c	0.0259 c	0.0106 c
Mo_1	0.431 a	0.272 b	0.342 b	0.0321 b	0.0115 b
Mo_2	0.452 a	0.299 a	0.365 a	0.0356 a	0.0131 a
$LSD_{(0.05)}$	0.027	0.009	0.009	0.003	0.0009
Significance level	0.01	0.01	0.01	0.01	0.01
CV(%)	6.80	8.84	4.74	6.89	4.37

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

B_0: 0 kg B ha^{-1} (control)
B_1: 1.0 kg B ha^{-1}
B_2: 1.5 kg B ha^{-1}
B_3: 2.0 kg B ha^{-1}

Mo_0: 0 kg Mo ha^{-1} (control)
Mo_1: 1.0 kg Mo ha^{-1}
Mo_2: 1.5 kg Mo ha^{-1}

Statistically significant variation was recorded due to the interaction effect of boron and molybdenum in terms of N, P, K, B and Mo concentration in seed (Appendix VI). The maximum concentration in seed for N (0.0497%), P (0.384%), K (0.419%), B (0.0409%) and Mo (0.0151%) was observed from B_3Mo_2 (2.0 kg B ha^{-1} and 1.5 kg Mo ha^{-1}), whereas the minimum concentration in seed for N (0.350%), P (0.215%), K (0.305%), B (0.0252%) and Mo (0.0093%) was found from B_0Mo_0 (0 kg B ha^{-1} and 0 kg Mo ha^{-1}) treatment combination (Table 6).

4.11 N, P, K, B and Mo concentration in stover

N, P, K, B and Mo concentration in stover showed statistically significant variation due different levels of boron (Appendix VII). The maximum concentration in stover for N (0.361%), P (0.046%), K (1.329%), B (0.0037%) and Mo (0.0028%) was observed from B_3 (2.0 kg B ha^{-1}), whereas the minimum concentration in stover for N (0.287%), P (0.041%), K (1.214%), B (0.0025%) and Mo (0.0018%) was found from B_0 (0 kg B ha^{-1}) (Table 7).

Statistically significant variation was recorded in terms of N, P, K, B and Mo concentration due to different levels of molybdenum (Appendix VII). The maximum concentration in stover for N (0.350%), P (0.046%), K (1.327%), B (0.0036%) and Mo (0.0027%) was recorded from Mo_2 (1.5 kg Mo ha^{-1}), while the minimum concentration in stover for N (0.314%), P (0.041%), K (1.218%), B (0.0026%) and Mo (0.0019%) was observed from Mo_0 (0 kg Mo ha^{-1} (Table 7).

Interaction effect of boron and molybdenum showed statistically significant variation in terms of N, P, K, B and Mo concentration in stover (Appendix VII). The maximum concentration in stover for N (0.425%), P (0.048%), K (1.378%), B (0.0042%) and Mo (0.0032%) was observed from B_3Mo_2 (2.0 kg B ha^{-1} and 1.5 kg Mo ha^{-1}), again the minimum concentration in stover for N (0.285%), P (0.036%), K (1.107%), B (0.0021%) and Mo (0.0015%) was found from B_0Mo_0 (0 kg B ha^{-1} and 0 kg Mo ha^{-1}) treatment combination (Table 8).

Table 6. Interaction effect of boron and molybdenum on N, P, K, B and Mo concentrations in seeds of BARI motorshuti-1

Treatment	Concentration (%) in seeds				
	N	P	K	B	Mo
B_0Mo_0	0.350 e	0.223 ef	0.305 f	0.0252 b	0.0093 f
B_0Mo_1	0.377 de	0.215 f	0.308 f	0.0270 b	0.0105 ef
B_0Mo_2	0.396 de	0.245 cd	0.307 f	0.0262 b	0.0113 cde
B_1Mo_0	0.413 cd	0.245 cd	0.306 f	0.0249 b	0.0105 ef
B_1Mo_1	0.409 cde	0.261 c	0.334 de	0.0297 b	0.0107 def
B_1Mo_2	0.433 bcd	0.259 c	0.353 c	0.0353 a	0.0125 bcd
B_2Mo_0	0.376 de	0.229 def	0.335 de	0.0260 b	0.0107 def
B_2Mo_1	0.464 abc	0.309 b	0.352 cd	0.0358 a	0.0119 bcde
B_2Mo_2	0.483 ab	0.307 b	0.379 b	0.0400 a	0.0135 ab
B_3Mo_0	0.381 de	0.237 de	0.319 ef	0.0274 b	0.0119 bcde
B_3Mo_1	0.476 ab	0.303 b	0.374 b	0.0360 a	0.0130 bc
B_3Mo_2	0.497 a	0.384 a	0.419 a	0.0409 a	0.0151 a
$LSD_{(0.05)}$	0.054	0.017	0.017	0.005	0.0017
Significance level	0.05	0.01	0.01	0.01	0.05
CV(%)	6.80	8.84	4.74	6.89	4.37

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

B_0: 0 kg B ha^{-1} (control)

B_1: 1.0 kg B ha^{-1}

B_2: 1.5 kg B ha^{-1}

B_3: 2.0 kg B ha^{-1}

Mo_0: 0 kg Mo ha^{-1} (control)

Mo_1: 1.0 kg Mo ha^{-1}

Mo_2: 1.5 kg Mo ha^{-1}

Table 7. Effect of boron and molybdenum on N, P, K, B and Mo concentrations in stover of BARI motorshuti-1

Treatment	Concentration (%) in stover				
	N	P	K	B	Mo
Levels of boron					
B_0	0.287 d	0.041 c	1.214 b	0.0025 b	0.0018 b
B_1	0.330 c	0.042 bc	1.281 ab	0.0029 ab	0.0023 a
B_2	0.351 b	0.045 ab	1.305 a	0.0033 ab	0.0025 a
B_3	0.361 a	0.046 a	1.329 a	0.0037 a	0.0028 a
$LSD_{(0.05)}$	0.0010	0.0031	0.076	0.0009	0.0009
Significance level	0.01	0.01	0.05	0.01	0.01
Levels of molybdenum					
Mo_0	0.314 c	0.041 b	1.218 b	0.0026 b	0.0019 b
Mo_1	0.332 b	0.044 a	1.302 a	0.0031 ab	0.0024 a
Mo_2	0.350 a	0.046 a	1.327 a	0.0036 a	0.0027 a
$LSD_{(0.05)}$	0.0085	0.0027	0.066	0.0008	0.0008
Significance level	0.01	0.01	0.01	0.01	0.01
CV(%)	5.09	4.84	6.13	7.63	6.09

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

B_0: 0 kg B ha^{-1} (control)

B_1: 1.0 kg B ha^{-1}

B_2: 1.5 kg B ha^{-1}

B_3: 2.0 kg B ha^{-1}

Mo_0: 0 kg Mo ha^{-1} (control)

Mo_1: 1.0 kg Mo ha^{-1}

Mo_2: 1.5 kg Mo ha^{-1}

Table 8. Interaction effect of boron and molybdenum on N, P, K, B and Mo concentrations in stover of BARI motorshuti-1

Treatment	Concentration (%) in stover				
	N	P	K	B	Mo
B_0Mo_0	0.285 d	0.036 c	1.107 b	0.0021 b	0.0015 b
B_0Mo_1	0.288 d	0.043 ab	1.267 a	0.0024 ab	0.0019 a
B_0Mo_2	0.287 d	0.043 ab	1.269 a	0.0029 ab	0.0022 a
B_1Mo_0	0.313 c	0.041 bc	1.240 a	0.0026 ab	0.0020 a
B_1Mo_1	0.338 b	0.042 bc	1.287 a	0.0029 ab	0.0022 a
B_1Mo_2	0.338 b	0.043 ab	1.315 a	0.0034 ab	0.0026 a
B_2Mo_0	0.346 b	0.042 ab	1.259 a	0.0025 ab	0.0019 a
B_2Mo_1	0.355 b	0.045 ab	1.311 a	0.0034 ab	0.0026 a
B_2Mo_2	0.351 b	0.048 a	1.345 a	0.0039 ab	0.0030 a
B_3Mo_0	0.312 c	0.043 ab	1.267 a	0.0031 ab	0.0024 a
B_3Mo_1	0.346 b	0.046 ab	1.342 a	0.0037 ab	0.0028 a
B_3Mo_2	0.425 a	0.048 a	1.378 a	0.0042 a	0.0032 a
$LSD_{(0.05)}$	0.017	0.0054	0.131	0.0017	0.0017
Significance level	0.01	0.05	0.05	0.05	0.05
CV(%)	5.09	4.84	6.13	7.63	6.09

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

B_0: 0 kg B ha^{-1} (control)

B_1: 1.0 kg B ha^{-1}

B_2: 1.5 kg B ha^{-1}

B_3: 2.0 kg B ha^{-1}

Mo_0: 0 kg Mo ha^{-1} (control)

Mo_1: 1.0 kg Mo ha^{-1}

Mo_2: 1.5 kg Mo ha^{-1}

4.12 pH

Different levels of boron showed statistically significant variation in terms of pH in post harvest soil (Appendix VIII). The highest pH in post harvest soil (6.66) was observed from B_3 (2.0 kg B ha^{-1}), which was statistically identical (6.64 and 6.53) with B_2 (1.5 kg B ha^{-1}) and B_1 (1.0 kg B ha^{-1}), while the lowest pH (6.26) was found from B_0 (0 kg B ha^{-1}) (Table 9).

Statistically significant variation was recorded for pH in post harvest soil due to different levels of molybdenum (Appendix VIII). The highest pH in post harvest soil (6.73) was recorded from Mo_2 (1.5 kg B ha^{-1}) which was statistically similar (6.53) with Mo_1 (1.0 kg Mo ha^{-1}), whereas the lowest pH (6.31) from Mo_0 (0 kg Mo ha^{-1}) (Table 9).

Interaction effect of different levels of boron and molybdenum showed significant variation on pH in post harvest soil (Appendix VIII). The highest pH in post harvest soil (6.90) was observed from B_3Mo_2 (2.0 kg B ha^{-1} and 1.5 kg Mo ha^{-1}) and the lowest pH in post harvest soil (6.11) was found from B_0Mo_0 (0 kg B ha^{-1} and 0 kg Mo ha^{-1}) treatment combination (Table 10).

4.13 Organic matter

Organic matter in post harvest soil showed statistically significant variation due to different levels of boron (Appendix VIII). The highest organic matter in post harvest soil (1.50%) was recorded from B_3 (2.0 kg B ha^{-1}), which was statistically identical (1.46% and 1.43%) with B_2 (1.5 kg B ha^{-1}) and B_1 (1.0 kg B ha^{-1}), whereas the lowest organic matter (1.36%) was observed from B_0 (0 kg B ha^{-1}) (Table 9).

Different levels of molybdenum varied significantly in terms of organic matter in post harvest soil (Appendix VIII). The highest organic matter in post harvest soil (1.50%) was found from Mo_2 (1.5 kg B ha^{-1}) which was statistically similar (1.43%) with Mo_1 (1.0 kg Mo ha^{-1}), while the lowest organic matter (1.37%) from Mo_0 (0 kg Mo ha^{-1}) (Table 9).

Table 9. Effect of boron and molybdenum on pH, organic matter, available B and Mo of post harvest soil of BARI motorshuti-1

Treatment	pH	Organic matter (%)	Available B (ppm)	Available Mo (ppm)
Levels of boron				
B_0	6.26 b	1.36 b	0.477 c	0.297 d
B_1	6.53 ab	1.43 ab	0.590 b	0.328 c
B_2	6.64 a	1.46 a	0.671 a	0.354 b
B_3	6.66 a	1.50 a	0.687 a	0.369 a
$LSD_{(0.05)}$	0.271	0.082	0.031	0.0098
Significance level	0.05	0.01	0.01	0.01
Levels of molybdenum				
Mo_0	6.31 b	1.37 b	0.533 b	0.323 c
Mo_1	6.53 ab	1.43 ab	0.633 a	0.340 b
Mo_2	6.73 a	1.50 a	0.653 a	0.348 a
$LSD_{(0.05)}$	0.235	0.071	0.027	0.0085
Significance level	0.01	0.01	0.01	0.01
CV(%)	4.24	5.72	4.28	5.09

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

B_0: 0 kg B ha^{-1} (control)

B_1: 1.0 kg B ha^{-1}

B_2: 1.5 kg B ha^{-1}

B_3: 2.0 kg B ha^{-1}

Mo_0: 0 kg Mo ha^{-1} (control)

Mo_1: 1.0 kg Mo ha^{-1}

Mo_2: 1.5 kg Mo ha^{-1}

Table 10. Interaction effect of boron and molybdenum on pH, organic matter, available B and Mo of post harvest soil of BARI motorshuti-1

Treatment	pH	Organic matter (%)	Available B (ppm)	Available Mo (ppm)
B_0Mo_0	6.11 c	1.32 c	0.479 e	0.284 e
B_0Mo_1	6.13 c	1.35 bc	0.481 e	0.295 de
B_0Mo_2	6.54 abc	1.40 bc	0.470 e	0.310 d
B_1Mo_0	6.40 abc	1.36 bc	0.525 de	0.308 d
B_1Mo_1	6.45 abc	1.41 bc	0.598 bc	0.336 c
B_1Mo_2	6.73 ab	1.51 ab	0.648 b	0.341 bc
B_2Mo_0	6.39 abc	1.35 bc	0.554 cd	0.340 bc
B_2Mo_1	6.78 ab	1.51 ab	0.723 a	0.357 ab
B_2Mo_2	6.74 ab	1.50 ab	0.736 a	0.366 a
B_3Mo_0	6.34 bc	1.46 abc	0.573 cd	0.362 a
B_3Mo_1	6.74 ab	1.45 abc	0.731 a	0.370 a
B_3Mo_2	6.90 a	1.58 a	0.756 a	0.376 a
$LSD_{(0.05)}$	0.470	0.142	0.054	0.017
Significance level	0.05	0.05	0.01	0.05
CV(%)	4.24	5.72	4.28	5.09

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

B_0: 0 kg B ha^{-1} (control)

B_1: 1.0 kg B ha^{-1}

B_2: 1.5 kg B ha^{-1}

B_3: 2.0 kg B ha^{-1}

Mo_0: 0 kg Mo ha^{-1} (control)

Mo_1: 1.0 kg Mo ha^{-1}

Mo_2: 1.5 kg Mo ha^{-1}

Statistically significant variation was recorded on organic matter in post harvest soil due to the interaction effect of different levels of boron and molybdenum (Appendix VIII). The highest organic matter in post harvest soil (1.58%) was observed from B_3Mo_2 (2.0 kg B ha^{-1} and 1.5 kg Mo ha^{-1}), again the lowest organic matter in post harvest soil (1.32%) was recorded from B_0Mo_0 (0 kg B ha^{-1} and 0 kg Mo ha^{-1}) treatment combination (Table 10).

4.14 Available boron

Different levels of boron showed statistically significant variation in terms of available boron in post harvest soil (Appendix VIII). The highest available boron in post harvest soil (0.687 ppm) was found from B_3 (2.0 kg B ha^{-1}), which was statistically identical (0.671 ppm) with B_2 (1.5 kg B ha^{-1}) and closely followed (0.590 ppm) by B_1 (1.0 kg B ha^{-1}), while the lowest available boron (0.477 ppm) was found from B_0 (0 kg B ha^{-1}) (Table 9).

Significant variation was recorded for available boron in post harvest soil due to different levels of molybdenum (Appendix VIII). The highest available boron in post harvest soil (0.653 ppm) was recorded from Mo_2 (1.5 kg B ha^{-1}) which was statistically similar (0.633 ppm) with Mo_1 (1.0 kg Mo ha^{-1}), whereas the lowest available boron (0.533 ppm) from Mo_0 (0 kg Mo ha^{-1}) (Table 9).

Interaction effect of different levels of boron and molybdenum showed significant variation on available boron in post harvest soil (Appendix VIII). The highest available boron in post harvest soil (0.756 ppm) was observed from B_3Mo_2 (2.0 kg B ha^{-1} and 1.5 kg Mo ha^{-1}), whereas the lowest available boron in post harvest soil (0.479 ppm) was attained from B_0Mo_0 (0 kg B ha^{-1} and 0 kg Mo ha^{-1}) treatment combination (Table 10).

4.15 Available Molybdenum

Statistically significant variation was recorded due to different levels of boron in terms of available molybdenum in post harvest soil (Appendix VIII). The highest available molybdenum in post harvest soil (0.369 ppm) was recorded from B_3 (2.0

kg B ha^{-1}), which was statistically closely followed (0.354 ppm) by B_2 (1.5 kg B ha^{-1}). On the other hand, the lowest available molybdenum (0.297 ppm) was recorded from B_0 (0 kg B ha^{-1}) which was closely followed (0.328 ppm) by B_1 (1.0 kg B ha^{-1}) (Table 9).

Different levels of molybdenum showed statistically significant variation in terms of available molybdenum in post harvest soil (Appendix VIII). The highest available molybdenum in post harvest soil (0.348 ppm) was observed from Mo_2 (1.5 kg B ha^{-1}) which was closely followed (0.340 ppm) by Mo_1 (1.0 kg Mo ha^{-1}), while the lowest available molybdenum (0.323 ppm) from Mo_0 (0 kg Mo ha^{-1}) (Table 9).

Available molybdenum in post harvest soil showed significant variation due t o the interaction effect of different levels of boron and molybdenum (Appendix VIII). The highest available molybdenum in post harvest soil (0.376 ppm) was observed from B_3Mo_2 (2.0 kg B ha^{-1} and 1.5 kg Mo ha^{-1}), whereas the lowest available molybdenum in post harvest soil (0.284 ppm) was recorded from B_0Mo_0 (0 kg B ha^{-1} and 0 kg Mo ha^{-1}) treatment combination (Table 10).

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at the farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh during the period from November 2012 to March, 2013 to study the effect of boron and molybdenum on growth and yield of BARI motorshuti-1. The experiment comprised of two factors-Factor A: Levels of boron (4 levels); B_0: 0 kg B ha^{-1} (control), B_1: 1.0 kg B ha^{-1}, B_2: 1.5 kg B ha^{-1} and B_3: 2.0 kg B ha^{-1}; Factors B: Levels of molybdenum (3 levels)- Mo_0: 0 kg Mo ha^{-1} (control), Mo_1: 1.0 kg Mo ha^{-1} and Mo_2: 1.5 kg Mo ha^{-1}. The two factors experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Data on different growth parameter, yield, nutrient concentration in pods and stover and characteristics of post harvest soil was recorded and statistically significant variation was recorded for all the studied characters.

At 25, 35, 45, 55 and at harvest, the tallest plant (16.23, 38.54, 63.09, 76.60 and 82.54 cm, respectively) was recorded from B_3, whereas the shortest plant (14.42, 36.24, 57.97, 72.67 and 75.56 cm, respectively) was found from B_0. At 25, 35, 45, 55 and at harvest, the maximum number of branches $plant^{-1}$ (3,50, 4.41, 5.62, 7.58 and 7.77, respectively) was observed from B_3, while the minimum number of branches $plant^{-1}$ (2.44, 3.66, 5.11, 6.24 and 6.68, respectively) was recorded from B_0. The minimum days required for sowing to harvest (71.00) was found from B_3 (2.0 kg B ha^{-1}), while the maximum days required for sowing to harvest (76.78) was observed from B_0. The maximum number of pods $plant^{-1}$ (25.97) was recorded from B_3, whereas the minimum number (23.27) was attained from B_0. The longest pod (8.29 cm) was observed from B_3, while the shortest pod (7.31 cm) was found from B_0. The maximum number of seeds pod^{-1} (7.50) was found from B_3 and the minimum number (6.59) was recorded from B_0. The highest weight of 100 seeds (22.21 g) was observed from B_3, while the lowest weight (19.57 g) was attained from B_0. The highest seed yield (7.61 t ha^{-1}) was observed from B_3 and the lowest seed yield (6.28 t ha^{-1}) was observed from B_0. The highest stover yield (13.08 t ha^{-1}) was found from B_3, whereas the lowest stover yield (10.38 t ha^{-1}) was recorded from B_0.

The maximum concentration in seed for N (0.451%), P (0.308%), K (0.370%), B (0.0348%) and Mo (0.0133%) was found from B_3, while the minimum concentration in seed for N (0.374%), P (0.228%), K (0.307%), B (0.0261%) and Mo (0.0104%) was found from B_0. The maximum concentration in stover for N (0.361%), P (0.046%), K (1.329%), B (0.0037%) and Mo (0.0028%) was observed from B_3, whereas the minimum concentration in stover for N (0.287%), P (0.041%), K (1.214%), B (0.0025%) and Mo (0.0018%) was found from B_0. The highest pH in post harvest soil (6.66) was observed from B_3, while the lowest pH (6.26) was found from B_0. The highest organic matter in post harvest soil (1.50%) was recorded from B_3, whereas the highest available boron in post harvest soil (0.687 ppm) was found from B_3, while the lowest available boron (0.477 ppm) was found from B_0. The highest organic matter in post harvest soil (1.50%) was recorded from B_3, whereas the lowest organic matter (1.36%) was observed from B_0. The highest available molybdenum in post harvest soil (0.369 ppm) was recorded from B_3 (2.0 kg B ha^{-1}) and the lowest available molybdenum (0.297 ppm) was recorded from B_0.

At 25, 35, 45, 55 DAS and at harvest, the tallest plant (15.63, 38.70, 62.55, 77.50 and 82.32 cm, respectively) was found from Mo_2, while the shortest plant (14.71, 36.08, 59.12, 72.95 and 78.14 cm, respectively) was observed from Mo_0. At 25, 35, 45, 55 DAS and at harvest, the maximum number of branches $plant^{-1}$ (3.42, 4.46, 5.96, 7.71 and 7.78, respectively) was attained from Mo_2 and the minimum number (2.47, 3.98, 4.92, 6.07 and 6.83, respectively) was observed from Mo_0. The minimum days required for sowing to harvest (71.58) was observed from Mo_2, whereas the maximum days required for sowing to harvest (74.83) from Mo_0. The maximum number of pods $plant^{-1}$ (26.67) was recorded from Mo_2, while the minimum number (22.39) from Mo_0. The longest pod (8.38 cm) was recorded from Mo_2 and the shortest pod (7.39 cm) from Mo_0. The maximum number of seeds pod^{-1} (7.63) was recorded from Mo_2, while the minimum number (6.46) from Mo_0. The highest weight of 100 seeds (22.03 g) was found from Mo_2, again the lowest weight (20.26 g) from Mo_0. The highest seed yield (7.35 t ha^{-1}) was recorded from Mo_2 (1.5 kg Mo ha^{-1}), whereas the lowest seed yield (6.59 t ha^{-1}) from Mo_0. The highest stover yield (12.69 t ha^{-1}) was observed from Mo_2, while the lowest stover yield (11.03 t ha^{-1}) was recorded from Mo_0.

The maximum concentration in seed for N (0.452%), P (0.299%), K (0.365%), B (0.0356%) and Mo (0.0131%) was observed from Mo_2 (1.5 kg Mo ha^{-1}) and the minimum concentration in seed for N (0.380%), P (0.234%), K (0.316%), B (0.0259%) and Mo (0.0106%) was recorded from Mo_0. The maximum concentration in stover for N (0.350%), P (0.046%), K (1.327%), B (0.0036%) and Mo (0.0027%) was recorded from Mo_2, while the minimum concentration in stover for N (0.314%), P (0.041%), K (1.218%), B (0.0026%) and Mo (0.0019%) was observed from Mo_0. The highest pH in post harvest soil (6.73) was recorded from Mo_2, whereas the lowest pH (6.31) from Mo_0. The highest organic matter in post harvest soil (1.50%) was found from Mo_2, while the lowest organic matter (1.37%) from Mo_0. The highest available boron in post harvest soil (0.653 ppm) was recorded from Mo_2, whereas the lowest available boron (0.533 ppm) from Mo_0. The highest available molybdenum in post harvest soil (0.348 ppm) was observed from Mo_2, while the lowest (0.323 ppm) from Mo_0.

At 25, 35, 45, 55 DAS and at harvest, the tallest plant (17.31, 40.57, 65.49, 80.34 and 85.58 cm, respectively) was recorded from B_3Mo_2 and the shortest plant (13.22, 34.79, 57.01, 68.67 and 71.19 cm, respectively) was observed from B_0Mo_0. At 225, 35, 45, 55 DAS and at harvest, the maximum number of branches $plant^{-1}$ (3.90, 4.87, 6.52, 8.33 and 8.40, respectively) was recorded from B_3Mo_2, while the minimum number (2.10, 3.43, 4.50, 5.33 and 6.40, respectively) was found from B_0Mo_0. The minimum days required for sowing to harvest (66.33) was found from B_2Mo_2, again the maximum days required for sowing to harvest pod (78.67) was found from B_0Mo_0. The maximum number of pods $plant^{-1}$ (28.73) was found from B_3Mo_2 and the minimum number (20.47) was found from

B_0Mo_0. The longest pod (8.94 cm) was recorded from B_3Mo_2, whereas the shortest pod (7.05 cm) was found from B_0Mo_0. The maximum number of seeds pod^{-1} (8.33) was observed from B_3Mo_2 and the minimum number (6.20) was found from B_0Mo_0. The highest weight of 100 seeds (24.05 g) was observed from B_3Mo_2, whereas the lowest weight (18.32 g) was attained from B_0Mo_0. The highest seed yield (8.29 t ha^{-1}) was found from B_3Mo_2, while the lowest seed yield (6.14 t ha^{-1}) was found from B_0Mo_0. The highest stover yield (14.51 t ha^{-1}) was observed from B_3Mo_2 and the lowest stover yield (10.14 t ha^{-1}) from B_0Mo_0.

The maximum concentration in seed for N (0.0497%), P (0.384%), K (0.419%), B (0.0409%) and Mo (0.0151%) was observed from B_3Mo_2, whereas the minimum concentration in seed for N (0.350%), P (0.223%), K (0.305%), B (0.0252%) and Mo (0.0093%) was found from B_0Mo_0. The maximum concentration in stover for N (0.425%), P (0.048%), K (1.378%), B (0.0042%) and Mo (0.0032%) was observed from B_3Mo_2, again the minimum concentration in stover for N (0.285%), P (0.036%), K (1.107%), B (0.0021%) and Mo (0.0015%) was found from B_0Mo_0. The highest pH in post harvest soil (6.90) was observed from B_3Mo_2 and the lowest (6.11) was found from B_0Mo_0. The highest organic matter in post harvest soil (1.58%) was observed from B_3Mo_2, again the lowest (1.32%) was recorded from B_0Mo_0. The highest available boron in post harvest soil (0.756 ppm) was observed from B_3Mo_2, whereas the lowest (0.479 ppm) was attained from B_0Mo_0. The highest available molybdenum in post harvest soil (0.376 ppm) was observed from B_3Mo_2, whereas the lowest (0.284 ppm) was recorded from B_0Mo_0.

Conclusion

It may be concluded that application of 2.0 kg B ha^{-1} & 1.5 kg Mo ha^{-1} and 1.5 kg B ha^{-1} & 1.0 kg Mo ha^{-1} showed statistically similar results for yield contributing characters and yield of motorshuti. So, it can be concluded that combination of 1.5 kg B ha^{-1} & 1.0 kg Mo ha^{-1} can be more beneficial for the farmers to get maximum yield from the cultivation of BARI Motorshuti-1.

REFERENCES

Andrade, C.A.B., Pintro, J.C., Seapim, C.A. and Santos, E.B. (1999). Effects of different rates of molybdenum applied to leaves on various agronomic characteristics of beans (*Phaseolus vulgaris* L.). *Acta Sci.,* **21**(3): 543-548.

Anonymous. (1989). Annual Report 1987-88. Bangladesh Agricultural Research Institute. Joydebpur, Gazipur. p. 133.

Anonymous. (2005). Food and Agriculture organization of the United Nations. http/www.fao.org.

Banu, M.A. (2003). Effects of sulphur and boron on some physiological and biochemical parameters of chickpea at different growth stages. M.S. Thesis, Dept. of April. Chem. Bangladesh Agricultural University, Mymensingh.

BARC. (2005). Critical limits of nutrients in soils. *In* Fertilizer Recommendation Guide, 2005. Soil Publication No. 45. The Bangladesh Agricultural Research Council, Dhaka. p. 240.

BBS (Bangladesh Bureau of Statistics). (2013). Statistical Bulletin-Bangladesh. June 2007. P. 65.

Berger, P.G., Vieira, C., Araujo, G.A.A. and Cassini, S.T.A. (1995). Pelleting of bean (*Phaseolus vulgaris L.*) seeds with calcium carbonate, Rhizobium and molybdenum. Empresa Baiana de Desenvolvimonto Agricola, 44900-000 Irece, BA, Brazil. *Revista Ceres*. **42** (243): 562-574; 14 ref.

Bhat, T.A., Gupta, M., Ganai, M.A., Ahanger, R.A. and Bhat, H.A. (2013). Yield, soil health and nutrient utilization of field pea (*Pisum sativum* L.) as affected by phosphorus and Biofertilizers under subtropical conditions of Jammu, *Intl. J. Modern Plant & Animal Sci.,* **1**(1): 1-8.

Bhuiyan, A.H., Khanam, D., Rahman, M.H.H and Hossain, A.K.M. (1997). Influence of *Rhizobium* inoculum, molybdenum and boron on Chickpea in Grey Terrace Soil of Bangladesh. *Ann. Bangladesh Agric*., **7**: 119-126.

Campbell, W.H., (1999). Nitrate reductase structure, function and regulation. Binding the gap between biochemistry and physiology, *Ann. Rev. Plant Physiol. Plant Molec. Biol*., **50**: 277-303.

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

Duke, J.A. (1981). Hand book of legumes of world economic importance. Plenum Press, New York. P. 199-265.

Dutta, R.K., Uddin, M. and Rahman, L. (1984). Production of mungbean, rice and mustard in relation to boron in Brahmaputra Floodplain soils. *Bangladesh J. Soil Sci*., **20**: 77-78.

Fageria, N.K., Baligar, V.C., Zobel, R.W. (2007). Yield, nutrient uptake and soil chemical properties as influenced by liming and boron application in common bean in a No Tillage system. *Commn. Soil Sci. & Plant Analysis*. **38**: 1637 - 1653.

FAO (Food and Agriculture Organization of the United Nations). (2012). Production Year Book. Rome, Italy.

FAO (Food and Agriculture Organization). (1983). Micro-nutrients. FAO fertilizer and plant nutrition Bulletin 7. Food and Agricultural Organization. Roam.

FAOSTAT. (2013). Available online: http://faostat.fao.org/29 September 29, 2013.

Gomez, K.A. and Gomez, A.A. (1984). Statistical Procedure for Agricultural Research (2^{nd} edn.). Int. Rice Res. Inst., A Willey Int. Sci., p. 28-192.

Graham, R.D. and Stangoulis, J.R.S. (2005). Molybdenum and disease. In:Mineral nutrition and plant diseases (Dantoff L, Elmer W, Huber D.Eds) St. Paul, MN: APS Press.

Gupta, U.C. and Lipsett, J. (1981). Molybdenum in soil, plants, and animals, Adv. in Agronomy, 34, 73-115.

Hamsa Aparna and Puttaiah, E.T. (2012). Residual Effect of Zinc and Boron on Growth and Yield of French bean (*Phaseolus vulgaris* L.) - Rice (*Oryza sativa* L.) Cropping system. *Intl. J. Env. Sci*., **3**(1): 167-172.

Hazra, C.R., and Tripathi, S.B. (1998). Effect of secondry micronutrient on yield and quality of forages. FertilizerNews. NewDelhi India. 43(12): 77-82.

Hristozkova, M., Geneva, M. and Stancheva, I. (2006). Response of Pea Plants (*Pisum sativum* L.) to Reduced Supply with Molybdenum and Copper. *Intl. J. Agri. Biol.,* **8**(2): 218-220.

Hunter, A.H. (1984). Soil Fertility Analytical Service in Bangladesh. Consultancy Report BARC, Dhaka.

Kalyani, R.R., Sree Devi, V., Satyanarayana, N.R. and Rao, M.K. (1993). Effect of foliar application of boron on crop growth and yield of Pigonpea (*Cajanus Cajan* L.) (Mill sp). *Indian J. Plant. Phyto*. **4**: 223 – 226.

Kastori, R. and Petrovic, N. (1989). Effect of boron on nitrate reductase activity in young sunflower plants. *J. Plant Nutr.*, **12**(5): 621-632.

Kushwaha, B.L. (1999). Studies on response of frenchbean to to zinc, boron and molybdenum application. Indian Institute of Pulses Research, Kanpur 208024, *India. Indian J. Pulses Res.*, **12**(1): 44-48.

Lalit Bhatt, Srivastava, B.K. and Singh, M.P.M. (2004). Studies on the effect of foliar application of micronutrients on growth, yield and economics of tomato (*Lycopersicon esculantum* Mill). *Prog. Hort.*, **2**: 331 – 334.

Li, Y., and Gupta, P.. (1995). Physiological changes in soybean treated with ozone and molybdenum. *Commn. Soil Sci. & Plant Analysis*. **26**(9-10): 1649-1658.

Lin, K.H., and Deng, J.N. (1992). Effects of Mg. Zn and B fertilizers on some physiological biochemical indices, yield and quality of flue cured tobacco. Ed. S. Portch, Sulphur Institute. Symposium on the role of S, Mg and micronutrients in balanced plant nutrition Chengdu. 352-356.

Liu, P., Yang, Y., Liu, P. and Yang, Y.A. (2000). The effect of boron and molybdenum stress on nitrate reductase activity and contents of nitrate-N in leaves of soybean. *J. Zheijiang Univ. Agric. Life Sci*., **26**(2): 151-154.

Lopez Martinez, E., Carbonell Barrachina, A., Burlo Carbonell, F., Arenas Pozo, M., Alemany Garcia, M. and Mataix Beneyto, J. (1996). Molybdenum uptake, distribution and accumulation in bean plants. Departamento de Agroquimica y Bioquimica. Facultad de Ciencias, Universidad de Alicante, Apartado de correos 99, 03080-Alicante, Spain. *Fresenius Environmental Bulletin*. **5**(1-2): 73-78.

Luo, X.Y., Peng, Y.C. and Wang, B.Y. (1990). Effect of boron fertilizer on yield and quality of groundnut. *Zheijiang Agric. Sci*., **1**: 30-32.

Manga, A.A., Chiezey, U.F. and Yusuf, Y. (1999). Effect of phosphorus, molybdenum and staking on yield and yield components of winged bean (*Psophocarpus tetragonolobus* (L.) D.C.). National Horticultural Research Institute, Bagauda Sub-station, P.M.B. 3390, Kano, Nigeria.

Marschner, H. (1995). Mineral Nutrition of Higher Plants, 2nd edn. Academic Press, London, UK.

Mengel, K. and Kirkby, E.A. (1982). Principles of plant nutrition. 3rd Edn. Pub. International Potash Institite, Bern, Switzerland.pp. 142-155.

Mengel, K., Kirkby, E.A., Kosegarten, H., Appel, T. (2001). Principles of Plant Nutrition. Kluwer Academic Publishers, Dordrecht, The Netherlands.

Moghazy A.M., Saed, S.M. El. and Awad, El. S.M. (2014). The Influence of Boron Foliar Spraying with Compost and Mineral Fertilizers on Growth, Green pods and Seed Yield of Pea. *Nat Sci*., **12**(7): 50-57. [http://www.sciencepub.net /nature].

Muralidharan, P. and Jose, A.I. (1994). Effect of Boron and Molybdenum on the uptake of nutrients in pulse crops. *J. Trop. Agrl.* 32 (2): 157-158.

Nadia, G., and Abd El-Moez, M.R. (2013). Influenced of Molybdenum on nodulation, Nitrogen fixation and yield of Cowpea. *J. Appl. Sci. Res*., **9**(3): 1498-1504

Nasreen, S. and Farid, A.T.M. (2003). Nutrient uptake and yield of garden pea as influenced by various fertilizer treatments. *Thai J. Agril. Sci.*, **36**(2): 185-192.

Negi S., Sing, R.V. and Dwivedi, O.K. (2006). Effect of Biofertilizers, nutrient sources and lime on growth and yield of garden pea, *Legume Res*., **29** (4): 282-285.

Olsen, S.R., Cole, C.V., Watanabe, F.S. and Dean, L.A. (1954). Estimation of available phosphorus in soils by extraction with sodium bicarbonate, U.S. Dept. Agric. Circ., p. 929.

Padma, M., Reddy, S.A. and Babu, R.S. (1989). Effect of foliar sprays of molybdenum (Mo) and boron (B) on vegetative growth and dry matter production of French bean (*Phaseolus vulgaris L.*). Department of Horticulture, College of Agriculture, Rajendranagar, Hyderabad 500 030, India. *Journal Res., APAU*. **17**(1): 87-89.

Page, A.L., Miller, R.H. and Keeney, D.R. (1982). Methods of analysis part 2, Chemical and Microbiological Properties, Second Edition American Society of Agronomy, Inc., Soil Science Society of American Inc. Madson, Wisconsin, USA. p. 403-430.

Pessoa, A.C.S,, Ribeiro, A.C., Xhagas, J.M. and Cassini, S.T.A. (2000). Molybdenum leaf concentration and nutrient accumulation by common beans “Ouro Negro” in response to leaf molybdenum application. Departamento de Agronomia da Universidade Estadual do Oeste do Parana (UNIOESTE), CEP 85960-000, Mal. Candido Rondon. PR, Brazil. *Revista Brasileira Ciencia*. **24**(1): 75-84; 27 ref.

Pires, A.A., Araujo, G.A.A., Miranda, G.V., Berger, P.G., Ferreira, A.C.B., Zampirolli, P.D. and Leite, U.T. (2004). Grain yield, yield components and bean SPAD index of common bean (*Phaseolus vulgaris* L.) in relation to time and partitioning of molybdenum foliar spray. Departamento de Fitotecnia, UFV, 36571-000-Vicosa, MG, Brazil. *Ciencia Agrotech*., **28**(5): 1092-1098.

Ratna Kalyani, R., Sree Devi, V., Satyanarayana, N.V. and Madhana Rao, K.V. (1993). Effect of foliar application of boron on crop growth and yield of pigeon pea (*Cajanus Cajan* (L) Mill sp). *Indian J. Plant Physio*., **4**: 223-226.

Rizk, W.M. and Abdo, F.A. (2001). The response of two mungbean cultivars to zinc, manganese and boron II. Yield and chemical composition of seeds. *Bulletin Fac. Agril. Cairo Univ.*, **52**(3): 467-477.

Rodrigues Carvalho, J.G.B., Andrade, M.J. and Carvalho, J.G. (1996). Response of bean (*Phaseolus vulgaris L.*) cultivars to different rates of foliar applied molybdenum. *Ciencia Agrotecnologia*. **20**(3): 323-333.

Roy R.N., Finck A., Blair G.J., Tandon H.L.S. (2006). Plant nutrition for food security. A guide for integrated nutrient management. FAO Fertilizer and Plant Nutrition Bulletin 16. FAO, Rome, Italy. 368 pp.

Saha, A., Mandal, B. K. and Mukhopadhyay, P. (1996). Residual effect of boron and molybdenum on the yield of succeeding mungbean in summer. *Indian Agriculturist*. **40**(1): 11-16.

Sakal, R., Singh, R.B. and Singh, A.P. (1988). Effect of boron application on blackgram and chickpea production in calcareous soil. *Fert. News.* **33**(2): 27-30.

Sakal, Singh, R.B. and Singh, A.P. (1995). Report of AICRP on Micro and Secondary Nutrients, Pollutant Elements in soils and plants Dep. Soil Sci. RAU, Pusa, Bihar, 1995.

Sarkar, R.K. and Banik, P. (1991). Response of green gram to nitrogen, phosphorus and molybdenum. *Indian J. of Hill Terming.* **5**(1): 75-76.

Sathya, S., Pitchai, G.J, Indirani, R. (2009). Boron nutrition of crops in relation to yield and quality review. *Agric. Rev*., **2**: 139-144.

Sheudzhen, A.K., Ryman, V.T. and Chizhikova, O.I. (1985). Effect of trace elements on the chemical composition and yield of rice. *Agrokhimiya*. 11:82-84. [Rice Abst. 16 (4): 267, 1993].

Shil, N.C., Noor, S. and Hossain M.A. (2007). Effects of Boron and molybdenum on the Yield of Chickpea. *J. Agric. Rural Dev.*, **5**(1&2): 17-24.

Singh, A.; Singh, B.B. and Petel, C.S. (1992). Response of vegetable pea (*Pisum sativum*) to Zince, Boron and Molybdenum. *Indian. J. Agron.* **31**(3): 615-618.

Singh, J.P., Dahiya, D.J. and Narwal, R.P. (1990). Boron uptake and toxicity in wheat in relation to zinc supply. *Fertilizer Res.*, **24**(2): 105-110.

Singh, V. and Singh, S.P. (1984). Effect of applied boron on nutrient uptake by barley crop. *Curr. Agric.* **8**: 89-90.

Sinha, A.C., Mandal, B.B. and Jana, P.K. (1994). Yield and water use efficiency of rainfed lentil (*Lens culinaris*) as influenced by boron zinc and molybdenum. *J. Agric. Sci.*, **64**(12): 863-866.

Srivastava, P.C. and U.C. Gupta (1996). Trace Elements in crop production. Science Pub.Inc. Lebanon, NHO3766 USA. p. 366.

Srivastava, S.P. (1994). Effect of soil Multiple a (Micronutrient mixture) and foliar Multiplex (boron) with or without nitrogen. Presented at the GLRP-NARC/CLAN-ICRISAT Review and Planning Meeting, Nepal.

Srivastava, S.P., Johi, Johansen C. and Rego, J.J. (1999). Boron deficiency of lentil in Nepal. *J. Indian Soil Sci*., **47**(2): 22-24.

Srivastava, S.P., Yadav, C.R., Rego, T.J. Johansen, C. and Saxena, N.P. (1997). Diagnosis and alleviation of boron deficiency causing flower and pod abortion in chickpea (*Cicer arietinum L.*) in Nepal. In: Proc. Boron in soils and plants. R.W. Bell and B, Rerkaseni ed. Kluwer Acad. Pub. p. 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.

Tej, Agarwal, S.K. and Singh, K.P. (1995). Effect of molybdenum and nitrogen levels on the grain yield and protein content of Mung varieties. *Haruana Agril. Univ. J. Res.*, **5**(3): 231-235.

Tisdale, S.L., Nelson, W.L., Beatson, J.D. and Havlin, J.L. (1999). Soil Fertility and Fertilizers. 6th Ed.Perntice Hall of India. p. 220.

Tiwari, V.N., Lehri, L.K. and Pathak, A.N. (1989). *Rhizobium* inoculation of legumes as influenced by phosphorus and molybdenum fertilization *J. Indian Soc. Soil Sci.*, **37**, 712-716.

Togay, Y., N. To gay and Y. Dogan, (2008). Research on the effect of phosphorus and molybdenum applications on the yield and yield parameters in lentil (Lens culinaris Medic.). African Journal of Biotechnology, 7(9): 1256-1260.

Verma, L.P., Ram, P.C. and Maurya, B.R. (1988). Response of chickpea to phosphorus and molybdenum in alluvium of Eastern Uttar Pradesh. Inter chickpea Newsletter. **18**, 31-33.

Verma, R.J. and Mishra, P.H. (1999). Effect of doses and methods of boron application on growth and yield of mungbean. *Indian J. Pulses Res*., **12**(1): 115-118.

Wang, Y.H., Wel, W.X., Tan, Q.L. and Xusong, L. (1995). Study on the molybdenum deficiency of winter wheat and molybdenum application to the yellow-brown earths in Hubei. *Soils & fertilizers*. **3**: 24-28. [Field crop Abst. 49(12): 1137, 1996]

Williams R.J.P and Frausto da Silva, J.J.R. (2002). The involvement of molybdenum in life. Bioch.and Biophy. Res. Commun.292: 293–299.

Yang, Y.A., Xu., H.K., Jie, Z.Q. and Wang, B.Y. (1989). Influence of B, N and K nutrient level on B uptake, quality and yield of rape seed. *Scientia Agricultura Sinica*. **22**(1): 44-51.

Zaman, A.K.M.M, Alam, M.S., Biswas, B.K., Roy, B. and Beg, A.H. (1996). Effect of B and Mo application on mungbean. Bangladesh *J. Agril. Res.*, **21**: 118-124.

Zohary, D. and Hopf, M. (2000). Domestication of Plants in the Old World. 3rd edition. Oxford University Press. p. 316.

APPENDICES

Appendix I. Monthly average of air temperature, relative humidity and total rainfall of the experimental site during the period from November, 2012 to March, 2013

Month	*Air temperature (^oC)		*Relative humidity (%)	*Rainfall (mm) (total)
	Maximum	Minimum		
November, 2012	25.8	16.0	78	00
December, 2012	22.4	13.5	74	00
January, 2013	25.2	12.8	69	00
February, 2013	27.3	16.9	66	39
March, 2013	31.7	19.2	57	23

* Monthly average,

* Source: Bangladesh Meteorological Department (Climate & weather division) Agargoan, Dhaka - 1212

Appendix II. Characteristics of soil of experimental field

A. Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Agronomy field , SAU, Dhaka
AEZ	Madhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled

B. Physical and chemical properties of the initial soil

Characteristics	Value
% Sand	27
% Silt	43
% clay	30
Textural class	silty-clay
pH	5.6
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20.00
Exchangeable K (me/100 g soil)	0.10
Available S (ppm)	45

Source: Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka

Appendix III. Analysis of variance of the data on plant height of BARI motorshuti-1 as influenced by different levels of boron and molybdenum

Source of variation	Degrees of freedom	Mean square				
		Plant height (cm) at				
		25 DAS	35 DAS	45 DAS	55 DAS	Harvest
Replication	2	0.207	0.110	1.197	0.521	0.290
Levels of boron (A)	3	6.359**	12.436**	54.399**	36.954*	109.834**
Levels of molybdenum (B)	2	5.278**	25.985**	45.775**	66.028**	54.163*
Interaction (A×B)	6	1.472*	7.835*	20.813*	25.409*	20.952*
Error	22	0.553	2.064	6.409	12.235	13.329

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

Appendix IV. Analysis of variance of the data on number of branches plant^{-1} of BARI motorshuti-1 as influenced by different levels of boron and molybdenum

Source of variation	Degrees of freedom	Mean square				
		Number of leaves plant^{-1} at				
		25 DAS	35 DAS	45 DAS	55 DAS	Harvest
Replication	2	0.013	0.001	0.136	0.337	0.079
Levels of boron (A)	3	2.119**	1.383**	0.480*	3.734**	2.350**
Levels of molybdenum (B)	2	3.211**	0.695**	3.204**	8.270**	2.719**
Interaction (A×B)	6	0.103*	0.160**	0.237*	0.431*	1.429*
Error	22	0.034	0.035	0.142	0.225	0.327

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

Appendix V. Analysis of variance of the data on yield contributing characters and yield of BARI motorshuti-1 as influenced by different levels of boron and molybdenum

Source of variation	Degrees of freedom	Mean square						
		Days required from sowing to Harvest	Number of pods per plant	Pod length (cm)	Number of seeds pod^{-1}	Weight of 100 seeds (g)	Pod yield (t ha^{-1})	Stover yield (t ha^{-1})
Replication	2	0.194	1.120	0.003	0.014	0.103	0.0001	0.395
Levels of boron (A)	3	56.398**	12.740**	1.817**	1.435**	12.942**	3.298**	13.615**
Levels of molybdenum (B)	2	32.028*	60.881**	3.029**	4.350**	10.286**	2.003**	9.353**
Interaction (A×B)	6	39.287**	5.278**	0.325*	0.338*	3.784*	0.599*	2.429**
Error	22	7.467	1.587	0.220	0.142	1.477	0.192	0.527

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

Appendix VI. Analysis of variance of the data on N, P, K, B and Mo concentrations in pods of BARI motorshuti-1 as influenced by different levels of boron and molybdenum

Source of variation	Degrees of freedom	Mean square				
		Concentration (%) in pods				
		N	P	K	B	Mo
Replication	2	0.000	0.000	0.000	0.0001	0.0001
Levels of boron (A)	3	0.011**	0.011**	0.007**	0.0001**	0.0001**
Levels of molybdenum (B)	2	0.016**	0.013**	0.007**	0.0001**	0.0001**
Interaction (A×B)	6	0.002*	0.004**	0.001**	0.0001**	0.0001*
Error	22	0.001	0.000	0.000	0.00001	0.000001

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

Appendix VII. Analysis of variance of the data on N, P, K, B and Mo concentrations in stover of BARI motorshuti-1 as influenced by different levels of boron and molybdenum

Source of variation	Degrees of freedom	Mean square				
		Concentration (%) in pods				
		N	P	K	B	Mo
Replication	2	0.0001	0.0001	0.005	0.0001	0.0001
Levels of boron (A)	3	0.010**	0.0001**	0.022**	0.0001**	0.0001**
Levels of molybdenum (B)	2	0.004**	0.0001**	0.039**	0.0001**	0.0001**
Interaction (A×B)	6	0.002**	0.0001*	0.052*	0.0001*	0.0001*
Error	22	0.000	0.00001	0.006	0.000001	0.0001

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

Appendix VIII. Analysis of variance of the data on pH, organic matter, available B and Mo of post harvest soil of BARI motorshuti-1 as influenced by different levels of boron and molybdenum

Source of variation	Degrees of freedom	Mean square			
		pH	Organic matter (%)	Available B (ppm)	Available Mo (ppm)
Replication	2	0.003	0.0001	0.0001	0.0001
Levels of boron (A)	3	0.304*	0.033**	0.083**	0.009**
Levels of molybdenum (B)	2	0.527**	0.047**	0.050**	0.002**
Interaction (A×B)	6	0.211*	0.022*	0.007**	0.000*
Error	22	0.077	0.007	0.001	0.000

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability