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Effect of nitrogen and molybdenum on the growth and yield of bush bean (*phaseolus vulgaris* l.).

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Abstract: A field experiment was conducted at Sher-e-Bangla Agricultural University Farm, Dhaka 1207 during the *Rabi* season of 2006-2007 to study the effect of nitrogen and molybdenum on the growth and yield of bush bean (*Phaseolus vulgaris*). The treatments used were 5 levels of each of nitrogen viz. 0, 40, 80, 120 and 160 kg N $ha^{-1}$and 3 levels of molybdenum viz. 0, 0.5, and 1.0 kg Mo ha^{-1}, respectively. 0.08% total N, 0.78% organic carbon, 1.34% OM, 9.75:1 C:N ratio, 15 ppm available P, 0.18% exchangeable K and 16.0 ppm S. The land is above flood level and well drained. Urea and ammonium molybdate were used as the sources of nitrogen and molybdenum, respectively. There was a positive impact of each nutrient and their interaction on yield parameters. The highest green pod yield (18.00 t ha^{-1}) and seed yield (3.10 t ha^{-1}) was obtained from 120 kg ha^{-1} level of N. The highest green pod yield (12.88 t ha^{-1}) and seed yield (2.50 t ha^{-1}) was obtained from 0.5 kg ha^{-1} level of Mo. The results demonstrated that the increasing doses of nitrogen and molybdenum increased growth of bush bean significantly.
Key words: Growth and yield of Bush bean, Nitrogen (N) and Molybdenum (Mo).

Introduction

Bush bean or french bean (*Phaseolus vulgaris* L.) is an important vegetable crop belonging to the family *Leguminosae* and sub-family *Papiolionaceae*, which was originated in the Central and South America (Swiader *et al*., 1992). In our country it is known as 'Farashi Seem' (Rashid, 1993). In Bangladesh, bush bean is mainly used as green vegetable. Its young pods and mature seeds are used as cooked vegetable. It is very rich in protein**.** Geographical and agro climatic conditions of Bangladesh are favourable for bush bean cultivation. According to the recent FAO statistics, bush bean including other related species of the genus *Phaseolus* occupied 27.08 million hectares of the World's cropped area, and the production of dry pods was about 18.94 million tons with an average yield of 699 kg ha^{-1} (FAO, 2000). In Bangladesh there is no statistics about the area and production of this crop. Its edible pods supply protein, carbohydrate, fat, fibre, thiamin, riboflavin, Ca and Fe (Shanmugavelu, 1989) and the seed contains significant amount of thiamin, niacin, folic acid (Rashid, 1993). Recently cultivation of bush bean is gaining popularity in Bangladesh mainly because of its demand as a commodity for export. Hortex foundation exported 23.86 tons of vegetable bush bean during July- December 2001 (Anonymous, 2001). Bush bean shows high yield potential, but unlike other leguminous crops it does not nodulate with the native rhizobia (Ali and Kushwaha, 1987). Therefore, requirement of nitrogenous fertilizers for the crop is of prime importance. Nutrient requirement for different cultivars usually is similar except on poor soils (Adams, 1984). Nitrogen is necessary for its vegetative growth and development. Molybdenum (Mo) is responsible for formation of nodule tissue and increase nitrogen fixation (Sharma *et al.,* 1988). However, the requirement is so small that the seed of grain legumes can contain sufficient molybdenum for the growth of one generation of plant. So, combined applications of both nitrogen and molybdenum need to be applied for the improvement of soil physical properties and requisite supply of essential plant nutrients

Materials and Methods

The experiment was conducted at the research field in Sher-e-Bangla Agricultural University, Dhaka-1207, during the period from December 2006 to February 2007 and the soil of the experimental field belongs to the Tejgoan soil series of the Madhupur Tract (Agro ecological Zone AEZ-28). The experiment was undertaken to study the effect of 5 levels of Nitrogen (N_0: Control, N_{40}: 40 kg N ha^{-1}, N_{80}: 80 kg N ha^{-1}, N_{120}:120 kg N ha^{-1} and N_{160}:160 kg N ha^{-1}) and 3 levels of Molybdenum (Mo_0: Control, $Mo_{0.5}$: 0.5 kg Mo ha^{-1} and Mo1.0: 1.0 kg Mo ha^{-1}) on the growth and yield of bush bean. There were 15 treatment combinations of nitrogen and molybdenum levels used in the experiment (T_1 : N $_0$ Mo_0 (Control), T_2 : N_{40} Mo_0, T_3 : N_{80} Mo_0, T_4 : N_{120} Mo_0, T_5 : N_{160} Mo_0, T_6 : N_0 $Mo_{0.5}$, T_7 : N_{40} $Mo_{0.5}$, T_8 : N_{80} $Mo_{0.5}$, T_9 : N_{120} $Mo_{0.5}$, T_{10} : N_{160} $Mo_{0.5}$, T_{11} : N_0 $Mo_{1.0}$, T_{12} : N_{40} $Mo_{1.0}$, T_{13} : N_{80} $Mo_{1.0}$, T_{14} : N_{120} $Mo_{1.0}$ and T_{15} : N_{160} $Mo_{1.0}$). BARI Jhar Sheem-1, a high yielding variety of bush bean was used as the test crop in this experiment. The experiment was laid out in a two factor Randomized Complete Block Design with three replications. The required amounts of P and Mo fertilizers (Triple super phosphate and Ammonium molybdate) were applied at a time during final land preparation. 50% of N (urea) was applied during the final land preparation. The remaining 50% of N (urea) was applied after first irrigation. Bush bean seeds were sown in lines following the recommended line to line distance of 30 cm and plant to plant distance of 5 cm. Bush bean seeds were sown on the 3rd December 2006 and the crop was harvested at maturity on 28th February 2007. Necessary cultural practices and plant protection measures were done as and when required. Data were collected on the following parameters- plant height, number of branches/plant, total dry weight of plant (g $plant^{-1}$), crop growth rate (g $plant^{-1}$ day^{-1}), plant population m^{-2}, length of green pod and number of green pod $plant^{-1}$. The data obtained from the experiment were analyzed statistically to find out the significance of the difference among the treatments. The significance of the differences among pairs of treatment means was estimated by the least significant

difference (LSD) test at 5% and 1% level of probability and DMRT was calculated (Gomez and Gomez, 1984).

Results and Discussion

Plant height was found to be statistically significant for nitrogen treatments used in the experiment. The plant height ranged from 35.17 to 48.65 cm for nitrogen application. Plant height increased with increasing the application of N. The maximum plant height (48.65 cm) was attained in the treatment N_{160} which was statistically similar with that of treatment of N_{120} and the minimum plant height of bush bean plants (35.17 cm) was obtained in control treatment. Ghosal *et al.* (2000) have also obtained the similar results. Plant height varied significantly due to application of different levels of molybdenum. The plant height ranged from 35.17 to 37.63 cm for molybdenum. The highest plant height (37.63 cm) was obtained in treatments 0.5 kg Mo ha^{-1} which was statistically similar with that of 1.0 kg Mo ha^{-1}. The lowest plant height (35.17cm) was obtained in the control treatment (0 kg Mo ha^{-1}) (Table 1). Total dry weight of plant was gradually increased due to nitrogen application. The highest total dry weight of plant (40.50 g $plant^{-1}$) was recorded 160 kg N ha^{-1}, which was statistically different with other treatment. The lowest total dry weight of plant (18.46 g $plant^{-1}$) was recorded in control plot. Similar result was obtained by the Ghosal *et al.* (2000). The highest total dry weight of plant (27.04 g $plant^{-1}$) was recorded in 0.5 kg Mo ha^{-1}, which was statistically similar with $Mo_{1.0}$ and the lowest total dry weight of plant (18.46 g $plant^{-1}$) was recorded in control (Table 1). The number of plants per square meter of the experimental crop varied significantly influenced by the application of different nitrogen levels (Table 1). The highest number of plant per square meter (26.55) was recorded from the treatment of 120 kg N ha^{-1}, which was statistically similar with that of 160 kg N ha^{-1} and the lowest number of plant per square meter (20.54) was obtained in the control treatment. The number of plant population per square meter also influenced significantly with different molybdenum levels. The number of plant per square meter ranged from 20.54 to 24.55. The highest number of plant per square meter (24.55) was recorded from the treatment of 0.5kg Mo ha^{-1}, which was statistically similar with that of 1 kg Mo ha^{-1} .The lowest number of plant population per square meter (20.54) was obtained in the control treatment (Table 1).

Nitrogen had highly significant effect on the number of green pods $plant^{-1}$ (Table 1). The number of green pods $plant^{-1}$ ranged from 13.53 to 23.40. The highest number of green pods $plant^{-1}$ (23.40) was recorded from the treatment of 120 kg N ha^{-1}, which was significantly different from others, treatments. The lowest number of green pods $plant^{-1}$ (13.53) was found in the control treatment (0 g N ha). Application of 160 kg N ha^{-1} did not result in any further increase in number of pods per $plant^{-1}$ compared with 120 kg N ha^{-1}(Table 1). Singh and Verma (2002), Tewari and Singh. (2000) and Calvache *et al.* (1997) also observed the similar results in bush bean. The number of green pods $plant^{-1}$ ranged from 13.53 to 16.50. The highest number of green pods $plant^{-1}$ (16.50) was recorded from the treatment of 0.5 Mo ha^{-1}, which was statistically similar with $Mo_{1.0}$ ha^{-1}. The lowest number of green pods $plant^{-1}$ (13.53) was found in the control treatment (Table 1). Pod size significantly influenced by the application of different nitrogen levels. The pod size ranged from 11.59 to 29.45 cm^2. The highest pod size (29.45 cm^2) was recorded from the treatment of 120 kg N ha^{-1} and the lowest length of green pods (11.59 cm^2) was found in the control treatment (0 kg N ha^{-1}). The pod size ranged from 11.59 to 18.16 cm^2 in respect of molybdenum application. The highest pod size (18.16 cm^2) was recorded from the treatment of 0.5 kg Mo ha^{-1}, which was significantly different from other treatment. The lowest pod size (11.59 cm^2) was found in the control treatment (0 kg Mo ha^{-1}) (Table 1).

There were significant differences among the different levels of N on seeds pod^{-1} (Table1). It was observed that the number of seeds was increased with the increase of nitrogen level. The number of green seed $pods^{-1}$ ranged from 5.07 to 6.20 in case of N application. The maximum number of green seeds pod^{-1} (6.20) was found at 120 N ha^{-1}, which was closely followed 160 kg N ha^{-1} (5.87) and the lowest (5.07) was obtained in the control treatment (0 kg N ha^{-1}). The highest number of green seeds pod^{-1} (5.83) was obtained when the crop was fertilized with 0.5kg Mo ha^{-1}, which was statistically similar with that of 1 kg Mo ha^{-1} and the lowest (5.07) was obtained in the control treatment (Table1). The pod yield ranged from 8.73 to 18.00 t ha^{-1} in case of N application. The maximum pod yield was recorded (18.00 t ha^{-1}) with the application of 120 kg N ha^{-1}, which was significantly different with other treatments and the minimum (8.73 t ha^{-1}) from the control treatment. The results are in agreement with that of Chandel *et al.* (2002), Singh and Verma (2002) and Tewari and Singh (2000). The pod yield ranged from 8.73 to 12.14 t ha^{-1} in case of molybdenum. The highest pod yield was obtained (12.14 t ha^{-1}) when the crop was fertilized with 0.5kg Mo ha^{-1}, which was statistically similar $Mo_{1.0}$ treatments and the lowest (8.73 t ha^{-1}) in the control treatment (Table1). Seed yield was significantly affected by different levels of N and Mo (Table 1). The highest seed yield (3.10 t ha^{-1}) was recorded with the application of 120 kg N ha^{-1}, which was significantly different with other treatments and thelowest (1.46 t ha^{-1}) was found from the control treatment. The results are in agreement with that of Dhanjal *et al.* (2003 and Singh and Verma (2002). The highest seed yield was obtained (2.50 t ha^{-1}) when the crop was fertilized with 0.5kg Mo ha^{-1}, which was statistically similar $Mo_{1.0}$ kg Mo ha^{-1} and the lowest pod yield was obtained (1.46 t ha^{-1}) in the control (Table 1). The highest straw yield (4.02 t ha^{-1}) was obtained when the crop was fertilized with 160 N ha^{-1}, which was statistically similar to N_{120} and the lowest (3.18 t ha^{-1})

was obtained in the control. This result is in agreement with the finding of Prajapati *et al*. (2004) and Singh and Verma (2002). The effect of molybdenum on straw yield was found statistically significant (Table1). The highest straw yield (3.77 t ha^{-1}) was obtained when the crop was fertilized with 0.5 kg Mo ha^{-1}, which was statistically similar with the 1.0 kg Mo ha^{-1} and the lowest (3.48 t ha^{-1}) was obtained in the control (Table 1). The interaction effects of nitrogen and molybdenum on the yield and yield contributing characters were shown in table 2. The maximum plant height was obtained (49.90 cm) from the treatment combination of N_{160} $Mo_{1.0,}$ which was statistically similar with N_{120} $Mo_{0.5}$ and the lowest (35.17 cm) was obtained from the control treatment (Table 2). The maximum total dry weight was obtained (50.86 g $plant^{-1}$) from the treatment combination of N_{160} $Mo_{0.5}$ and the lowest total dry weight was obtained (18.46 g $plant^{-1}$) from the control. The highest number of plant per square meter (27.33) was obtained from the treatment combination of N_{120} $Mo_{0.5}$ which was statistically similar with that of treatment combination of $N_{120}Mo_0$ and $N_{160}Mo_{1.0}$ and the lowest (20.54) was obtained from the control which was statistically similar with that of treatment combination of $N_{40}Mo_0$ (Table 2). The highest numbers of green pods per $plant^{-1}$ (24.50) was recorded from the treatment combination of N_{120} $Mo_{0.5}$ and the lowest number of green pods per $plant^{-1}$ (13.53) was obtained from the control. The pod size ranged from 11.59 to 31.36 cm^2. The highest pod size (31.36 cm^2) was obtained from the treatment combination of N_{120} $Mo_{0.5}$, which was statistically similar with $N_{120}Mo_0$ and $N_{160}Mo_0$. The lowest pod size (11.59 cm^2) was obtained from the control (Table 2).

The number of green seeds pod^{-1} ranged from 5.07 to 6.50 due to the interaction effects of nitrogen and molybdenum. The highest number of green seed pod^{-1} (6.50) was obtained from the treatment combination of 120 N ha^{-1} and 0.5 kg Mo ha^{-1} which was statistically similar to $N_{120}Mo_0$. The lowest number of green seed pod^{-1} (5.07) was obtained from the control treatment (Table 2). Different treatment combinations of nitrogen and molybdenum influenced significant effect on pod yield (Table 2). The highest pod yield (18.50 t ha^{-1}) was recorded from the treatment combination of 120 N ha^{-1} and 0.5 kg Mo ha^{-1}, which was significantly different from other treatments. The lowest pod yield (8.73 t ha^{-1}) was in the control treatment (Table 2).

Table 1 Effect of Nitrogen and Molybdenum on the yield and yield contributing characters of bush bean

Nitrogen Fertilizer (kg ha^{-1})	Plant height (cm)	Total Dry weigh (g $plant^1$)	Plant Population m^{-2}	Green pods $plant^{-1}$	Pod Size (L×D) (cm^2)	Green Seeds pod^{-1}	Pod yield (t ha^{-1})	Seed yield (t ha^{-1})	Straw yield (t ha^{-1})
N_0	35.17d	18.46e	20.54d	13.53e	11.59 cd	5.07c	8.73 e	1.46 e	3.18 d
N_{40}	37.00 c	29.10d	21.44cd	16.07d	15.77 b-d	5.33bc	13.94 d	2.28 d	3.52 c
N_{80}	37.93 b	31.90c	23.07bc	16.97c	17.99 a-d	5.50bc	14.62 c	2.48 c	3.58 b
N_{120}	48.50a	39.10b	26.55a	23.40a	29.45 a	6.20a	18.00 a	3.10 a	3.97 a
N_{160}	48.65a	40.50a	24.55ab	22.20b	22.92 ab	5.87ab	1.77 b	2.98 b	4.02 a
LSD (1%)	0.78	0.102	2.16	-	0.1191	-	0.15	0.016	0.053
Molybdenum fertilizer (kg ha^{-1})									
Mo_0	35.17b	18.46b	20.54b	13.53b	11.59 bc	5.07b	8.73 b	1.46 a	3.48 b
$Mo_{0.5}$	37.63a	27.04a	24.55a	16.50a	18.16 a	5.83a	12.14 a	2.50 a	3.77 a
$Mo_{1.0}$	37.20a	25.50a	23.44a	16.40a	16.28 ab	5.70a	11.90 a	2.30 a	3.74 a
LSD (1%)	0.76	2.05	1.492	-	.998	-	0.34	0.24	.041

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Different treatment combinations of nitrogen (N) and molybdenum (Mo) had significant effect on seed yield (Table 2). The seed yield ranged from 1.46 to 3.50 t ha^{-1}. The highest seed yield (3.50 t ha^{-1}) was recorded from the treatment combination of 120 N ha^{-1} and 0.5 kg Mo ha^{-1}, which was statistically different with the other treatments. The lowest seed yield (1.46 t ha^{-1}) was found by the control treatment (Table 2). The straw yield ranged from 2.90 to 4.20 t ha^{-1} due to interaction effect of nitrogen and molybdenum. The highest straw yield (4.20 t ha^{-1}) was obtained from the treatment combination of 160 kg N ha^{-1} and 0.5 kg Mo ha^{-1}, which was statistically similar with N_{120} $Mo_{0.5}$ .The lowest straw yield (2.90 t ha^{-1}) was obtained from the control (Table 2).

From this study it was found that Nitrogen and molybdenum fertilization at different levels individually influenced plant characters. The individual and interaction effects of N and Mo on growth yield and yield contributing characters were found positive. Both the growth and yield increased with increasing nitrogen and molybdenum. The yield increased with increasing N rate up to 120 kg N ha^{-1} and Mo rate up to 0.5 kg Mo ha^{-1}.

Table 2 Interaction effects of Nitrogen and Molybdenum on the yield and yield contributing characters of bush bean

Nitrogen × Molybdenum (kg ha^{-1})	Plant height (cm)	Total Dry weight (gplant^{-1})	Plant Population m^{-2} (no.)	Green pods plant^{-1} (no.)	Pod Size (L×D) (cm^2)	Green Seeds pod^{-1} (no.)	Pod yield (t ha^{-1})	Seed yield (t ha^{-1})	Straw yield (t ha^{-1})
NoMo0	35.17k	18.46 n	20.54f	13.53h	11.59gf	5.07f	8.73m	1.46e	2.90i
N40 Mo0	37.00j	29.10 i	21.44f	16.06fg	15.77def	5.33ef	13.94j	2.28 d	3.40fg
N80Mo0	37.93hi	31.90 h	23.07e	16.97ef	17.99cde	5.50def	14.62i	2.48cd	3.45f
N120Mo0	48.50b	30.10 g	26.55ab	23.40b	29.45 ab	6.20ab	18.00c	3.10 b	3.80c
N160Mo0	48.55b	40.50 f	24.55cde	22.20c	22.92abc	5.87bcd	17.66e	2.70 c	3.85c
NoMo0.5	37.63ij	23.40 l	24.55cde	16.50f	18.01def	5.83bcde	12.14k	2.35cd	3.77d
N40Mo0.5	38.10fgh	27.04 k	24.50cde	17.60e	21.33bcd	5.50def	15.36h	2.50cd	3.55e
N80Mo0.5	38.20fgh	35.86 g	24.47cde	18.77de	21.89bcd	6.00bcd	15.47g	2.60cd	3.60e
N120Mo0.5	49.70a	47.10 b	27.33a	24.50a	31.36 a	6.50a	18.50a	3.50a	4.15a
N160Mo0.5	49.90a	50.86 a	25.33bcd	22.40bc	22.48 bc	5.67cde	17.70e	2.90bc	4.20a
N0Mo1.0	37.20jk	21.00 m	23.44e	16.40f	16.56 ef	5.70cde	11.90l	2.30 d	3.74h
N40Mo1.0	38.50e	27.70 j	23.88de	17.90e	20.02bcd	5.70cde	17.52f	2.52cd	3.60e
N80Mo1.0	39.40d	42.04 e	25.50bc	19.20d	20.83 cd	5.7obcde	15.34h	2.55cd	3.70d
N120Mo1.0	45.50c	45.94 b	25.44bcd	22.27c	26.62 bc	6.00bcd	18.24b	2.92bc	3.95b
N160Mo1.0	48.50b	43.78 d	26.33ab	22.00c	20.44 cd	6.00bcd	17.84d	2.95bc	4.00b
LSD (1%)	0.46	0.396	20.54f	1.04	0.112	0.4519	0.074	0.350	0.092

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