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# Effect of Nitrogen and Molybdenum on Post Harvest Soil Characteristics and Economic Yield of Bush Bean (*Phaseolus vulgaris* L.)

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**Abstract**
A field experiment was carried out at the research field of Sher-e-Bangla Agricultural University, Dhaka during December 2006 to February 2007 to study the effect of nitrogen and molybdenum on post harvest soil characteristics and economic yield of bush bean (*Phaseolus vulgaris* L.). The treatments consisted of 5 levels of N (0, 40, 80, 120 and 160 kg $ha^{-1}$) designated and 3 levels of Mo (0, 0.5 and 1.0 kg $ha^{-1}$). Urea and ammonium molybdate were used as the sources of nitrogen and molybdenum, respectively. The characteristics of the post harvest soils showed a marked variation in relation to soil pH, soil organic carbon, N, P, K and S content in the post harvest soil due to application of N and Mo. The highest organic carbon (0.60%) and total N (0.072%) was obtained from $N_{120}$. The highest organic carbon (0.60%) and total N (0.068%) was obtained from $Mo_{0.5.}$ The maximum organic carbon was obtained (0.63%) from $N_{120}Mo_{0.5}$ treatment combination. The maximum total N was obtained (0.075%) from $N_{160}Mo_{0.5}$ treatment combination. The results of economic analysis showed that the highest net benefit of Tk.1,68,722.00 $ha^{-1}$ was obtained in $N_{120}Mo_{0.5}$ treatment and the lowest net benefit of Tk.16,559.00 $ha^{-1}$ was found in control.

***Keywords****:* pH, organic carbon, N P K & S content in soil, economic yield

## 1. Introduction

Bush bean or french bean is an important vegetable crop which was originated in the Central and South America (Swiader *et al*., 1992). It is also known as kidney bean, snap bean, pinto bean, green bean, raj bean, navy bean, pole bean, wax bean, string bean and bonchi (Duke, 1983; Salukhe *et al*., 1987; Tindall, 1988). 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 were about 18.94 million tons with an average yield of 699 kg $ha^{-1}$ (FAO, 2000). Hortex foundation exported 23.86 tons of vegetable bush bean during July- December 2001 (Anonymous, 2001). The crop shows high genotypic variability in pod and seed yield and those variations could be exploited for developing high yielding variety (Roy *et al*., 2006).

Nitrogen nutrition is a major consideration for increasing yield and quality of bush bean. Molybdenum is an important micronutrient that is found deficient in most of the areas of Bangladesh. Evidences reveal that nitrogen and molybdenum fertilizers play an important role for french bean production (Ahmed, 1982). As a part of nitrogenase enzyme, Mo is essential for atmospheric nitrogen fixation. In addition, Mo availability is reduced in acidic soil. The yield of french bean may be increased through judicious combination of nitrogen, which is obviously much below the critical level in Bangladesh soils. This experiment was initiated to study the effect of nitrogen and molybdenum on the changes in post harvest

soil characteristics and economic productivity of bush bean.

## 2. Materials and Methods

The experiment was conducted at the research field of Sher-e-Bangla Agricultural University, Dhaka-1207, during December 2006 to February 2007 to determine the effect of N and Mo application on postharvest soil characteristics and economic productivity of bush bean (*Phaseolus vulgaris* L.). The soil of the experimental field belongs to the Tejgoan soil series of the Madhupur Tract (AEZ-28). Topsoil is silty clay loam in texture. Organic matter content is very low (1.34 %) and soil pH varies from 5.8 – 6, total N (%) was 0.08 and available S was 16.0 (ppm). There were 5 levels of Nitrogen, viz. 0, 40, 80, 120 and 160 kg N $ha^{-1}$ designated as $N_0$ (control), $N_{40,}$ $N_{80,}$ $N_{120}$ and $N_{160,}$ respectively and three levels of Molybdenum such as 0, 0.5 and 1.0 kg Mo $ha^{-1}$ designated as $Mo_0$ (control), $Mo_{0.5}$ and $Mo_{1.0,}$ respectively. Thus, there were 15 treatment combinations in the experiment laid out in a randomized completely block design (RCBD) with three replications.

Required amounts of nitrogen and molybdenum fertilizers were applied as per treatments and all other fertilizers were applied in the whole plots as basal dose according to the Fertilizer Recommendation Guide (BARC, 2005). Sowing was done on 3 December, 2006. Green pods were harvested at regular intervals from each plot and their weight was recorded. The green pod yield $plot^{-1}$ was finally converted in to yield $hectare^{-1}$. Soil samples were collected from 5 cm depths after the harvesting of crop and mixed together to make a composite sample and was analyzed for soil pH, organic matter, total nitrogen, available phosphorus, exchangeable potassium and available sulphur**.**

Economical analysis was done in order to determine the most profitable treatment combinations. Calculation was done in details according to the procedure of Alam *et al*. (1989). Interest was calculated at the rate of 13% of six months and miscellaneous cost was considered as 5% of the total input cost. Data obtained from the experiment were analyzed statistically. The significance of the differences among pairs of treatment means was estimated by the least significant difference (LSD) test at 1% level of probability and DMRT was calculated (Gomez and Gomez, 1984).

## 3. Results and Discussion

### *3.1. Postharvest soil characteristics*

The characteristics of the post harvest soils as influenced by different treatments showed a marked variation on soil pH, soil organic carbon, N, P, K and S content in the post harvest soil due to addition of N and Mo in soil.

#### 3.1.1. Single and combined effect of nitrogen and molybdenum on soil pH

A significant variation was observed on soil pH after harvest, where the nitrogen and molybdenum were incorporated in soil (Table 1). Soil pH values of the post harvest soils ranged from 6.30 to 6.80 due to N application and 6.46 to 6.71 due to Mo application. The highest pH value (6.80) was recorded in $N_{40}$ treatment which was statistically similar to that in $N_{120.}$ . The lowest pH value (6.30) was recorded in control treatment. The highest pH value (6.71) was recorded in $Mo_{0.5}$ treatment and the lowest (6.46) was in control treatment (Table 1). Combined application of different doses of nitrogen and molybdenum showed a significant effect on soil pH after harvest (Table 2). The soil pH ranged from 5.80 to 6.90. The higher soil pH (6.90) recorded in the treatments: $N_{120}Mo_{0.5}$, $N_{80}Mo_{0.5}$, $N_{160}Mo_{0.5}$ which was statistically similar with $N_{120}Mo_{1.0}$, $N_{40}Mo_{1.0}$, $N_{160}Mo_{0.}$ The minimum soil pH (5.80) was obtained in the control (Table 2). When N fertilizer was applied in the soil, it produces $H^+$ in soil and cause soil acidity. Crop uptake of cations can either reduce or increase the soil acidity produced by nitrification of $NH_4^+$ from fertilizers, crop and animal wastes.

**Table 1.** Effect of N and $M_o$ fertilizers on soil pH, %Organic Carbon, total N, available P, exchangeable K and available S content in the soil after bush bean harvest

| Nitrogen Fertilizer (kg $ha^{-1}$) | Soil pH | Organic carbon (%) | Total N (%) | Available P (ppm) | Exchangeable K(meq100 $g^{-1}$) | Available S (ppm) |
|---|---|---|---|---|---|---|
| $N_0$ | 6.30 d | 0.56 c | 0.059 c | 14.3 | 0.12 | 17.3 |
| $N_{40}$ | 6.80 a | 0.58 b | 0.061 bc | 16.9 | 0.13 | 16.7 |
| $N_{80}$ | 6.66 b | 0.59 a | 0.064bc | 16.3 | 0.13 | 19.0 |
| $N_{120}$ | 6.70 ab | 0.60 a | 0.069 b | 18.0 | 0.14 | 24.3 |
| $N_{160}$ | 6.58 c | 0.60 a | 0.072 a | 18.9 | 0.14 | 25.3 |
| LSD (1%) | 0.081 | 0.018 | 0.0097 | NS | NS | NS |
| CV% | 4.28 | 5.31 | 6.49 | 5.54 | 4.34 | 6.18 |
| Molybdenum Fertilizer (kg $ha^{-1}$) | | | | | | |
| $Mo_0$ | 6.46 c | 0.58 c | 0.061 | 15 | 0.13 | 19 |
| $Mo_{.5}$ | 6.71 a | 0.60 a | 0.068 | 18 | 0.14 | 22 |
| $Mo_1$ | 6.64 b | 0.59 b | 0.066 | 18 | 0.14 | 21 |
| LSD (1%) | 0.0626 | 0.0074 | NS | NS | NS | NS |
| CV% | 3.45 | 4.55 | 6.49 | 5.54 | 4.34 | 6.18 |

NS: Non significant
In a column figures having similar letter(s) do not differ significantly.

#### 3.1.2. Single and combined effect of nitrogen and molybdenum on organic carbon content

A significant variation was observed on the organic carbon content after harvest, where the nitrogen and molybdenum was incorporated in soil .The organic carbon content of the post harvest soil ranged from 0.56 to 0.60% due to N application and 0.58 to 0.60% due to Mo application (Table 1). The maximum organic matter content (0.60%) was obtained in treatment $N_{120}$ and $N_{160}$ which was statistically similar with $N_{80.}$ The minimum organic matter content (0.56%) was obtained in control treatment. The maximum organic carbon content (0.60%) was obtained in the treatment $Mo_{0.5}$ and the minimum (0.56%) was obtained in control (Table 1). Combined application of different doses of nitrogen and molybdenum showed a significant effect on the organic carbon content in soil after harvest (Table 2). The organic carbon content in the post harvest soil ranged from 0.53 to 0.63 %. The higher organic carbon contents (0.63%) were recorded in the treatment $N_{120}Mo_{0.5}$ which was statistically similar with $N_{80}Mo_0$, $N_{160}Mo_0$, $N_0Mo_{0.5}$ and $N_{160}Mo_{1.0}$, and the minimum organic carbon content (0.53%) was obtained in control (Table 2). Organic carbon also increased due to addition of nitrogenous fertilizer in soil. The addition of extra N in soil accelerated residue decomposition by some microorganisms and encouraged the formation of soil organic matter.

#### 3.1.3. Single and combined effect of nitrogen and molybdenum on the total N content

The total N content of the post harvest soil varied from 0.059 to 0.072% due to N application and 0.061 to 0.068% due to Mo application (Table 1). The highest total N content (0.072%) was observed in $N_{160}$ treatment and the lowest of 0.059% was in control. The highest total N content (0.068%) was observed in $Mo_{0.5}$ treatment and the minimum value (0.061%) was found in control (Table 1). The combined effect of different doses of nitrogen and molybdenum resulted significant variations in nitrogen content

in the post harvest soil (Table 2). The total N content in the post harvest soil ranged from 0.055 to 0.075%. The higher total N content of the post harvest contents (0.075%) were recorded in the treatment $N_{160}Mo_{0.5}$ which was statistically similar with treatments $N_{120}Mo_{0,}$ $N_{40}Mo_{0..5}$, $N_{80}Mo_{0.5,}$ $N_{120}Mo_{0.5,}$ $N_{80}Mo_{1.0,}$ $N_{120}$ $Mo_{1.0}$ and $N_{160}Mo_{1}$ and the lowest value of 0.055% in ($N_0Mo_0$) (Table 2). Total N in soil was changed due to application of nitrogenous fertilizer.

#### 3.1.4. Single and combined effect of nitrogen and molybdenum on the available P content

The effect of applied of N and Mo at different levels showed no significant differences in P content in soil after harvest (Table 1). The P content in post harvest soils ranged from 14.3 to 18.9 ppm due to N application and 15.0 to18.0 ppm due to Mo application (Table 1). The highest P content was recorded in $N_{160}$ treatment (18.9 ppm) and the lowest (14.3 ppm) was found in the control. The highest P content (18.0ppm) was observed in $Mo_{0.5}$ and $Mo_{1.0}$ treatment and the minimum (15.0 ppm) was found in the control (Table 1). The combined effect of nitrogen and molybdenum showed no significant differences in P content in soil after harvest. The P content in the post harvest soil ranged from 12.0 ppm to 19.7 ppm. The highest P content (19.7 ppm) was observed in $N_{160}Mo_{0.5}$ treatment and the minimum value (12.0 ppm) was found in the control (Table 2).

**Table 2.** Combined effect of N and Mo fertilizers on soil pH, organic carbon, total N, available P, exchangeable K and available S content in the soil after bush bean harvest

| Nitrogen × Molybdenum (kg $ha^{-1}$) | Soil pH | Organic carbon (%) | Total N (%) | Available P (ppm) | Exchangeable K(meq100 $g^{-1}$) | Available S (ppm) |
|---|---|---|---|---|---|---|
| $N_0Mo_0$ | 5.80 e | 0.53 d | 0.0 55 b | 12.0 | 0.11 | 13.0 |
| $N_{40}$ $Mo_0$ | 6.80ab | 0.59 b | 0.056 b | 13.0 | 0.12 | 16.0 |
| $N_{80}$ $Mo_0$ | 6.20d | 0.62 a | 0.060 b | 15.0 | 0.12 | 18.0 |
| $N_{120}$ $Mo_0$ | 6.70b | 0.53 d | 0.065 ab | 17.0 | 0.13 | 23.0 |
| $N_{160}$ $Mo_0$ | 6.80ab | 0.62 a | 0.062 b | 17.7 | 0.13 | 23.3 |
| $N_0$ $Mo_{.0.5}$ | 6.90a | 0.62 a | 0.062 b | 14.0 | 0.12 | 21.0 |
| $N_{40}$ $Mo_{.0.5}$ | 6.7 b | 0.59 b | 0.064 ab | 18.0 | 0.13 | 13.0 |
| $N_{80}$ $Mo_{0.5}$ | 6.90 a | 0.59 b | 0.066 ab | 18.0 | 0.13 | 19.0 |
| $N_{120}$ $Mo_{0.5}$ | 6.90a | 0.63 a | 0.073 ab | 18.7 | 0.14 | 25.0 |
| $N_{160}$ $Mo_{0.5}$ | 6.90a | 0.57c | 0.075 a | 19.7 | 0.15 | 26.7 |
| $N_0$ $Mo_{1.0}$ | 6.10 d | 0.60 b | 0.059 b | 17.0 | 0.12 | 18.0 |
| $N_{40}$ $Mo_{1.0}$ | 6.80ab | 0.56 c | 0.062 b | 17.7 | 0.14 | 21.0 |
| $N_{80}$ $Mo_{1.0}$ | 6.60 b | 0.59 b | 0.065 ab | 18.0 | 0.14 | 20.0 |
| $N_{120}$ $Mo_{1.0}$ | 6.80ab | 0.57 c | 0.070 ab | 18.3 | 0.14 | 25.0 |
| $N_{160}$ $Mo_{1.0}$ | 6.50c | 0.62 a | 0.072 ab | 19.3 | 0.14 | 26.0 |
| LSD (1%) | 0.015 | 0.017 | 0.013 | NS | NS | NS |

NS: Non significant
In a column figures having similar letter(s) do not differ significantly.

**3.1.5. Single and combined effect of nitrogen and molybdenum on exchangeable K content**

Applied N and Mo showed no significant effects on K content in soil after harvest (Table 1). The combined effect of nitrogen and molybdenum on K content in soil after harvest was not significant. The highest K content (0.15 mgq 100 $g^{-1}$) was observed in $N_{160}Mo_{0.5}$ treatment and the lowest (0.11 mgq 100 $g^{-1}$) was found in the control (Table 2).

**3.1.6. Single and combined effect of nitrogen and molybdenum on the available S content**

The effect of applied N and Mo was not significant on S content in soil after harvest (Table 1). The highest S content (25.3 ppm) was recorded in $N_{160}$ treatment and the lowest (17.3 ppm) was in control. The highest S content in (22.0 ppm) was observed in $Mo_{0.5}$ treatment and the lowest (19.0 ppm) was in control (Table 1). The effect of combined application of nitrogen and molybdenum showed no significant differences in respect of S content of soil after harvest (Table 2). The S content of the post harvest soil ranged from 13.0 ppm to 26.7 ppm. The highest S content (26.7 ppm) was observed in $N_{160}Mo_{0.5}$ treatment.

### *3.2. Effect of nitrogen and molybdenum on the economic yield of bush bean*

Applied N upto 120 kg $ha^{-1}$ generally increased pod yield. The largest pod yield around 18 t $ha^{-1}$ was gotten by $N_{120}$ with or without $M_{0.0}$ (Table 3). The total cost of production varied from Tk. 89881/- to Tk. 91500/- among the treatment combinations.

**Table 3.** Cost and benefit analysis of bush bean as influenced by different levels of nitrogen and molybdenum.

| Treatment combination | Pod yield (t $ha^{-1}$) | Gross return (Tk $ha^{-1}$) | Total cost of production (Tk$ha^{-1}$) | Net return (Tk $kgha^{-1}$) | Benefit cost ratio (BCR) |
|---|---|---|---|---|---|
| $N_0Mo_0$ | 8.73 | 106440 | 89881 | 16559 | 1.18 |
| $N_{40}Mo_0$ | 13.94 | 167280 | 90147 | 77133 | 1.86 |
| $N_{80}Mo_0$ | 14.62 | 175440 | 90413 | 85027 | 1.94 |
| $N_{120}Mo_0$ | 18.00 | 246240 | 90680 | 155560 | 2.72 |
| $N_{160}Mo_0$ | 17.66 | 211920 | 90946 | 120974 | 2.33 |
| $N_0Mo_{0.5}$ | 12.14 | 145680 | 89482 | 56198 | 1.63 |
| $N_{40}Mo_{0.5}$ | 15.36 | 184320 | 89746 | 94574 | 2.05 |
| $N_{80}Mo_{0.5}$ | 15.47 | 186000 | 90691 | 95309 | 2.05 |
| $N_{120}Mo_{0.5}$ | 18.50 | 259680 | 90958 | 168722 | 2.85 |
| $N_{160}Mo_{0.5}$ | 17.70 | 212400 | 91224 | 121176 | 2.33 |
| $N_0Mo_{1.0}$ | 11.90 | 127200 | 90437 | 36763 | 1.41 |
| $N_{40}Mo_{1.0}$ | 17.52 | 210240 | 90702 | 119538 | 2.32 |
| $N_{80}Mo_{1.0}$ | 15.34 | 184080 | 90968 | 93112 | 2.02 |
| $N_{120}Mo_{1.0}$ | 18.24 | 230880 | 91235 | 139645 | 2.53 |
| $N_{160}Mo_{1.0}$ | 17.84 | 214080 | 91500 | 122580 | 2.34 |
| LSD (1%) | 0.074 | 0.062 | 0.007 | 0.214 | 0.04 |

Price of Urea = Tk. 6.00 $kg^{-1}$
TSP = Tk. 15.00 $kg^{-1}$
MP = Tk. 15.00 $kg^{-1}$
Gypsum = Tk. 6.00 $kg^{-1}$
Zinc = TK. 50.00 $kg^{-1}$
Mo = TK. 500 $kg^{-1}$
Per labor wage = TK. 75.00 $day^{-1}$.

Price of harvested green pod @ TK. 15,000/t
BCR = Gross return: Total cost of production

The variation in cost was due to variable cost of urea. The gross income was recorded from Tk.106440/- to Tk. 259680/- for the various treatment combinations (Table 3). The results are in agreement with that of Chandel *et al.* (2002), Singh and Verma (2002) and Tewari and Singh (2000). Net return varied from Tk.16559/- to 168722/-. The highest net income was obtained from the treatment combination of 120 kg N $ha^{-1}$ and 0.5 kg Mo $ha^{-1}$. The result also revealed that the highest net return (Tk.168722/-) was associated with the highest pod yield (18.50 t $ha^{-1}$). The benefit cost ratio was found to be the highest (2.85) in the treatment combination of 120 kg N and 0.5 kg Mo $ha^{-1}$ (Table 3). Here the highest net return (Tk.168722) showed the highest BCR (2.85). From economic point of view, the treatment combination of 120 kg N $ha^{-1}$ and 0.5 kg Mo $ha^{-1}$ was found to be the most suitable treatment combination for bush bean production.

**4. Conclusions**

It may be concluded that both nitrogen and molybdenum increased the nutrient content in soil after bush bean harvest. It was observed that the combination of 120 kg N and 0.5 kg Mo $ha^{-1}$ produced the highest bush bean pod yield and gave the highest economic return.

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