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INTERACTIVE EFFECTS OF PHOSPHORUS AND POTASSIUM ON BIOMASS PRODUCTION AND ACCUMULATION OF NITROGEN IN FIELD GROWN MUNGBEAN (*Vigna radiata* L.)

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Abstract

A field experiment was carried out in the paddy field of Charfession Govt. College, Bhola, Bangladesh during rabi season 2017 to evaluate growth, biomass production and nitrogen accumulation in mungbean plants. The size of the plot was 60 cm x 45 cm. The distance between row to row and plant to plant was 30 cm and 10 cm, respectively. Eight plants were raised per plot. Seven treatments were P_0K_0 (Control), P_5K_6, P_5K_{12}, P_5K_{18}, $P_{10}K_6$, $P_{10}K_{12}$ and $P_{10}K_{18}$ kg ha^{-1}. Forty day old plants were harvestedas root, stem and leaf. The highest plant height (17.2 cm) and number of leaves (14.3 no. plant^{-1}) were recorded in P_5K_{12} kg ha^{-1} treatment at harvest. The maximum concentration of nitrogen in root, stem and leaf were 1.59, 2.51 and 3.82% in the treatments of P_5K_{12}, P_5K_{12} and P_5K_{18} kg ha^{-1}, respectively. The highest amount of dry matter yield 1.88 g plant^{-1} was observed in P_5K_{12} kg ha^{-1} treatment. The overall better dose was P_5K_{12} kg ha^{-1}. Thus, a considerable amount of nitrogen and organic matter might be added to paddy fields through the cultivation of mungbean in the coastal region of Bangladesh.

Keywords: Biomass Production, Mungbean, Nitrogen, Paddy Field.

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Introduction

Mungbean (*Vigna radiata* L.) is one of the important pulse crops in Bangladesh (Kaul, 1982). It can ideally be fitted for fallow periodsin rice and wheat production systems. Grown between two cereal crops, mungbean provides additional income for farmers and nutritious food for people. As a legume crop, mungbean associates with nitrogen- fixing bacteria and improve soil fertility, lowering the need for nitrogen fertilizers and increasing yield and quality of subsequent cereal harvests. Bangladesh is facing two opposite natural calamities. One is flood in monsoon and dry in winter. Climate change will affect cropping pattern particularly in the coastal belt of Bhola, Patuakhali, Barguna, Satkhira, Laxmipur, Noakhali, Feni, Chittagong and Cox's Bazar regions. Devastating tidal surge like SIDR, excessive rainfall, increase in temperature and salinity, severe thunder storm *etc*. occurring frequently in Bangladesh, probably the climate is changing. The agricultural production in the coast is characterized by rain-fed cultivation, low nutrient levels in the soil and poor access to agricultural technologies. The organic matter content islow in the seashore and offshore landmass of sand-dominated soils. Growing crops in the coast will not be feasible for lack of sweet water. Plant nutrients are depleting rapidly because farmers are cultivating hybrid seeds of sunflower, soybean, watermelon, capsicum *etc*. Besides, uptake of plant nutrients from soil will be accelerated when genetically modified (GM) crops would be introduced in the near future. Incorporation of mungbean plants into sandy soil will improve soil properties and minimize nitrate leaching. Phosphorus is involved in several key plant functions, including energy transfer, photosynthesis, transformation of sugars and starches, nutrient movement within the plant and transfer genetic characteristics from one generation to the next (Anonymous, 1999). Potassium is important in the regulation of stomata, the biochemical reactions, water and nutrient transportation, protein and starch synthesis in plants (Tajer, 2016). A little information is available on the cultivation of mungbean in relation to its incorporation into paddy fields to increase the fertility status in the coastal belt of Bangladesh.

Thus, the objective of the experiment was to evaluate the growth, biomass production and accumulation of N in root, stem and leaf of mungbean as influenced by phosphorus and potassium application.

Material and Methods

Field Experiment

A field experiment was conducted in the paddy field in front of Charfession Government College, Bhola district of Bangladeshin Rabi season 2017 to evaluate the growth, biomass production and concentration of nitrogen in root, stem and leaf of mungbean. A composite soil sample (0 to 15 cm depth) was collected before ploughing the land and air- dried, ground, and sieved (< 2 mm sieve) and kept in polyethylene bags for physico-chemical properties analysis (Table 1). The size of the plot was 60 cm x 45 cm. The distance between row to row and plant to plant was 30 cm and 10 cm, respectively. Different doses of phosphorus and potassium in the form of TSP and MOP were 0, 5, 10 kg and 0, 6, 12, 18 kg ha^{-1}, respectively. Seven treatments with three replications were as P_0K_0 (Control), P_5K_6, P_5K_{12}, P_5K_{18}, $P_{10}K_6$, $P_{10}K_{12}$ and $P_{10}K_{18}$ kg ha^{-1}. The experiment was arranged in a randomized complete block design (RCBD). Mungbean (BARI mug 6) seeds were collected from Bangladesh Agricultural Research Institute (BARI), Gazipur and sown at the rates of two and finally one seedling was allowed to grow per hole. Total eight plants were raised per plot for 40 days. Different practices *viz*. weeding, pesticide application, protection *etc*. were done as and when needed. Plant height and leaf numbers were recorded at harvest.

Table 1. Some physicochemical properties of the soil used.

Characteristics	*Values*
Moisture content (%)	19.22
Particle density (g/cc)[a]	2.36
Bulk density (%)	1.35
Particles size (%)[b]	
Sand (%)	12.30
Silt (%)	54.34
Clay (%)	33.36
Texture	Silty clay loam
pH (1: 2:5 w/v H_2O)	8.36
Organic-C (%)[c]	0.65
Organic matter (%)	1.12
Total N (%)[d]	0.18
Total P (%)[e]	0.06
Total K (%)	1.23

[a]Picnometer method (Blake, 1965), [b]Hydrometer method (Bouyoucos,1962), [c]Wet oxidation method (Walkley and Black,1934),[d] Kjeldahl extraction method (Marr and Cresser,1983), [e]Vanadomolybdate yellow colour method (Jackson, 1958)

Harvesting

Forty days old plants were harvested as root, stem and leaf, washed with tap water and finally with distilled water, and wrapped with soft tissue paper. Immediately after harvest, fresh weight of root, stem and leaf were taken and then air-dried in the room temperature and finally oven-dried at 65^{o} C in the laboratory for two days. Dry weight of the samples were recorded and ground with a mechanical grinder and stored in polythene bags for chemical analysis. For N analysis, the plant samples were digested with concentrated sulphuric and perchloric acid (62%). The digest was cooled and diluted to 100 ml with distilled water (Cresser and Parsons, 1979). LSD test of the results was performed using Microsoft Excel 2013.

Results and Discussion

Plant growth and biomass production was evaluated in terms of plant height, leaf number (Table 2) and fresh and dry weight of root, stem and leaf (Table 3). The highest plant height (27.2 cm) was recorded in P_5K_{12} treatments and lowest (9.0 cm) in P_0K_0 treatment for 40 days old plants. Results varied significantly ($p<0.05$). Highest number of leaves (14.3 no. plant^{-1}) was found in P_5K_{12} treatment and lowest (8.6 no. plant^{-1}) was achieved in P_0K_0 treatment for 40 days old plants and the values varied significantly ($p<0.5$). Rahman *et al*. (2015) conducted an experiment to study the effects of P and Zn on the growth and yield of mungbean (BARI mug 6) using four levels of P and three levels of Zn. The results revealed that seed and stover yield of mungbean increased with increasing levels of P and Zn up to certain levels. In case of P, the maximum significant seed yield (1.5 ton ha^{-1}) and stover yield (2.47 ton ha^{-1}) were obtained with the treatment of 2.5 kg P ha^{-1} and the minimum yield was recorded in the control treatment (P_0Zn_0).

Table 2. Effects of phosphorus and potassium on the plant height and leaf number and concentration of nitrogen in root, stem and leaf of mungbean plants grown in paddy field at the coastal belt of Bhola region in Bangladesh.

Treatments (kg ha^{-1})	Plant height (cm)	Leaf (no. plant^{-1})	Root N conc. (%)	Stem N conc. (%)	Leaf N conc. (%)
P_0K_0 (Control)	9.0^a	8.6^a	0.86^a	1.16^a	1.95^a
P_5K_6	13.6^b	10.3^b	1.23^b	1.97^b	3.48^b
P_5K_{12}	17.2^c	14.3^c	1.59^c	2.40^c	3.65^b
P_5K_{18}	13.6^b	11.6^b	1.32^b	1.32^a	3.82^b
$P_{10}K_6$	13.5^b	11.3^b	1.51^c	1.92^b	3.24^c
$P_{10}K_{12}$	14.3^b	11.2^b	1.10^b	2.51^c	3.81^b
$P_{10}K_{18}$	10.6^a	11.6^b	1.32^b	1.88^b	3.79^b
LSD at 5%	3.41	1.67	0.17	0.27	0.21

^{abc} *Data bearing different superscripts in the same column differ significantly at 5% level.*

Table 3. Effects of phosphorus and potassium on the fresh and dry weights of root, stem and leaf of mungbean plants grown in paddy field at the coastal belt of Bhola region in Bangladesh.

Treatments (kg ha^{-1})	Root fresh weight (g plant^{-1})	Stem fresh weight (g plant^{-1})	Leaf fresh weight (g plant^{-1})	Total fresh weight (g plant^{-1})	Root dry weight (g plant^{-1})	Stem dry weight (g plant^{-1})	Leaf dry weight (g plant^{-1})	Total dry matter yield (g plant^{-1})
P_0K_0 (Control)	0.36^a	1.10^a	1.71^a	3.17	0.18^a	0.36^a	0.49^a	1.03
P_5K_6	0.44^a	1.20^b	2.10^b	3.74	0.26^b	0.40^a	0.70^b	1.36
P_5K_{12}	0.49^a	1.27^c	2.32^c	4.08	0.26^b	0.54^c	1.08^d	1.88
P_5K_{18}	0.50^a	1.29^c	2.45^d	4.24	0.18^a	0.42^b	0.54^a	1.14
$P_{10}K_6$	0.61^b	1.35^d	2.31^c	4.27	0.31^c	0.53^c	0.89^c	1.73
$P_{10}K_{12}$	0.55^a	1.32^d	2.52^e	4.39	0.35^c	0.54^c	0.93^c	1.82
$P_{10}K_{18}$	0.52^a	1.31^d	2.46^d	4.29	0.17^a	0.33^a	0.50^a	1.00
LSD at 5%	0.096	0.024	0.03	-	0.045	0.055	0.058	-

^{abcde} *Data bearing different superscripts in the same column differ significantly at 5% level.*

Total fresh yields of root, stem and leaf were 3.17, 3.74, 4.08, 4.24, 4.27, 4.39 and 4.29 g plant^{-1} and total dry matter yields of root, stem and leaf were 1.03, 1.36, 1.88, 1.14, 1.73, 1.82 and 1.00 g plant^{-1} recorded in P_0K_0 (Control), P_5K_6, P_5K_{12}, P_5K_{18}, $P_{10}K_6$, $P_{10}K_{12}$ and $P_{10}K_{18}$ kg ha^{-1} treatments, respectively (Table 3). The highest dry matter yield was (1.88 g plant^{-1}) obtained in P_5K_{12} kg ha^{-1}. The values varied significantly ($p<0.05$). Tisdale *et al.* (1995) reported that over 50 factors affect crop growth and yield. Factors involved in a crop growth can be classified as genetic or environmental. Among the environmental factors known to influence plant growth probably most important are temperature, moisture supply, radiant energy, composition of the atmosphere and soil.

The concentration of nitrogen was 0.86, 1.23, 1.59, 1.32,1.51, 1.10 and 1.32% in root, 1.16, 1.97, 2.51, 1.32, 1.92, 2.40 and 1.88% in stem, and 1.95, 3.48, 3.65, 3.82, 3.24, 3.8 and 3.79 in leaf were achieved in P_0K_0 (Control), P_5K_6, P_5K_{12}, P_5K_{18}, $P_{10}K_6$, $P_{10}K_{12}$ and $P_{10}K_{18}$ kg ha^{-1} treatments, respectively (Table 2). Results varied significantly ($p<0.05$). The highest concentration of N was 1.59, 2.51 and 3.82% in root, stem and leaf in P_5K_{12}, P_5K_{12} and P_5K_{18} kg ha^{-1} treatments, respectively. Marr and Cresser (1983) concluded that the typical concentrations of elements in dried healthy foliage are N 0.8-3.0%, K 0.5-2.5%, Ca 1.5-2.80%, Mg 0.15-0.45%, P 0.08-0.35%, Fe 40-150 mg kg^{-1}, Mn 30-100 mg kg^{-1}, B 10-50 mg kg^{-1}, Cu 5-12 mg kg^{-1}, Zn 30-200 mg kg^{-1} and Mo 0.1-1.5 mg kg^{-1}. The results of the concentration of nitrogen of the present experiment are in agreement with Marr and Cresser (1983).

Conclusion

It may be concluded that the combined application of phosphorus and potassium P_5K_{12} kg ha^{-1} was the better dose for growth, biomass production and N accumulation in mungbean and might be incorporated to paddy fields before rice cultivation in the coastal belt of Bangladesh.

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