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Effect of phosphorus and boron on the performance of summer mungbean in high Ganges river floodplain soil

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Abstract: An experiment was carried out at the Multilocation Testing site (MLT) Atghoria, Pabna during the kharif season of 2006 to findout the effect of levels of applied P and B on the performance of summer mungbean. Four different levels of P (0, 10, 20 and 30 kg ha^{-1}) and three levels of B (0, 1 and 2 kg ha^{-1}) were employed in RCB design with 3 replications. The result revealed that yield attributes and yield of summer mungbean significantly influenced by the application of phosphorous (P) and boron (B) except plant height and plant population m^{-2}. The highest seed yield was obtained from the application of 20 kg P and 1 kg B ha^{-1} which was 21.68% higher over control (P and B omission). The maximum economic return in terms of gross margin and marginal benefit-cost ratio was achieved with the same level of phosphorous and boron fertilization.

Key words: Phosphorus, boron, summer mungbean, Ganges river floodplain soil

Introduction

Mungbean has been gaining its popularity as an important pulse crop in the High Ganges River Floodplain Soil due to its short duration and lucrative return. The High Ganges River Floodplain Soil is characterized by low fertility with medium to low level of P and B content (BARC, 2005). Farmers in this region grow mungbean either with nitrogen only or without any fertilizer. But phosphorous (P) fertilization is the major mineral nutrient yield determinant in legume crops. Applied Phosphorous significantly influence the yield performance of pulse crop (Nasreen *et al*., 2006, Tariq *et al*. 2001). Phosphorous deficiency reduces the total vegetative growth, secondary branches, leaf development and finally yields of mungbean (Smith, 1980). Micronutrients like Boron also have the significant effect to achieve the potential yield of mungbean. Intensification of cropping system with adoption of high yielding varieties has resulted in the mining of nutrients from soils leading to nutrients deficiency. As a result farmers are not achieved their targeted production. The balanced fertilization may result in increasing productivity of the crop (Afzal *et al*., 2004). Since no systematic attempt has been made so far with regard to P and B fertilization of Mungbean in the High Ganges River Floodplain Soils, the present study was, therefore, carried out to find out the effect of levels of applied P and B on the performance of summer mungbean.

Materials and Methods

Site description: The experiment was carried out at the Multilocation Testing Site (MLT), Atghoria Pabna during the kharif season of 2006. The experimental site was in Gopalpur soil series belonging to the High Ganges River Floodplain Soils (AEZ-12). Before starting the experiment, initial composite soil samples (0-15 cm depth) were collected from the experimental plots and were analyzed. The analytical result indicated that soil was clay loam with low organic matter content (1.75%) and slightly alkaline in nature. Nitrogen, P and K content of the soil were low but S and B content were medium. Zinc content of the soil was optimum (Table 1). The experiment was laid out in randomized complete block (RCB) design with three replications. The unit plot size was 4 m x 4 m.

Table 1. Nutrient status of the initial soil sample (0-15cm depth) of experimental plots at MLT Site, Atghoria, Pabna

Soil test parameters	P^H	Organic matter (%)	K	% Total N	P	S	B	Zn
			meq100g^{-1} soil		Microgram g^{-1} soil			
Soil test value	7.7	1.75	0.11	0.095	6.5	16	0.39	1.65
Interpretation	Slightly alkaline	Low	low	Low	Very low	Medium	Medium	Optimum

Treatments: Treatment consisted of four different levels of P (0, 10, 20 and 30 kg ha^{-1}) and three levels of B (0, 1 and 2 kg ha^{-1}) which were tested for mungbean crop.

Field and crop management: The land of the experimental plot was prepared with a power tiller by ploughing followed by laddering. Phosphorous and Boron was applied in the form of triple super phosphate and boric acid as per treatment specification. For nitrogen, inoculum was used at the rate of 50g kg^{-1} seed. A blanket dose (30-10-1 kg K S Zn ha^{-1}) was applied for growing mungbean. The full amount of N, P, K, S, Zn and B were applied at the time of final land preparation in the forms of urea, triple super phosphate, muriate of potash, gypsum, zinc oxide and boric acid, respectively. Mungbean (var. BARI Mung-6) seed was sown on March 01, 2006 in line (30 cm apart) with continuous seeding at the rate of 30 kg ha^{-1}. The experimental field appeared shortage of residual soil moisture and hence one light irrigation was applied at 12 days after sowing for better seed germination. One weeding was done at 17 days after sowing of seed. Other intercultural operations and plant protection measures were taken as and when required. The crop was harvested on May 20, 2006.

Measurement: The data on crop parameters except grain and straw yield were measured from ten randomly selected plants of the sampling area of each treatment. Grain and straw yields were measured from the total area of each treatment. Grain yield per hectare was then calculated on 9% moisture content. Collected data were statistically analyzed and mean differences for each character were compared by Duncan's New Multiple Range Test (DMRT). Cost and return analysis of different treatments were done for net benefit. Variable cost was counted from monetary cost (fertilizer) and opportunity cost (labour) only while the other cost considered as fixed cost. Gross return was computed by adding market values of grain and straw yield.

Results and Discussion

Yield contributing characters and yield of mungbean was significantly influenced due to the application of different levels of phosphorous. Among the studied characters, plant height, plant population m^{-2}, seeds pod^{-1} and pod length did not respond to different levels of phosphorous. Pods $plant^{-1}$, weight of 1000 seed, seed yield and stover yield exerted significant variation due to application of phosphorus (Table 2). The highest number of pods $plant^{-1}$ was recorded where P was applied at the rate of 20 kg ha^{-1} and it was followed by 10 kg ha^{-1}. The result showed that the number of pods $plant^{-1}$ was increasing in trend with increasing P application up to 20 kg ha^{-1} and then declined with more addition. The results are in agreement with the finding of many researcher's who observed that yield and yield contributing characters of mungbean affected significantly due to application of phosphorous (Amir Khan *et al*. 1999, Tariq *et al*. 2001, and Bismillah Khan *et al*. 2003). The maximum weight of 1000 seeds was attained in 20 kg P ha^{-1} which was statistically similar with 10 and 30 kg P ha^{-1}. The highest seed yield was obtained from 20 kg P ha^{-1} which was similar to 10 kg P ha^{-1}. The cumulative effect of pods $plant^{-1}$, seeds pod^{-1} and 1000 seed weight might be attributed to increased yield in 20 kg P. Olivera *et al.*, 2004 also investigated that some physiological parameters like leaf area, whole plant dry weight, nodule biomass and shoot and root P content increased with the application of P in P deficient condition. Though the application of 20 kg P ha^{-1} contributed to the highest yield, but from the quadratic function the optimum dose of P for maximizing seed yield was 18 kg ha^{-1} (Fig. 2). The lowest seed yield was recorded from P omission.

Yield and yield contributing characters of mungbean did not response significantly due to application of different levels of B except 1000 seed weight. The maximum weight of 1000 seed was attained from 1 kg B ha^{-1} which was statistically similar to 2 kg B ha^{-1}. The minimum weight of 1000 seed was noted in B omission (Table 3).

The combine effect of P and B showed significant response on yield and yield attributes of mungbean except plant height and plant population m^{-2}. The highest pods $plant^{-1}$ was attained from P_{20} x B_1 combination and it was identical with P_{30} x B_1 and P_{10} x B_1. The lowest number of pods $plant^{-1}$ was observed in P_0 x B_0. Similar trend of response was noted in seeds pod^{-1}. Maximum pod length was achieved in P_{20} x B_0 which was statistically identical to P_{20} x B_1, P_{10} x B_0 and P_{10} x B_2 combinations. The application of P and B significantly enhanced the weight of 1000 seed. The highest weight of 1000 seed was recorded in P_{10} x B_1 and it was identical to P_{20} x B_1. The minimum weight of 1000 seed was obtained from P_0 x B_0. The highest seed yield was obtained from P_{20} x B_1 followed by P_{30} x B_1 and P_{10} x B_1. The cumulative effect of pods $plant^{-1}$, seeds pod^{-1} and identical 1000 seed weight might be attributed to the highest seed yield in P_{20} x B_1. The lowest seed yield was achieved from P_0 x B_0. The maximum stover yield was in P_{10} x B_1 while the minimum in P_0 x B_0 (Table 4).

Phosphorus use efficiency: The application of 20 kg P ha^{-1} had the maximum agronomic efficiency of P which was followed by 10 kg P ha^{-1}. The lowest agronomic efficiency of P was found due to the application of 30 Kg P ha^{-1}. The result indicated that agronomic efficiency of P increased with increasing rate of applied P up to 20 kg ha^{-1} and thereafter the efficiency declined with further addition of applied P irrespective of B application. Regarding partial factor productivity (PFP), the maximum value was due to the application of 10 kg P ha^{-1} and the highest application of P (30 kg ha^{-1}) had the minimum PFP value. However, the reverse relationship was noted between partial factor productivity and applied P (Table 5).

Yield increase: The combined application of different levels of P and B contributed to increase yield of mungbean over control (both P and B omission). The yield increase (%) was varied with different combinations. The maximum increase in yield (21.68%) was achieved with P_{20} x B_1 combination which was followed by P_{30} x B_1 and P_{10} x B_1 (Fig. 1). The minimum increase in yield (3.04%) was attained from P_0 x B_2 combination.

Cost and return: Economic return varied due to different treatment combinations. The maximum gross margin and marginal benefit-cost ratio (MBCR) was achieved with P_{20} x B_1 which was followed by P_{10} x B_1 combination. Probably the maximum grain yield and its satisfactory price resulted in the maximum economic return in P_{20} x B_1 (Table 6). The minimum gross margin and MBCR was attained from P_0 x B_0 and P_0 x B_2 respectively.

In the light of the above result, it revealed that the performance of summer mungbean was responsive to phosphorous and boron fertilization. Considering yield and yield contributing characters, the highest performance exhibited due to application of 20 kg ha^{-1} phosphorous along with 1 kg ha^{-1} boron. Moreover, the said treatment combination resulted in the maximum economic return. Therefore, for growing summer mungbean in the High

Ganges River Flood plain soil, the growers may be advised to apply recommended fertilizer package along with 20 kg ha^{-1} phosphorous and 1 kg ha^{-1} boron for maximizing yield and economic return.

Table 2. Yield and yield contributing characters of summer mungbean as affected by different levels of P

Levels of P (kg ha^{-1})	Plant height (cm)	Pods $plant^{-1}$	Plant population m^{-2}	Seeds pod^{-1}	Pod length (cm)	1000 seed weight (g)	Seed yield (kg ha^{-1})	Stover Yield (kg ha^{-1})
P_0	46.36	17.00b	31.11	10.18b	9.06	33.37b	1231b	1276
P_{10}	45.22	17.20ab	31.37	11.21a	9.36	37.22a	1286ab	1350
P_{20}	47.50	17.64a	31.31	11.44a	9.45	37.67a	1363a	1327
P_{30}	48.33	17.00b	30.84	11.09ab	9.22	36.71ab	1272b	1298
CV (%)	6.56	5.93	3.90	7.75	3.10	5.58	6.74	8.47
$LSD_{0.05}$	NS	0.59	NS	1.18	NS	3.56	88.88	NS

Table 3. Yield and yield contributing characters of summer mungbean as affected by different levels of B

Levels of B (kg ha^{-1})	Plant height (cm)	Pods $plant^{-1}$	Plant population m^{-2}	Seeds pod^{-1}	Pod length (cm)	1000 seed weight (g)	Seed yield (kg ha^{-1})	Stover Yield (kg ha^{-1})
B_0	47.23	16.88	31.02	10.97	9.35a	35.18b	1297	1299
B_1	46.10	17.47	31.32	11.33	9.25a	37.08a	1298	1351
B_2	47.22	17.28	31.14	11.07	9.21a	36.47ab	1269	1289
CV (%)	6.56	5.93	3.90	7.75	3.10	5.58	6.74	8.47
$LSD_{0.05}$	NS	NS	NS	NS	NS	1.75	NS	NS

Table 4. Combine effect of P and B on yield and yield contributing characters of summer mungbean

Interaction P x B	Plant height (cm)	Pods $plant^{-1}$	Plant population m^{-2}	Seeds pod^{-1}	Pod length (cm)	1000 seed weight (g)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})
P_0B_0	43.93	15.87b	31.10	10.33b	8.92bc	31.77f	1183b	1267b
P_0B_1	47.73	16.93ab	32.07	10.80ab	9.41ab	33.73def	1204b	1277b
P_0B_2	47.40	16.87ab	30.93	10.55ab	9.25abc	33.63ef	1199b	1273b
$P_{10}B_0$	44.10	16.95ab	30.73	11.00ab	9.50a	36.90abcde	1282b	1292b
$P_{10}B_1$	48.80	17.80a	31.30	11.63ab	9.31abc	40.23a	1323ab	1490a
$P_{10}B_2$	46.60	17.20ab	31.30	11.10ab	9.43a	37.37abc	1291ab	1268b
$P_{20}B_0$	45.07	17.23ab	30.73	11.53ab	9.59a	37.20abcd	1290ab	1297b
$P_{20}B_1$	47.20	17.93a	31.17	12.00a	9.54a	39.43a	1438a	1309ab
$P_{20}B_2$	46.50	17.40ab	30.63	11.23ab	9.14abc	36.97abcde	1298ab	1289b
$P_{30}B_0$	48.40	17.27ab	31.50	10.63ab	8.89c	36.27bcde	1296ab	1341ab
$P_{30}B_1$	48.20	17.81a	30.73	11.87a	9.36abc	37.80abc	1327ab	1316ab
$P_{30}B_2$	48.40	17.33ab	31.70	10.93ab	8.92bc	34.60cdef	1279b	1325ab
CV(%)	6.56	5.93	3.90	7.75	3.10	5.58	6.74	8.47
$LSD_{0.05}$	NS	1.77	NS	1.49	0.49	3.50	150.20	192.50

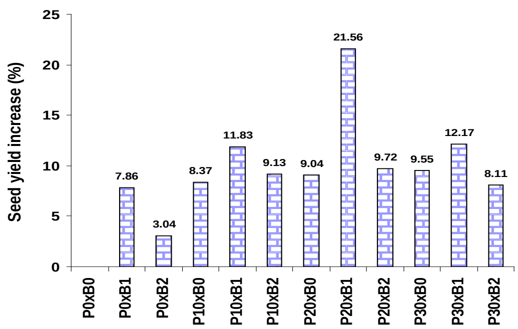

Fig. 1 Seed yield increase due to interaction effect of P and B over control

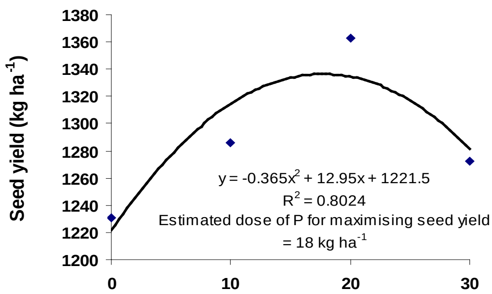

Fig.2 Quadratic relationship between P level and seed yield of mungbean

Table 5. Phosphorous use efficiency as affected by different levels of P

Levels of P	Agronomic efficiency	Partial factor productivity
P_0	-	-
P_{10}	5.5	135
P_{20}	6.6	66.35
P_{30}	1.37	43.27

Table 6. Partial budget analysis for fertilizer use in summer mungbean as influenced by levels of P and B

Level of K (kg ha^{-1})	Gross return (Tk ha^{-1})			Variable cost (Tk ha^{-1})			Gross margin (Tk ha^{-1})	MBCR (over control)
	Wheat		Total					
	Grain	Straw		Monetary cost (fertilizer)	Opportunity cost (labour)	Total		
P_0B_0	59150	634	59784	1447	700	2147	57637	-
P_0B_1	60200	639	60839	1800	700	2500	58339	2.99
P_0B_2	59950	637	60587	2153	700	2853	57734	1.14
$P_{10}B_0$	64100	646	64746	2297	800	3097	61649	5.22
$P_{10}B_1$	66150	745	66895	2650	800	3450	63445	5.46
$P_{10}B_2$	64550	634	65184	3003	800	3803	61381	3.26
$P_{20}B_0$	64500	649	65149	3147	800	3947	61202	2.98
$P_{20}B_1$	71900	655	72555	3500	900	4400	68155	5.67
$P_{20}B_2$	64900	645	65545	3853	900	4753	60792	2.21
$P_{30}B_0$	64800	671	65471	3997	900	4897	60574	2.07
$P_{30}B_1$	66350	658	67008	4350	900	5250	61758	2.33
$P_{30}B_2$	63950	663	64613	4703	800	5503	59110	1.44

Input price (Tk. kg^{-1}): Inoculums = 70.00, TSP = 17.00, MP = 15.00, Gypsum = 5.00, Zinc sulphate = 60.00, Boric acid = 60.00, Output price (Tk. kg^{-1}): Grain = 50.00, Straw = 0.50

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