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CURD YIELD AND PROFITABILITY OF BROCCOLI AS AFFECTED BY PHOSPHORUS AND POTASSIUM

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ABSTRACT

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An experiment was conducted at the Horticulture Farm, Bangladesh Agricultural University, Mymensingh during October, 2004 to March, 2005 to study the effect of phosphorus and potassium on curd yield and profitability of broccoli. The experiment consisted of three levels of phosphorus (0, 100 and 200 kg P_2O_5/ha) and four levels of potassium (0, 100, 200 and 300 kg K/ha). Results revealed that application of phosphorus and potassium at different levels influenced independently and also in combination on the yield and yield contributing characters of broccoli. Phosphorus had significant effect on the days required to curd initiation, diameter and weight of primary curd, number and weight of secondary curds per plant. Similarly, potassium significantly influenced most of the characters. The yield was also significantly influenced either independently or in combination of phosphorus and potassium. The highest curd yield of broccoli 8.05 t ha^{-1} and 8.26 t ha^{-1} was obtained from 200 kg P_2O_5 t ha^{-1} and 200 kg K ha^{-1}, respectively. The treatment combination of 200 kg P_2O_5 ha^{-1} and 200 kg K ha^{-1} was found to produce the highest yield (9.37 t/ha). The economic analysis depicted that the treatment combination of 200 kg P_2O_5 ha^{-1} and 200 kg K/ha gave the highest net return (Tk. 75731.82) and maximum benefit cost ratio (2.16).

Key words: broccoli, curd yield, profitability, benefit cost ratio

INTRODUCTION

Broccoli (*Brassica oleracea* var. *italica* L.) is a biennial winter vegetable crop belonging to the family Cruciferae. Broccoli originated in west Europe. It is one of the uncommon winter vegetables in Bangladesh which is a horticultural hybrid closely related to cauliflower and is considered as a commercial crop in India (Nonnecke, 1989). Its cultivation in Bangladesh has not been extended much beyond the farms of different agricultural organizations. This is mainly due to the lack of awareness regarding its nutritive value and appropriate method of production technology. It is fairly rich in vitamin A, ascorbic acid and contains appreciable amounts of calcium, phosphorus, riboflavin, thiamin, niacin and iron. Watt (1983) reported that broccoli is more nutritious than any other cole crops such as cabbage, cauliflower and kohlrabi. On the other hand, broccoli is environmentally better adapted than cauliflower, and reported to withstand comparatively higher temperature than cauliflower (Rashid, 1976).

Broccoli responds significantly to major essential elements like N, P, and K in respect of its growth and yield (Mital *et al*., 1975; Thompson and Kelly, 1988). Phosphorus fertilization can influence the curd initiation and development of broccoli. Demchak and Smith (1990) reported that phosphorus was the key element for the increased yield of broccoli. Similarly, the potassium is the most important element for yield and dry weight of broccoli. Additive effects were observed on yield and vitamin C content when potassium was applied together with nitrogen or nitrogen and phosphorus (Ying *et al*., 1997). The production technology of broccoli has not yet been standardized in Bangladesh. Few works has been done on fertilizer requirement of broccoli especially P and K in Bangladesh. Profitability is a good concern of a technology to disseminate it among the farmers. In view of the above situation the present study was undertaken to investigate the effect of different levels of phosphorus and potassium on curd yield and profitability of broccoli.

MATERIALS AND METHODS

The research work was carried out at the Horticulture Farm of Bangladesh Agricultural University, Mymensingh during October, 2004 to March, 2005 to study the effect of different levels of phosphorus and potassium on the curd yield and profitability of broccoli. The soil of the experimental plot was silty loam with a pH of 6.8 under the Old Brahmaputra Floodplain Alluvium under the Agro-Ecological Zone 9 (UNDP, 1988). The soil contained 0.15% total nitrogen, 17 ppm available phosphorus, 0.10 meq 100^{-1} g soil exchangeable Potassium, 5.8 ppm, 1.12 ppm available sulphur, boron and 0.062 ppm zinc. There were two sets of treatments, first set-three levels of phosphorus (Factor A) viz. 0 kg of P_2O_5/ha (P_0), 100 kg of P_2O_5/ha (P_1) and 200 kg of P_2O_5/ha (P_2) and second set-four levels of potassium (Factor B) viz. 0 kg of K/ha (K_0), 100 kg of K/ha (K_1), 200 kg of K/ha (K_2) and 300 kg of K/ha (K_3). The experiment was laid out in a randomized completed block design (RCBD) with three replications. The size of each unit plot was 2.4 m × 1.8 m. The land of the experimental area was well prepared by ploughing followed by laddering to obtain good tilth and then the soil was treated with Cinocarb 3g @ 4 kg/ha. Well decomposed cowdung @ 20 t/ha and total amount of Triple Super Phosphate (TSP) were

applied at final land preparation. TSP and MP were applied to the experimental plots as per treatment. First one third of Urea and MP were applied 15 days after transplanting. The remaining of the urea and MP were top dressed in two equal installments at 30 and 45 days after transplanting. Healthy and uniform sized twenty-six days old seedlings were transplanted in the experimental plots on November 22, 2004 maintaining a spacing of 60 cm × 45 cm. Intercultural operations viz. gap filling, weeding, earthing up etc. and plant protection measures were taken for Alternaria leaf spot disease, bird pests etc. as and when necessary. The primary curds and secondary curds developed after removing the main curd from secondary shoots of the leaf axils were harvested on January 28, 2004 and March 6, respectively. The plants were randomly selected from the middle rows from each unit plot for recording yield attributes. Data on days required for curd initiation, diameter of primary/central curd, weight of primary/central curd, number of secondary curds per plant, weight of secondary curds and yield per hectare were recorded. The data were analyzed statistically and the mean differences among the treatment means were evaluated by the least significance difference (LSD) at 5% level of probability (Gomez and Gomez, 1984). For economic analysis, all input costs including the cost for lease of land and interest on running capital were considered for computing the cost of production. The interests were calculated @ 13% per year for 6 months. The cost and analyses were done according to Alam *et al*. (1989). The benefit cost ration (BCR) was calculated with the following formula:

$$\text{Benefit cost ratio (BCR)} = \frac{\text{Gross return per hectare (Tk)}}{\text{Total cost of production per hectare (Tk)}}$$

RESULTS AND DISCUSSION

Effect of phosphorus

The application of phosphorus had significant influence on the number of days required for curd initiation, diameter of primary curd, weight of primary curd plant^{-1}, number of secondary curds plant^{-1}, weight of secondary curds plant^{-1} and yield per hectare of broccoli (Table 1 and Fig. 1). The number of days for curd initiation was decreased with increasing levels of phosphorus. The highest (60.53 days) and the lowest (58.36 days) number of days to curd initiation were obtained from P_0 and P_2 (200 kg P_2O_5/ha) treatment respectively (Table 1). The result indicated that phosphorus might have retarded vegetative growth and forced the plants to reach reproductive stages earlier. Mitra *et al*. (1990) reported that application of phosphorus hastened the crop to reach reproductive stage, which is an agreement with the findings of the present work. Cuteliffe and Munro (1976) also stated that maturity of cauliflower was slightly delayed by lack of phosphorus. The highest diameter of primary curd (15.12 cm) was observed in the highest level of P_2 (200 kg P_2O_5 ha^{-1}) which was statistically similar with primary curd diameter of P_1 but the lowest was observed at control treatment. Similar trend was observed in case of weight of primary curd plant^{-1}. The highest weight of individual primary curd (163.4 g) was found from P_2 (200 kg P_2O_5 ha^{-1}) treatment. The findings supported with the findings of Mitra *et al*. (1990) who obtained higher average individual head weight of broccoli of 0.87 lb form 100 kg ha^{-1} of P. The highest number of secondary curd (4.31), maximum weight of secondary curds plant^{-1} (54.64 g) and curd yield per hectare (8.05 t ha^{-1}) were obtained from the plants that received phosphorus at the rate of P_2 (200 kg P_2O_5/ha) while the lowest number of secondary curd plant^{-1} (3.74), minimum weight of secondary curds plant^{-1} (32.08 g) and the lowest curd yield per hectare (5.89 t ha^{-1}) were recorded in control treatment (Table 1 and Fig. 1). The results are in agreement with the findings of Karim *et al*. (1987) who stated that more nitrogen, phosphorus and potassium application significantly increased the curd yield (940.6 g plant^{-1}) of broccoli.

Effect of potassium

Potassium application had significant effect on the yield and yield contributing characters of broccoli. (Table 2 and Fig. 2). Yield was found to increase with the increasing of K levels up to 200 kg Kha^{-1} and then decreased. The highest number of days (62.17 days) required for curd initiation was recorded in control followed by K_1(59.53 days) and K_3 showed the least time (57.57 days). The primary curd diameter was found to be the highest (15.44 cm) in K_2 (200 kg K/ha) followed by K_1 (100 kg Kha^{-1}) and K_3 (300 kg Kha^{-1}) producing curd of 14.88 cm and 13.95 cm, respectively while the lowest curd diameter (12.87 cm) was noticed in control. The results were partially supported by Pascual *et al.* (1996) who stated that the higher dose of potassium produced healthy curds of broccoli with calcium and magnesium in combination. The weight of primary curd per plant was increased with the increasing levels of potassium up to K_2 level. The maximum weight of primary curd plant^{-1} (171.23 g), the highest number of secondary curds (4.46), maximum weight of secondary curds (52.51 g) and the highest curd yield (8.26 t ha^{-1}) were obtained from K_2 (200 kg K ha^{-1}) treatment while the minimum values (124.25 g, 3.66, 37.38 g and and 5.97 t ha^{-1}, respectively) were recorded from control treatment (Table-2 and Fig. 2). The findings were also supported by Ying *et al*. (1997). They observed that when K was applied together with N+P gave 110.8% higher yield than N alone and it was also in partial agreement with the findings of Castellanos *et al*. (1999) and Everaarts *et al.* (1997) that the superior marketable yield obtained from K of 300 kg ha^{-1} and 250 kg K ha^{-1}.

Interaction effect of phosphorus and potassium

Application of phosphorus and potassium had significant impact on the yield and yield contributing characters of broccoli (Table 3 and Fig. 3). The highest days to curd initiations (65 days) were recorded from the control, while the lowest (57.03 days) was observed in P_1K_3. The highest curd diameter (16.07 cm), primary curd weight (193.68), number of secondary curd/plant (4.68) and weight of secondary curd/plant (59.77g) were obtained from the treatment combination of P_2K_2 while the lowest (11.47 cm, 89.25 g, 3.17 and 25.00 g, respectively) were found from control. The highest yield (9.37 t ha^{-1}) was recorded with the P_2K_2 treatment combination and the lowest yield (4.21 t ha^{-1}) was recorded from control (Fig. 3). The findings of the present study are in agreement with the findings of Yang *et al*. (1994) who reported that phosphorus and potassium application should be balanced to obtain higher yields of broccoli. The result of the present study was also in partial agreement with that of Brahma *et al*. (2002).

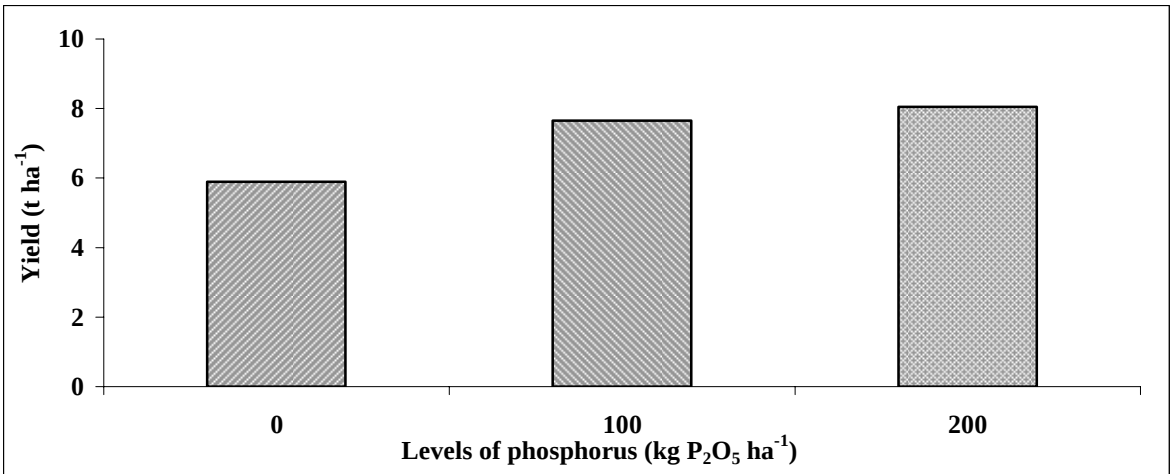

Fig. 1. Effect of different levels of phosphorus on the yield of broccoli

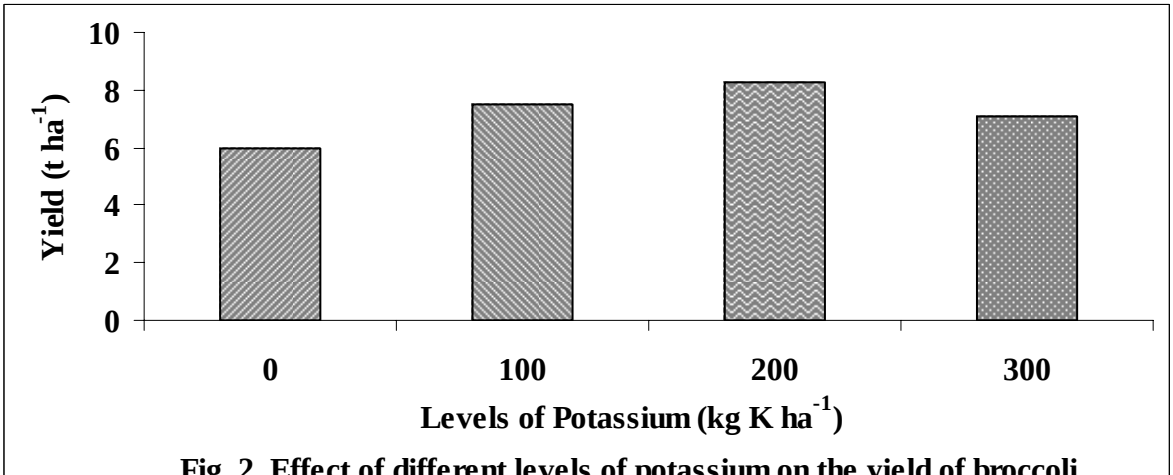

Fig. 2. Effect of different levels of potassium on the yield of broccoli

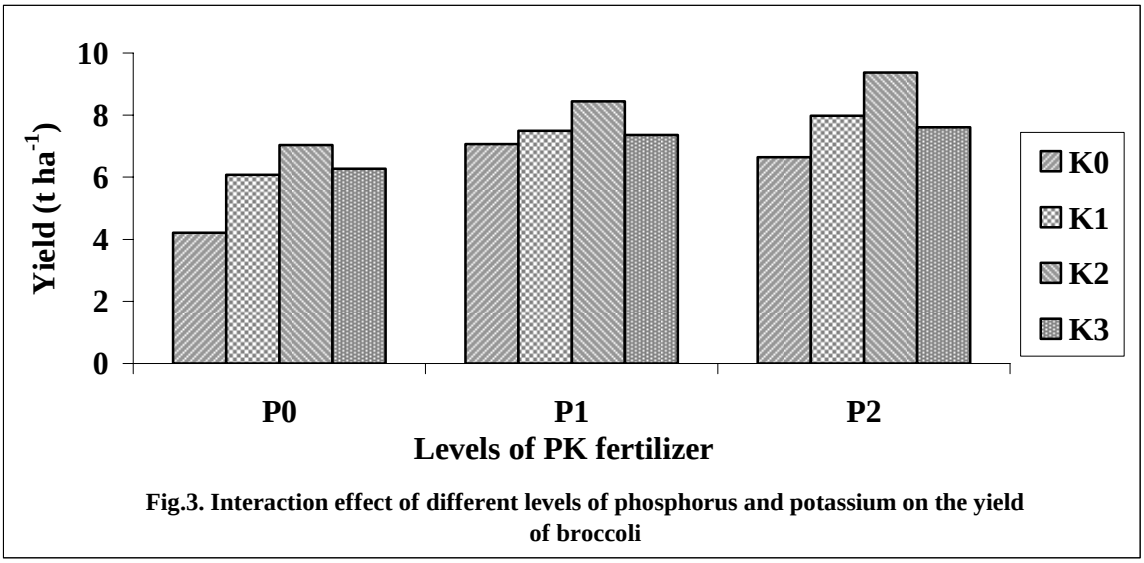

Fig.3. Interaction effect of different levels of phosphorus and potassium on the yield of broccoli

Economic analysis

It was found from the economic analysis that the treatment P_2K_2 (200 kg P_2O_5 ha^{-1} and 200 kg K ha^{-1}) gave the highest net return of Tk. 75731.82 followed by P_1K_2 (100 kg P_2O_5 ha^{-1} and 200 kg K ha^{-1}) while the lowest (Tk. 15029.64) with P_0K_0 (0 kg P_2O_5 ha^{-1} and 0 kg K ha^{-1}) (Table 5). Considering the benefit cost ratio (BCR), the treatment combination P_2K_2 (200 kg P_2O_5 ha^{-1} and 200 kg K ha^{-1}) showed higher BCR (2.16) than any other treatment combinations. The lowest BCR (1.31) was found in P_0K_0 (0 kg P_2O_5 ha^{-1} and 0 kg K ha^{-1}) treatment combination (Table 4).

The present experiment revealed that the application of 200 kg P_2O_5/ha with 200 kg K/ha was found to be conducive to higher economic return from broccoli under the soil and climatic conditions of AEZ-9.

Table 1. Effect of phosphorus on the yield parameters of broccoli

Treatments	Days to curd initiation	Diameter of primary curd (cm)	Wt. of primary curd/plant (g)	No. of secondary curd/plant	Wt. of secondary curd/plant (g)
P_0	60.53	13.30	127.71	3.74	32.08
P_1	59.49	14.44	159.21	4.33	47.85
P_2	58.36	15.12	163.38	4.31	54.64
$LSD_{0.05}$	1.027	0.782	6.101	0.227	1.321

Each value is an average of three replications

P_0 : 0 kg P_2O_5 ha^{-1}; P_1 : 100 kg P_2O_5 ha^{-1}; P_2 : 200 kg P_2O_5 ha^{-1}

Table 2. Effect of potassium on the yield parameters of broccoli

Treatments	Days required for curd initiation	Diameter of curd (cm)	Wt. of primary curd/plant (g)	No. of secondary curd/plant	Wt. of secondary curd/plant (g)
K_0	62.17	12.87	124.25	3.66	37.38
K_1	59.53	14.88	156.51	4.11	46.56
K_2	58.57	15.44	171.23	4.46	52.51
K_3	57.56	13.95	148.41	3.88	42.98
$LSD_{0.05}$	1.185	0.904	7.045	0.262	1.526

Each value is an average of three replications

K_0: 0 kg K/ha K_2: 200 kg K/ha

K_1: 100 kg K/ha K_3: 300 kg K/ha

Table 3. Interaction effect of phosphorus and potassium on the yield parameters of broccoli

Treatments	Days required for curd initiation	Diameter of primary curd (cm)	Wt. of primary curd/plant (g)	No. of secondary curd/plant	Wt. of secondary curd/plant (g)
$P_0 K_0$	65.00	11.47	89.25	3.17	25.00
P_0K_1	59.86	14.16	132.38	3.88	32.50
P_0K_2	58.76	14.37	148.00	4.25	42.50
P_0K_3	58.50	13.19	141.22	3.65	28.33
$P_1 K_0$	62.20	13.47	189.83	3.87	39.66
P_1K_1	60.05	14.91	166.27	3.95	49.50
P_1K_2	58.70	15.89	172.10	4.45	55.26
P_1K_3	57.03	13.50	158.66	3.88	47.00
$P_2 K_0$	59.33	13.67	143.66	3.95	47.50
P_2K_1	58.70	15.57	170.90	4.50	57.70
P_2K_2	58.26	16.07	193.60	4.68	59.76
P_2K_3	57.16	15.17	145.36	4.13	53.61
$LSD_{0.05}$	2.053	1.566	12.20	0.454	2.642

Each value is an average of three replications

P_0 : 0 kg P_2O_5/ha
P_1 : 100 kg P_2O_5/ha
P_2 : 200 kg P_2O_5/ha

K_0 : 0 kg K/ha
K_1 : 100 kg K/ha
K_2 : 200 kg K/ha
K_3 : 300 kg K/ha

Table 4. Cost and return analysis of broccoli production due to phosphorus and potassium application

Treatment combinations	Yield (t/ha)	Gross return (Tk./ha)	Total cost of production (Tk./ha)	Net return (Tk./ha)	Benefit cost ratio (BCR)
P_0K_0	4.21	63150	48120.36	15029.64	1.31
P_0K_1	6.08	91200	52089.15	39110.85	1.75
P_0K_2	7.03	105450	56058.93	49391.07	1.88
P_0K_3	6.27	94050	59469.6	34580.4	1.58
P_1K_0	7.06	105900	51939.99	53960.01	2.04
P_1K_1	7.50	112500	56468.9	56031.1	1.99
P_1K_2	8.44	126600	60438.69	66161.31	2.09
P_1K_3	7.36	110400	64408.48	45991.52	1.71
P_2K_0	6.64	99600	55760.36	43839.64	1.79
P_2K_1	7.98	119700	60289.27	59410.73	1.99
P_2K_2	9.37	140550	64818.18	75731.82	2.16
P_2K_3	7.61	114150	69347.1	44802.9	1.65

Each value is an average of three replications

P_0: Control
P_1: 100 kg P_2O_5/ha
P_2: 200 kg P_2O_5/ha

K_0: Control
K_1: 100 kg K/ha
K_2: 200 kg K/ha
K_3: 300 kg K/ha

Sale of broccoli @ Tk. 15000/t
Gross return = Total yield (t/ha) × Tk. 15000
Benefit Cost Ratio (BCR) = Gross return ÷ Total cost of production
Net return = Gross return – Total cost of production

CONCLUSION

From the findings of the study, it could be concluded that the application of 200 kg P_2O_5 ha^{-1} and 200 kg K ha^{-1} is found remarkable influence on the curd yield of broccoli. The economic analysis also depicted that 200 kg P_2O_5 ha^{-1} and 200 kg K ha^{-1} is the best combination for getting highest net return and maximum benefit cost ratio.

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