J. Sher-e-Bangla Agric. Univ., 2(2): 57-64, July 2008 ISSN 1997-6038

EFFECT OF PHOSPHORUS ON GROWTH, YIELD AND SHELF LIFE OF BROCCOLI (*Brassica oleracea* var. *botrytis*) CULTIVAR

J. Uddain[1], M. J. Rahman[2] and A. K. M. M. Uddin[3]

ABSTACT

The field and laboratory experiments were conducted at Horticultural farm of Sher-e-Bangla Agricultural University, Dhaka during the period from October 2005 to February 2006 to study the effect of phosphorus on growth, yield and shelf life of broccoli cultivars. Four levels of phosphorus fertilizers viz. P_0=0 kg P/ha, P_1 = 30 kg P/ha, P_2 = 40 kg P/ha and P_3 =50 kg P/ha were used in the field experiment. The field experiment was laid out in Randomized Complete Block Design with three replications. Considering the yield and yield atributes of broccoli the highest plant height (55.85 cm), stem diameter (5.69 cm), number of leaves (13.78), leaf length (45.97 cm) at 60 DAT, shoot length (39.93 cm), root length (30.81cm), fresh shoot weight (793.9 g), fresh root weight (83.42 g) and main curd weight (264.3 g) and curd yield (13.81 t/ha) were recorded from P_3. But the highest curd diameter (17.44 cm), number of secondary curd (4.25), weight of secondary curd (155.3 g) was found in P_2. The laboratory experiment was laid out in two factors Completely Randomized Design with four levels of phosphorus fertilizers viz. P_0=0 kg P/ha, P_1 = 30 kg P/ha, P_2 = 40 kg P/ha and P_3 =50 kg P/ha and three storage conditions. The storage conditions were as follows: i. stored in open condition at room temperature (24°C), ii. stored in perforated polythene bags at room temperature (24°C) and iii. stored in perforated polythene bags at 4°C in refrigerator. The maximum shelf life of broccoli in open at room temperature (2.62), polyethylene bag at room temperature (6.02) and polyethylene bag at refrigerator (17.01) were found in P_0.

Key words: Phosphorus, growth, yield, shelf life and broccoli

INTRODUCTION

Broccoli (*Brassica oleracea* var. *botrytis* L.) is a member crop of Brassicaceae family. There are three classes of sprouting broccoli, i.e., green, white and purple, but the green type is the most popular broccoli (Shoemaker, 1962). Broccoli is one of the most important cole crops in Europe and USA and it is a commercial crop in India (Tindall, 1983; Nonnecke, 1989), but a minor winter vegetable in Bangladesh. Broccoli is rich in vitamin A, ascorbic acid and appreciable amounts of thiamin, riboflavin, niacin, calcium and iron (Thompson and Kelly, 1957; Lincolin, 1987). Broccoli can be grown on a wide range of soil types, ranging from light sand to heavy loam or, even clay that are optimum supplied with organic matter (Katayal, 1994). Successful production of broccoli depends on various factor. Fertilizer management is one of the most important factors, which assured crop production. Broccoli responds greatly to macro elements like nitrogen, phosphorus and potassium in respect of its growth and yield (Mital *et al.*, 1975; Pieters, 1976; Singh *et al.*, 1976; Thompson and Kelly, 1957).Phosphorus influences curd initiation and vegetative growth of broccoli. Demchak and Smith (1990) reported that phosphorus was the most responsible element for the increased yield of broccoli. It is one of the perishable commodities due to high moisture contents. In our country about 70% vegetables are grown in rabi season. If we can increase shelf life of vegetables, the availability of vegetable in the off-season can be increased. Broccoli is an important vegetable having short shelf life, which hasten the postharvest losses and make the crop unpopular even than it has a greater potential to improve the nutritional situation of our country. The postharvest loss of broccoli

[1]Lecturer, [2]Assistant Professor, [3]Professor, Department of Horticulture and Postharvest Technology, Sher-e-Bangla Agricultural University, Dhaka

due to the short shelf life results economic loss of the growers as well as the traders, which in turn affects over national economy. In order to have a good return and avoid market glut it becomes essential to store for a considerable period. The major aims of the investigation was to evaluate growth, yield and shelf life performance of broccoli cultivars under different levels of phosphorus.

MATERIALS AND METHODS

The field experiment was conducted at Horticultural farm in Sher-e-Bangla Agricultural University, Dhaka during October 2005 to February 2006.The hybrid variety 'Green Sprouting Broccoli' was selected for investigation. Seeds of 'Green Sprouting Broccoli' were collected from khustia seed store Mirpur-11, Dhaka.The experiment was laid-out in Randomiz Complete Block Design (RCBD) with three replications. Four levels of phosphorus fertilizers viz., P_0 = Control (No P application), P_1 =30 kg P/ha, P_2 = 40 kgP/ha P_3 =50kg P/ha were used in the experiment. The seeds were sown on 28 October 2005 in the seedbed.Healthy and 21 days old seedlings were transplanted into the experimental field on 27 November 2005.Irrigation and weeding was done at ten days interval.Data were collected on plant height (cm), stem diameter (cm), number of leaves per plant, leaf length (cm), shoot length, root length, days required for curd initiation, curd diameter (cm), curd weight (g), number of secondary curds, secondary curd weight (g), yield per plant (g), yield ha^{-1} (t). The laboratory experiment was laid out in two factors Complete Randomized Design (CRD) with four levels of phosphorus and three storage conditions. The storage conditions were as follows: i. stored in open condition at room temperature (24°C), ii. stored in perforated polythene bags at room temperature (24°C) and iii. stored in perforated polythene bags at 4°C in refrigerator. The three mature broccoli curds were selected for each treatment. The changes of florets color (just started to yellowish) were recorded by eye estimation.The data were analyzed using MSTAT-C software. The means were separated by DMRT at 5% level of significance (Gomez and Gomez,1984).

RESULTS AND DISCUSSION

Effect on plant height: Application of phosphorus exhibited a significant influence on height of broccoli plants at 20, 40 and 60 days after transplanting (DAT) (Figure 1).

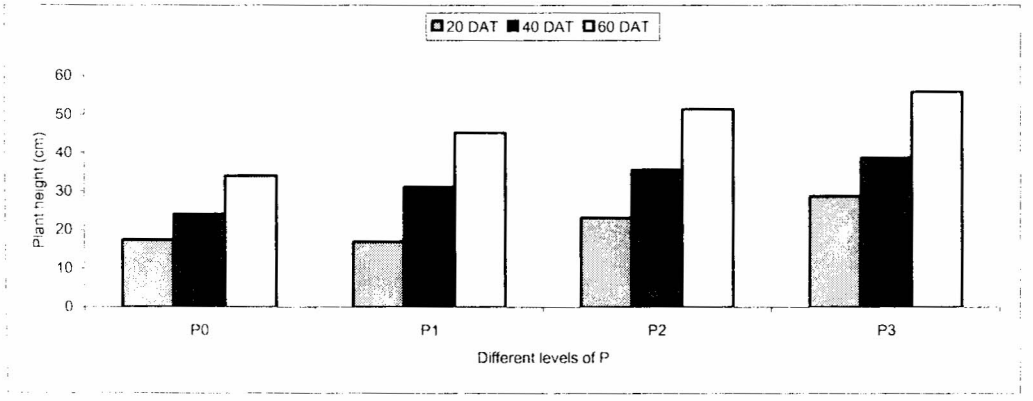

Figure 1. Effect of different levels of P on plant height at different days after transplanting
P_0 = 0 kg/ha, P_1 = 30 kg/ha, P_2 = 40 kg/ha and P_3 = 50 kg/ha

At 20 DAT, the plant height ranged from 16.93 cm to 28.73 cm. The tallest plant (28.73 cm) was found from the highest level of phosphorus application (P_3) and the shortest plant (16.93 cm) in P_1, which was statistically similar to that of P_0. At 40 DAT, the highest plant height (38.68 cm) was

recorded in P_3, which was statistically similar to P_2, while the lowest (24.09 cm) was found in P_0. At 60 DAT, the highest plant height (55.85 cm) was recorded from P_3, which was statistically similar to that of P_2 and the lowest (33.99 cm) was obtained from P_0.From this finding it was revealed that the plant height increased with the increased in days after transplanting (DAT) i.e., 20, 40 and 60 DAT and also revealed that the plant height increased with the increase of P application as well. This could be due to the synergistic effect of P, because it helped the efficiency of nitrogen uptake, which enhanced vegetative growth of broccoli plants. Mishra and Indulkarl (1993),5 Sharma *et al.* (2002), Singh (2004) and Reddy *et al.* (2005) found the about same results of the present investigation.

Effect on stem diameter: The stem diameter of broccoli was significantly influenced by different DAT (i.e., 20, 40 and 60) due to application of different levels of phosphorus (Figure 2).

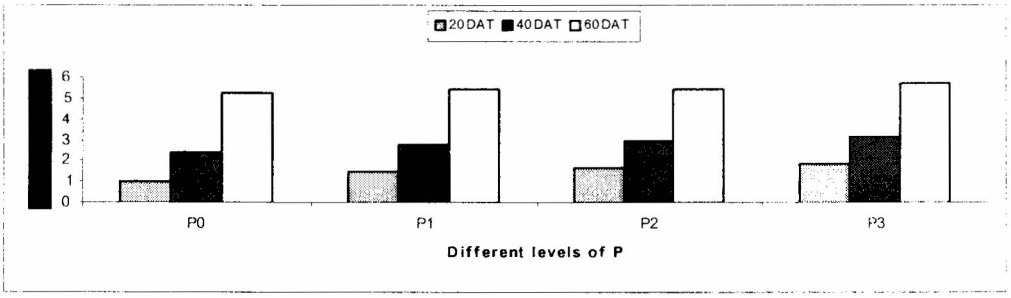

Figure 2. Effect of different levels of P on stem diameter at different days after transplanting(DAT)
P_0 = 0 kg/ha, P_1 = 30 kg/ha, P_2 = 40 kg/ha and P_3 = 50 kg/ha.

At 20 DAT, the maximum diameter (1.81 cm) was recorded in P_3, which was statistically similar to P_2 (1.66 cm) and the minimum (1.01 cm) was recorded in P_0. At 40 DAT, the stem diameter ranged from 2.40 cm to 3.13 cm. The highest stem diameter (3.13 cm) was recorded in P_3, which was statistically similar to P_2 (3.00 cm), while the lowest value (2.40 cm) was recorded in P_0. At 60 DAT, the stem diameter was statistically insignificant due to the application of different levels of phosphorus. The maximum stem diameter (5.69 cm) was observed in P_3 and the minimum (5.22 cm) was recorded in P_0. This result revealed that the stem diameter increased significantly with the increase of phosphorus application. This might be due to the synergistic effect of P and N. Phosphorus increased the nitrogen uptake efficiency, which ultimately stimulated the stem growth. Dufault (1988) found about the similar trend of results, which support the present study.

Effect on the number of leaves per plant: Application of phosphorus exhibited a significant influence on the number of leaves of broccoli plants at 20, 40 and 60 DAT (Figure 3).

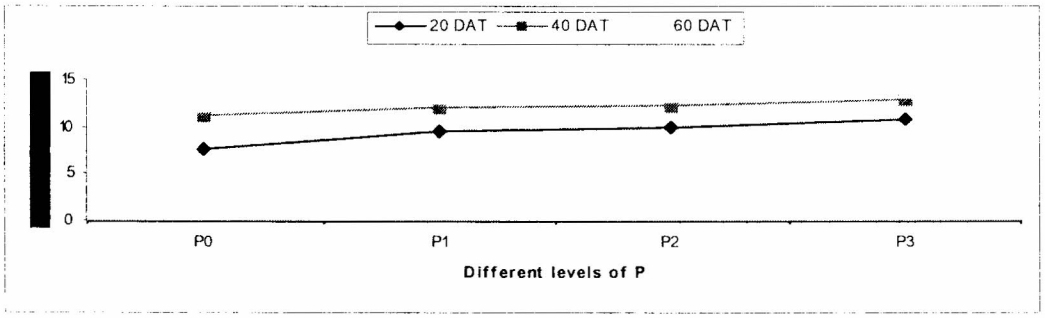

Figure 3. Effect of different levels of P on number of leaves at different days after transplanting (DAT)
P_0 = 0 kg/ha, P_1 = 30 kg/ha, P_2 = 40 kg/ha and P_3 = 50 kg/ha.

At 20 DAT, the maximum number of leaves (10.88) was recorded in P_3, which was statistically similar to that of P_1 and P_2 and the minimum (7.63) was found in P_0. At 40 DAT, the maximum number of leaves (12.98) was recorded in P_3 and the minimum (11.25) was observed in P_0. At 60 DAT, there were no significant differences on number of leaves due to the application of different levels of phosphorus. The maximum number of leaves (13.78) was recorded in P_3 and the minimum (12.18) was observed in P_0. It was revealed that the number of leaves per plant increased with the increase of P application. This might be caused that phosphorus had significant role in photosynthesis, energy storage, cell division and cell enlargements, which enhanced the number of leaves.

Effect on the leaf length: Phosphorus had a significant influence on the length of leaves of broccoli plants at 20, 40 and 60 DAT (Figure 4). At 20 DAT, P_3 produced the longest leaf (41.97 cm), which was statistically similar to P_1 and P_2, while the lowest (31.67 cm) was recorded in P_0. At 40 DAT, the largest leaf (45.21 cm) was recorded in P_3, which was statistically similar to $P_1$and P_2, while the smallest leaf (35.52 cm) was recorded in P_0. At 60 DAT, the longest leaf (45.87 cm) was recorded in P_3, which was statistically similar to $P_1$and P_2 while the smallest (36.53 cm) was recorded in P_0.

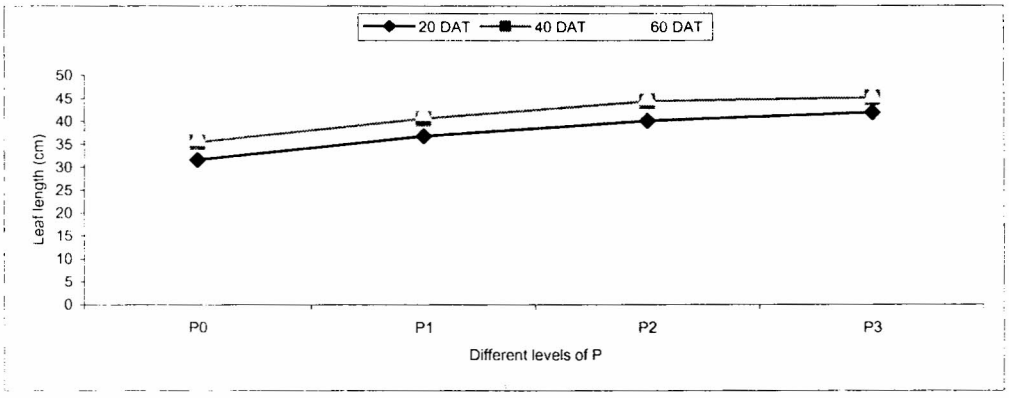

Figure 4. Effect of different levels of P on leaf length at different days after transplanting(DAT)
P_0 = 0 kg/ha, P_1 = 30 kg/ha, P_2 = 40 kg/ha and P_3 = 50 kg/ha.

It was revealed that the leaf length increased with the increase in P application and DAT as well. This might be due to the synergistic effect of P and N. Phosphorus helped the nitrogen uptake efficiency, which stimulated the vegetative growth of broccoli plant. Singh (2004) and Reddy *et al.* (2005) found about similar trend of results, which agreed to the present investigation.

Effect on shoot length: The shoot length of broccoli plant is important morphological character that influences the yield, because it is correlated with photosynthesis by the higher leaf area. Application of phosphorus exhibited a significant influence on shoot length of broccoli plants (Table 1). The maximum shoot length (39.93 cm) was recorded in P_3, which was statistically similar to P_1 and P_2, while the minimum shoot length (29.08 cm) was observed in P_0 which was identical to P_1. It was revealed that shoot length increased with the increase of phosphorus application. This might be due to its role in photosynthesis, energy storage, cell division and cell enlargement. About similar trend of results were reported by Saimbhi *et al.* (1969), Raut (1980) and Keder (1981).

Effect on root length: Phosphorus showed a significant influence on root length of broccoli plants (Table 1). The longest root (30.81 cm) was recorded in P_3, which was statically similar to that of P_1 and P_2, while the shortest root (24.62 cm) was observed in P_0. It was revealed that root length increased with the increased in phosphorus application. This might be caused that phosphorus increased physiological processes in the plant system leading to increased rate of growth, which

ultimately stimulated the root length of broccoli plants. The root length of broccoli plant is important morphological feature that influences the yield, because it is correlated with nutrient uptake for proper growth and development by the larger root length. Kumar *et al.* (1993) found about similar trend results, which support the present findings.

Fresh weight of shoot: Application of phosphorus exhibited a significant influence on fresh shoot weight of broccoli plants (Table 1). Fresh weight of shoot ranged from 581.30 g to 793.90 g. The maximum fresh weight of shoot (793.90 g) was recorded from P_3, which was statistically similar to that of P_1 and P_2 and the minimum fresh weight of shoot (581.30 g) was observed in P_0. It was revealed that fresh shoot weight increased with the increase of phosphorus application. This might be due to its role in photosynthesis, energy storage, cell division and cell enlargement. About similar effects of phosphorus have been reported by Singh (2004) and Sharma *et al.* (2002).

Fresh weight of root: Application of different levels of phosphorus exhibited a significant influence on fresh weight of root (Table 1). The maximum fresh weight of root (83.42g) was recorded from P_3, which was statistically similar to P_2 while the minimum fresh weight of root (57.92 g) was observed in P_0. It was revealed that the fresh root weight increased with the increase of phosphorus application. It might be due to its role of cell division and cell enlargement.

Total fresh weight: Phosphorus had a significant influence on total fresh weight of broccoli plants (Table 1). The maximum fresh weight (877.40 g) was recorded from P_3, which was statistically similar to P_1 and P_2 and the minimum fresh weight (647.90 g) was observed in P_0.

Table 1. Effect of different levels of phosphorus on vegetative growth of broccoli

Treatments	Shoot length (cm)	Root length (cm)	Fresh shoot weight (g)	Fresh root weight (g)	Total weight
P_0	20.08 b	24.62 b	581.3 b	57.92 c	647.9 b
P_1	34.53 ab	27.86 ab	688.1 ab	71.50 b	759.6 ab
P_2	37.63 a	29.37a	752.8 a	77.17 ab	830.7 a
P_3	39.93 a	30.81a	793.9 a	83.42 a	877.4 a
CV (%)	14.55	9.28	14.23	10.23	10.13
LSD (0.05)	7.418	3.775	144.6	10.71	113.9

Means in the column followed by different letter(s) differed significantly by DMRT at 5% level of significance
P_0 = 0 kg P/ha, P_1 = 30kg P/ha, P_2 = 40kg P/ha and P_3 = 50kg P/ha

Days to required for curd initiation

The number of days to require for curd initiation was not significantly influenced due to application of phosphorus (Table 2). Treatment P_0 took the minimum (52.00) days for curd initiation, while the maximum (59.92) days were required for P_3. The result indicated that phosphorus might have retarded the growth of plants to reach reproductive stages earlier. Such effect of phosphorus mainly responsible for delayed the curd initiation. Mitra *et al.* (1990) reported that application of phosphorus delayed the crop to reach reproductive stage, which was agreed with the present finding.

Main curd diameter: Application of phosphorus exhibited a significant influence on curd diameter of broccoli plants (Table 2). The maximum curd diameter (17.44 cm) was recorded in P_3, which was statistically similar to P_1 and P_2, while the minimum (13.27 cm) was observed in P_0. It was revealed that the curd diameter increased with the increase of phosphorus application. This might be due to its role of energy storage, cell division and cell enlargement. Sharma *et al.* (2002) and Singh (2004) were found about similer trend of results, which supported to the present study.

Main curd weight: Phosphorus exhibited a significant influence on main curd weight of broccoli plants (Table 2). The maximum main curd weight (264.30 g) was recorded in P_3, which was statistically similar to that of P_2, while the minimum main curd weight (181.70 g) was observed in P_0. It was revealed that the increased of main curd weight with the increase of phosphorus application.

Such effect of phosphorus was due to the fact that phosphorus was mainly responsible for improving the quality and quantity of curd by the way of increasing metabolic activities in broccoli plant. About similar trend of the results was found by Saimbhi *et al.* (1969) and Singh (2004).

Number of secondary curd per plant: The secondary curds were those, which develop after harvest of the main curd. The number of secondary curd of broccoli plant is important for increasing total production. Application of phosphorus exhibited a significant influence on the number of secondary curd of broccoli plants (Table 2). The maximum number of secondary curds (4.00) were recorded in P_3, which was statistically similar to that of P_1 and P_2, while the minimum (2.08) were observed in P_0. It was revealed that the number of secondary curd increased with the increase of phosphorus application. This might be caused due to its role in photosynthesis, cell division and cell enlargement. About similar effect of phosphorus has been reported by Sharma *et al.* (2002).

Secondary curd weight: Secondary curd weight of broccoli plant is important for increasing total yield. Phosphorus had a significant influence on secondary curd weight of broccoli plants (Table 2). The maximum secondary curd weight (155.30 g) was recorded in P_2, which was statistically similar to P_3 and the minimum (60 g) was observed in P_0. It was revealed that the weight of secondary curd increased with the increase of phosphorus application. This might be caused due to role of photosynthesis, cell division and cell enlargement. About similar effects of phosphorus have been reported by Sharma *et al.* (2002).

Yield per plant: Application of phosphorus exhibited a significant influence on yield per plant (Table 2). The maximum yield (414.50 g) was recorded in P_3, which was statistically similar to P_2, while the minimum (241.70 g) was observed in P_0.

Table 2. Effect of different levels of phosphorus on curd diameter, curd weight, number of secondary curd and weight of secondary curd of broccoli

Treatments	Days required for curd initiation	Main curd diameter (cm)	Main curd weight (g)	Number of secondary curd	Weight of secondary curd (g)	Yield / plant (g)
P_0	52.00 a	13.27 b	181.7 c	2.08 b	60.00 c	241.7 c
P_1	54.00 a	15.48 ab	222.3 b	3.25 a	105.5 b	327.4 b
P_2	57.00 a	16.43 a	245.8 ab	4.25 a	155.3 a	401.0 a
P_3	59.92 a	17.44 a	264.3 a	4.00 a	150.0 a	414.5 a
CV (%)	9.11	11.84	11.68	20.21	8.97	8.10
LSD (0.05)	7.329	2.677	38.54	0.9911	15.24	40.47

Means in the column followed by different letter (s) differed significantly by DMRT at 5% level of significance
P_0 = 0 kg P/ha, P_1 = 30kg P/ha, P_2 = 40kg P/ha and P_3 = 50kg P/ha

It was revealed that the yield per plant increased with the increase of phosphorus application. This might be caused that P had a role in photosynthesis, cell division and cell enlargement. About similar trend of the results were found by Sharma *et al.* (2002); Singh (2004) and Reddy *et al.* (2005).

Yield per hectare: Application of phosphorus exhibited a significant influence on yield per hectare of broccoli plants (Figure 5). The maximum yield (13.81 t/ha) was recorded in P_3, which was statistically similar to P_2, while the minimum yield (8.04 t/ha) was observed in P_0. It was revealed that yield per hectare increased with the increase of phosphorus application. This might be caused that phosphorus had a role in photosynthesis, cell division and cell enlargement. About similar trend of the results were found by Sharma *et al.* (2002), Singh (2004) and Reddy *et al.* (2005).

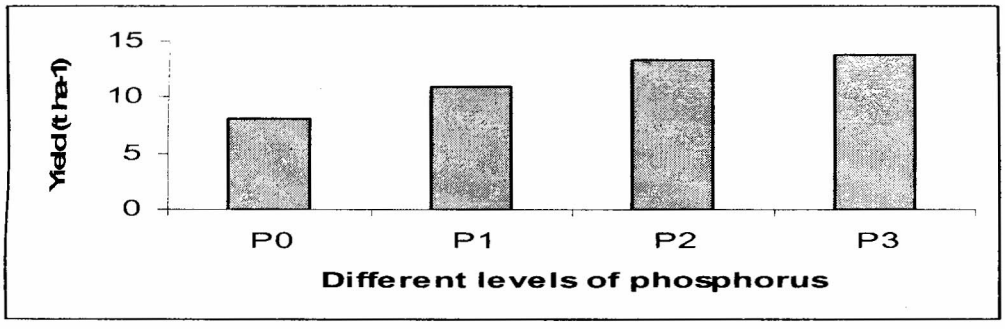

Figure 5. Effect of different levels of phosphorus on yield of broccoli
P_0 = 0 kg P/ha, P_1 = 30kg P/ha, P_2 = 40kg P/ha and P_3 = 50kg P /ha

Shelf life of broccoli: Phosphorus exhibited a significant influence on shelf life of broccoli at different storage conditions viz., open at room temperature, polyethylene bag at room temperature and polyethylene bag in refrigerator at 4°C (Table 3).

Table 3. Effect of different levels of phosphorus and storage condition on shelf life of broccoli

Treatments	Storage condition on shelf life (days) of broccoli.		
	Open at room temperature (24°C)	Polyethylene bag at room temperature (24°C)	Polyethylene bag at refrigerator (4°C)
P_0	2.62 a	6.02 a	17.01 a
P_1	2.18 b	4.83 b	15.49 ab
P_2	1.90 c	4.52 b	14.10 b
P_3	1.69 c	3.70 c	13.30 b
CV (%)	7.33	7.33	7.33
LSD(0.05)	0.2583	0.5824	2.332

Means in the column followed by different letter(s) differed significantly by DMRT at 5% level of significance
P_0 = 0 kg P/ha, P_1 = 30 kg P/ha, P_2 = 40 kg P ha and P_3 = 50 kg P /h

The maximum shelf life (2.62 days) of broccoli was recorded in P_0 and minimum (1.69 days) was recorded in P_3 at room temperature. In case of polyethylene bag at room temperature condition, the maximum shelf life (6.02 days) of broccoli was found in P_0 and minimum (3.70 days) was found in P_3. In case of polyethylene bag at refrigerator condition, the maximum shelf life (17.01 days) of broccoli was found in P_0, which was statistically similar to P_1 and minimum (13.30 days) was found in P_3. It was revealed that the shelf life of broccoli increased with the decrease of P application in all storage conditions. Among the three storage conditions, it was found that the shelf life of broccoli increased in the polyethylene bag at refrigerator condition. This could be due the effect of low temperature in refrigerator. Low temperature minimizes the respiration of broccoli followed by polyethylene bag. Anelli *et al.* (1985), Makhlouf *et al.* (1989) and Tan *et al.* (1993) reported that the cv. Stolto was stored up to 6 weeks at 1°C under different CO_2 and O_2 concentrations.

REFERENCES

Anelli, G. F. Mencaralli and Guaraldi F. 1985. Short storage of *Brassica oleraceae L.* and *Brassica campestris* L. in different types of modified atmospheres. *Acta Hort.*, 157: 177-184.

Demchak, K. T. and Smith, C. B. 1990. Yield responses and nutrient uptake of broccoli as affected by time type and fertilizer. *Amer. Soc. Hort. Sci.*, 115 (5): 737-740.

Dufaults R.J. 1988. Nitrogen and phosphorus requirements for green house broccoli production. *Hort. Sci.*, 23(3): 576-578.

FAO. 1988. The Year Book of production. FAO, Rome, Italy.

Gomez, K.A. and Gomez. 1983. *Statistical Procedures for Agricultural Research.* John Wiley and sons. N. Y. P. 200-215.

Katyal, S.L. 1994. *Vegetable growing in India.* Mohan primiani, Oxford and IBH publishing. 66, Janapath; New Delhi-110001; 45p.

Kumar, R., Ahalawat, V.P. and Daulata, B.S. 1993. Growth, yield and quality attributes of keno as affected by nitrogen and phosphorus application. *Haryana J. Hort. Sci.* 22: 8-13.

Lincolin, C.P. 1987. *Vegetable characteristics, production and marketing.* John Wiley and sons. Inc. New York. 217p.

Makhlouf. J., Castaigne, F., Arul, J., wilemot, C. and Gosselion A., 1989. Long term storage of broccoli under control atmosphere. *Hort. Sci.* 24(4): 637-639.

Mishra, G.U.and Indulkarl, B. S. 1993. Effect of phosphorus and boron on cauliflower. *Veg. Sci.* 49: 83-86.

Mital, R.K., Singh, T., Bhagat, M. and Maheshwari, K.P. 1975. Response of broccoli to nitrogen and row spacing. *Indian J. Agron.* 20(3): 278-279.

Nonnecke, I. L. 1989. *Vegetable production.* Van Nostrand Reinhold, NewYork. pp.394-399

Pieters, J.H. 1976. Effect of supplementary nitrogen manuring of sprouting broccoli for multiple harvesting. Bedrijsont wikkeling. 7(2): 111-115.

Rashid, M.M. 1976. *Bangladesher sabji.* First edition, Bangla Academy, Dhaka. 283p.

Raut, K.R. and Keder, V.P. 1980-1981. Effect of fertilizer levels and plant growth regulators on growth and yield of cauliflower. *Coll. Agric. Nagpur, Mag.* 53: 73-75.

Reddy, A. R., Padmaja, G. 2005. Effect of phosphorus and Zinc on curd yield and quality of cauliflower. *J. Res. ANGRAU,* 33(1): 65-98.

Saimbhi, M.S., Singh, K. and Padda, D.S. 1969. Influence of nitrogen and phosphorus fertilization on the yield and curd size of cauliflower. *Punjab. Hort. J.* 9: 188-202.

Sharma, S.K., Sharma, R, Korla, B. N. 2002. Effect of nitrogen and phosphorus on the growth and seed yield of sprouting broccoli cv. Green head. *Hort. J.* 15(2): 87-90.

Shoemaker, J.S., Benjamin, J.E. and Teskey. 1962. *Practical Horticulture.* John wiley & sons. Inc. New York. 219p.

Singh, A. K. 2004. Effect of nitrogen and phosphorus on growth and curd yield of cauliflower var. snowball-16 under cold arid region of Ladakh. *Haryana J. Hort. Sci.* 33(1&2): 127-129.

Singh, R.D., Tiwari, S.N., Singh, B.B., and Seth, J.N. 1976. Effect of nitrogen and potash on growth and curd yield of cauliflower variety Snowball-16. *Prog. Hort.* 7(4): 31-34

Singh, A.K, Singh, A., Singh, A. 2000. Influence of nitrogen and potassium on growth and head yield of broccoli (*Brassica oliracea.* var. *italica*) under low hills sub-tropical condition of Himachal Pradesh. *Veg. Sci.* 27(1):99-100

Tan, S.C., Bandarage, A., Haynes, Y. and Phillips, D. 1993. Storage characteristics and quality of four broccolis. *Aust. J. Exp. Agric.* 33 (1): 111-113.

Thompson, H.C. and Kally, W.C. 1957. *Vegetable crops.* Fifth edition. Mcgrow Hill Book Co. 6 New York, Tornoto, London. 307p.

Tindall, H.D. 1983. *Vegetables in the tropics.* Macmillan Education Ltd. Basingstoke Hampshire, London.

Ying, W.G., Zheng, Z.C. and Fushan, Z. 1997. Effect of nitrogen, phosphorus and potassium fertilizer on the yield and physiology target of broccoli. *China Veg.* 1: 14-17