

Yield and Nutritional Quality of Cabbage as Affected by Nitrogen and Phosphorus Fertilization

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Abstract

An experiment was conducted in field condition to study the effect of nitrogen-phosphorus fertilization on growth, yield and nutrient content of cabbage. The experiment was laid out in randomized block design with three replications. The yield and yield components were maximized by N₃P₂ fertilizer treatment. Nutrient content of cabbage varied with fertilizer treatment. The maximum amount of reducing sugar, ascorbic acid, phosphorus were found at the highest rate of N - P fertilization whereas accumulation of titrable acidity, iron, calcium were maximum at the rate of N₂P₂ treatment. However pH, ash content were more or less same throughout the experiment.

Introduction

Cabbage is an important and nutritious winter leafy vegetable in our country. It contains a range of essential vitamins and minerals as well as small amount of protein and good caloric value. In recent years vegetable consumption has increased. However, the productivity of cabbage per unit area is quite low as compared to the developed countries of the world.¹ Among the various factors involved nutrient supply is an important input for realizing higher cabbage yield and its nutrient content. Experimental evidence showed that the response of cabbage is high

to nitrogen application and moderate to phosphorus application.²⁻³ Several authors reported the importance of N-P fertilizer on the productivity and nutritional quality of cabbage.⁴⁻⁵ The information regarding N-P fertilizer on cabbage yield and its nutritional quality is very meagre in our local climatic condition. Therefore, attempts have been made in the present investigation to study the response of various level of nitrogen-phosphorus application on cabbage yield and its nutrient content.

Materials and Methods

The experiment was carried out at BCSIR agronomic field Dhaka during rabi season 2002-2003 using the variety Atlas-70. The soil of the experimental field was sandy clay loam having a pH 5.8, 1.52 % organic matter and 0.04 % total nitrogen, available sulphur (10 ppm), available phosphorus (15 ppm). The experiment was laid out in a randomized block design with three replications. The unit plot size was 3m x 6m. The row to row and plant to plant spacing were 60 and 40 cm respectively. The nitrogen fertilizer doses under study were 60 kg N/ha (N_1), 120 kg N/ha (N_2), 180 kg N/ha (N_3), and that of phosphorus were 30 kg P_2O_5 / ha (P_1), 60 kg P_2O_5 / ha (P_2) and 90 kg P_2O_5 / ha (P_3). The source of nitrogen and phosphorus were urea and triple super phosphate respectively. At the time of land preparation nitrogen and phosphorus were applied in the field. All the intercultural operation were done in proper time. At harvest time 10 plants were selected at random from each plot to collect data on plant height and yield components were recorded on the selected plants. The total yield were recorded from the whole plot. Each individual cabbage was divided longitudinally in four equal parts. Only composite sample taken from these parts were used for the determination of moisture, protein, total sugar, reducing sugar and titrable acidity by standard method of AOAC.⁶ The pH and total soluble solids (TSS) were determined by using standard pH meter and Abb's Refractometer respectively.

Ash was determined by heating sample at 600^o C for six hours or until a constant weight was reached. Vitamin C was analyzed by the titrimetric method using 2, 6, dichlorophenol-indophenol dye.⁷ The minerals were determined by the method described in a Manual of Laboratory Techniques.⁸ The collected data were statistically analyzed following the principles of analysis of Variance and Duncan's New Multiple Range Test.⁹

Results and Discussion

The results on the effect of nitrogen and phosphorus on the growth, yield components have been presented in Table I.

The maximum plant height (23.31cm) was recorded with the application of 180 kg N and 30 kg P_2O_5 per hectare which is closely followed by N_2P_3 treatment (22.50 cm). The minimum plant height was recorded from control treatment. The maximum head diameter of cabbage (20.41 cm) was produced from the plot receiving fertilizer at the rate of 180 kg N + 60 kg P_2O_5 per hectare. This is followed by N_3P_1 treatment. These two treatments are significantly different from the rest of the treatments. K. Srinivas recorded increase head diameter of cabbage by increased N application with P-fertilizer.¹⁰ The head thickness size of cabbage were found to vary 12.00 cm to 15.42 cm. The maximum weight of cabbage per plant was noticed at N_3P_2 treatment. The 2nd highest per plant was obtained from N_3P_1 treatment. The results indicate that N and P had a

Table I. Effect of nitrogen-phosphorus fertilization on growth and yield component of cabbage.

Fertilizer treatments	Plant height (cm)	Head size diameter (cm)	Head size thickness (cm)	Total Weight/ plant (kg)	Edible Weight/ plant (kg)	Cabbage yield (t/ha)
Control	19.10 b	17.90 c	12.00 c	1.60 b	1.20 c	45.71 c
N ₁ P ₁	19.41 b	18.21 c	12.25 c	1.67 b	1.25 bc	46.12 c
N ₁ P ₂	19.50 b	18.22 c	13.51 b	1.98 bc	1.60 abc	53.60 b
N ₁ P ₃	21.71 ab	19.13 b	13.62 b	1.99 bc	1.62 abc	53.41 b
N ₂ P ₁	21.53 ab	19.19 b	14.60 ab	2.00 bc	1.61 abc	53.79 b
N ₂ P ₂	21.70 ab	19.13 b	14.71 ab	2.47 ab	1.68 ab	58.89 ab
N ₂ P ₃	22.50 a	19.18 b	14.58 ab	2.48 ab	1.72 ab	59.41 ab
N ₃ P ₁	23.31 a	20.39 a	15.40 a	2.85 a	1.82 a	64.50 a
N ₃ P ₂	22.41 a	20.41 a	15.42 a	2.88 a	1.85 a	65.11 a
N ₃ P ₃	21.80 ab	19.20 b	14.57 ab	2.48 ab	1.72 ab	59.12 ab

* Means with the same letter are not different from one another at the 5 % level of significance.

pronounced effect on the yield of cabbage. The maximum cabbage yield 65.11 t/ha was found from the plot receiving fertilizer at the rate of 180 kg N + 60 kg P₂O₅ per hectare. The yield production increase progressively with the increase amount of N-fertilizer along with phosphorus fertilizer. Similar results were reported by F. M. Humadi *et al.* and Mohans *et al.*¹¹⁻¹²

The highest amount of total solid in cabbage was found at N₃P₃ treatment. It was significantly higher than the rest of the treatments. The next value was obtained from N₃P₂ treatment. Control treatment produced the lowest amount of total solid. The protein content of cabbage was found maximum from the plot receiving fertilizer at the rate of 180 kg N + 60 kg P₂O₅ kg/ha. It was closely

followed by N₃P₃ treatment. The results are in partial agreement with the results of Tanaka *et al.*¹³ who found higher content of protein by using higher amount of nitrogen level. The maximum amount of TSS was found from N₃P₂ treatment which is closely followed by N₃P₃ treatment. Lowest value of TSS are found in control and N₁P₁ treatment. The change of pH and ash component was insignificant during the growth period of cabbage in the experiment. Reducing sugar content was found maximum from N₃P₃ treatment. The 2nd highest was obtained from the plot receiving fertilizer at the rate of 180 kg N + 60 kg P₂O₅ kg/ha. The treatments N₂P₂ and N₂P₃ have same value of reducing sugar. The range of titratable acidity in cabbage is between 34.54 to 41.27. The highest value produced from N₂P₂ treatment.

Table II. Effects of nitrogen-phosphorus fertilization on total solid, protein, total soluble solid, ash, pH, reducing sugar, titratable acidity content of cabbage. (amounts per hundred g of edible portion).

Fertilizer treatments	Total solid (g %)	Protein (g %)	Total soluble solid (g %)	Ash (g %)	pH	Reducing sugar (g %)	Titratable acidity (mg citric acid equivalent)
Control	5.96 c	1.13 c	4.36 c	0.38 a	6.40 a	1.81 b	34.54 c
N ₁ P ₁	5.98 c	1.25 c	4.36 c	0.38 a	6.40 a	1.82 b	39.25 bc
N ₂ P ₁	6.15 b	1.35 bc	4.38 c	0.37 a	6.40 a	1.83 b	39.24 bc
N ₃ P ₁	6.16 b	1.40 b	5.52 b	0.39 a	6.39 a	1.82 b	40.86 ab
N ₁ P ₂	6.13 b	1.34 bc	5.53 b	0.38 a	6.39 a	1.82 b	40.86 ab
N ₂ P ₂	6.16 b	1.49 ab	5.59 b	0.38 a	6.41 a	1.90 ab	41.27 a
N ₃ P ₂	6.30 a	1.56 a	5.59 b	0.36 a	6.41 a	1.90 ab	40.87 ab
N ₁ P ₃	6.14 b	1.41 b	5.59 b	0.37 a	6.39 a	1.91 ab	40.85 ab
N ₂ P ₃	6.15 b	1.40 b	6.71 a	0.38 a	6.40 a	2.13 a	39.26 bc
N ₃ P ₃	6.15 b	1.41 b	6.22 ab	0.38 a	6.40 a	2.15 a	39.27 bc

* Means with the same letter are not different from one another at the 5 % level of significance.

Table III. Effects of nitrogen-phosphorus fertilization on ascorbic acid, iron, phosphorus, calcium, sodium and potassium content of cabbage (amount per hundred g of edible portion).

Fertilizer treatments	Ascorbic acid (mg %)	Iron (mg %)	Phosphorus (mg %)	Calcium (mg %)	Sodium (mg %)	Potassium (mg %)
Control	11.04 c	0.40 c	14.10 c	24.21 b	16.29 c	111.14 b
N ₁ P ₁	11.10 c	0.42 c	14.12 c	24.30 b	17.31 c	111.19 b
N ₁ P ₂	11.39 bc	0.47 b	14.43 bc	24.31 b	18.37 b	113.11 ab
N ₁ P ₃	11.39 bc	0.46 b	14.41 bc	25.78 ab	18.40 b	113.20 ab
N ₂ P ₁	11.40 bc	0.55 a	14.45 bc	27.07 a	19.15 a	113.20 ab
N ₂ P ₂	11.41 bc	0.56 a	14.74 b	27.09 a	18.39 b	113.22 ab
N ₂ P ₃	11.61 b	0.55 a	14.72 b	25.92 ab	18.39 b	113.21 ab
N ₃ P ₁	11.62 b	0.49 ab	14.76 b	25.89 ab	18.36 b	114.51 a
N ₃ P ₂	11.64 b	0.48 ab	14.78 b	25.88 ab	17.31 c	114.49 a
N ₃ P ₃	13.10 a	0.49 ab	15.46 a	25.91 ab	18.32 b	114.50 a

* Means with the same letter are not different from one another at the 5 % level of significance.

The highest rate of N - P fertilizer gave the highest concentration of vitamin C. The mean value of vitamin C was found to be 13.10 (mg/100 g) at N₃P₃ treatment. It was significantly higher than the rest of the treatments. Ram *et al* found increased amount of ascorbic acid in cabbage by increasing fertilizer rate.¹⁴ The next value (11.64) was by N₃P₂ treatment. Iron content in cabbage varied from 0.40 to 0.56 (mg/100 g). The highest value of iron were found from N₂P₂, N₂P₁ treatment which is closely followed by N₂P₃ treatment. The range of phosphorus accumulation in cabbage was 14.10 - 15.46 (mg %). The plot receiving N - P fertilizer at the rate of 180 kg N + 90 kg P₂O₅/ha produced maximum concentration of phosphorus. The value is highly significant among the rest of treatment. Calcium content varied from 24.21 to 27.09 (mg/100 g). The highest value at N₂P₁ treatment where as the lowest at control plot. The accumulation of sodium was found to vary 16.29 to 19.15 (mg/100 g). The highest accumulation of sodium was found from N₂P₁ treatment. Potassium concentration ranged between 111.14 to 114.51 (mg/100 g), the lowest value being recorded from the control treatment.

Conclusion

The finding of the study indicate that application of nitrogen-phosphorus treatment improve the yield contributionary characters of cabbage leading to higher yield and better nutrition concern. So further research is

needed in this direction with other varieties of cabbage to establish the present finding.

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References

1. Anonymous. Food and Agriculture Organization of United Nation. Rome Production. Year Book. **41**(1987) 176-177.
2. S. C. Mallik, B. B. Charya. Effect of different levels of nitrogen and different spacing on growth and yield of cabbage. *Environment and Ecology*. **14**(2) (1996) 304-306.
3. F. Vice and J. Polach. Effect of principal plant nutrient on cabbage yield and quality. *Hort. Abst.* **50** (1980) 535.
4. N. H. Peck, L. D. Grunes, R. M. Welch and G. E. Mac Denald. Nutritional quality of vegetable crop as affected by phosphorus and zinc fertilizer. *Agron. J.* **72**(3) (1980) 528-534.
5. J. Murkinski. Effect of mineral fertilizer on some nutrient values indices of cabbage. *Soil and Fertilizer*. **37**(8) (1973) 235.
6. Official Method of Analysis of A.O.A.C. 1984 14th Ed. Virginia. U. S. A.

7. D. Pearson. *The Chemical Analysis of Foods*. (1976). Churchill, Livingstone Edinburg. London.
8. *A Manual of Laboratory Techniques*. Indian Council of Medical Research. (1971) Hyderabad. India.
9. R. G. D. Steel and J. H. Torrie. *Principles and Procedures of Statistics*. Mc. Graw Hill Book Co. Inc. New York. (1960) 109
10. K. Srinivas. Growth yield of cabbage as spacing and fertilizer. *Singapore Journal of Primary Industries*. **10(1)** (1982) 58-63.
11. F. M. Humadi and H. A. A. Hadi. Effect of different source and rates of nitrogen and phosphorus fertilizer on the yield and quality of cabbage. *Journal of Agric. and Water Resource Plant Production*. **7(2)** 1988.249-59.
12. B. K. Mohans and M. M. Hossain. A role on effects of nitrogen and phosphorus on cabbage. *Orissa Journal of Horticulture*. **26(1)** (1998) 106-108.
13. T. Tanaka and T. Sato. Growth and nutrient absorption characteristics of three commercial cabbage cultivar under varying nitrogen levels. *Japanese Journal of Soil Science and Plant Nutrition*. **68(5)** (1997) 493-500.
14. K. Ram and R. K. Sharma. Effect of nitrogen supply on growth yield and ascorbic acid content of cabbage. *Poon. Agric. Coll. J.* **59 (122)** (1969) 25-29.