The Pharma Innovation Journal 2023; 12(3): 3113-3116

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(3): 3113-3116

www.thepharmajournal.com
Received: 09-01-2023
Accepted: 12-02-2023

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Impact of macronutrient levels on head quality of broccoli (*Brassica oleracea* var. *italica*)

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Abstract
This study was conducted to determine the effects of macronutrients *viz*. nitrogen (N), phosphorous (P) and potassium (K) doses on quality of broccoli heads, having four nitrogen levels *viz*. 80 (N_1), 120 (N_2), and 160 (N_3) kg N/ha; three P levels: 40 (P_1), 60 (P_2), and 80 (P_3) kg P_2O_5/ha; and two K levels: 0 (K_1) and 60 (K_2) kg K_2O/ha. Experiment revealed that quality characters were significantly influenced by N, P and K and their interaction. Head quality characters *viz*., vitamin C content recorded maximum with N_2 (120 kg N/ha) and P_2 (60 kg P_2O_5/ha) but not affected by K levels, crude fiber content decreased with increasing levels of N, P and K, total carbohydrate content not differed significantly under varying macronutrient levels. Chlorophyll content observed significantly superior under P_3 (80 kg P_2O_5/ha) but not affected by N and K levels. Therefore application 120 kg N, 60 kg P_2O_5 and 0 kg K_2O/ha along with bio-compost 5 t/ha can be recommended for getting better quality of broccoli head under these conditions.

Keywords: Broccoli, quality, vitamin C, crude fiber, carbohydrate, chlorophyll

Introduction
Broccoli recently risen to the top of the list of foods that are most frequently consumed due to its rich nutritional value and medicinal content. Several researches claim that broccoli has antioxidant and anticancer properties. The vitamins C and E, phenolics, and carotenoids in broccoli are responsible for its antioxidative properties. In terms of food production efficiency, broccoli is among the vegetables with the highest nutritional value. Moreover, studies have demonstrated the effectiveness of broccoli in preventing various malignancies (Yoldas *et al.*, 2008) [1]. Based on FAO statistics [2], in 2020, the global production of broccoli and cauliflower was 25.5million tons from an area of 1.36 million hectares. Fertilizer management techniques have an impact on a number of broccoli quality traits as well as diseases or problems. Increased nitrogen availability speeds up the production of chlorophyll and amino acids (Delvin, 1973) [3]. Babik and Elkner (2002) [4] found that broccoli had the highest ascorbic acid concentration at moderate N levels (400 kg ha-1), and that the sugar content and colour of the broccoli increased with higher N rates. In the same vein, raising phosphorus levels boosted broccoli plant growth, yield, and head quality, according to Brahma and Phookan (2006) [5] and Islam *et al.* (2010) [6]. According to Abdel *et al.* (2013) [7], the interactions between compost, biofertilizers, and 75 percent NPK improved carrot plant quality and yield. According to Hassan *et al.* (2013) [8], the application of rock phosphate fertiliser at 100 units P_2O_5/fed. in Egypt resulted in the highest grade broccoli plants in terms of TSS (8.27 percent). Depending on the soil, climate, plant density and cultivation methods, the amount of applied nutrients regarded as ideal for broccoli may fluctuate widely. In order to comprehend the impact of various N, P and K fertiliser combinations on broccoli nutritional content and quality indicators in clayey soils of south Gujarat, the current study was carried out.

Materials and Methods
The experiment was laid out in a randomized complete block design during the rabi seasons of 2017, 2018 and 2019 at the Soil and Water Management Research Farm, Navsari Agricultural University, Navsari, with three replications having three nitrogen levels *viz*. 80 (N_1), 120 (N_2), and 160 (N_3) kg N/ha; three P levels: 40 (P_1), 60 (P_2), and 80 (P_3) kg P_2O_5/ha; and two K levels: 0 (K_1) and 60 (K_2) kg K_2O/ha. There were a total of 18 different treatment combinations. There was also one control treatment present. The Urea, SSP and MOP were the source of N, P and K, respectively for the crop. A 50 percent dose of N and full dose of P was applied as basal, while second dose of N (25%) was applied 30 days after transplanting

(DATP) and third dose of N (25%) was applied before head emergence.

A common dose of biocompost was applied at 10 t/ha. Nursery was raised in low cost net house of the station and one month old healthy seedlings of broccoli cv. TSX-0788 F1 were transplanted with a spacing of 45×30 cm on a gross plot of 4.5×3.6 m (10 lines each of 12 plants) and net plot of 2.7×2.4 m size. Irrigation with good quality water was applied during the growth period of the crop as flood irrigation. To determine quality parameters, five broccoli heads of good size from each plot of each replication from the sampling site at the time of harvesting. The dried samples were analyzed for various quality parameters using standard method as described in A.O.A.C. (2006) [9]. The data collected on quality characters of broccoli were subjected to statistical analysis. The method of analysis of variance for factorial randomized block design was adopted using the method as described by Panse and Sukhatme (1978) [10].

Results and Discussion

Vitamin C content

Vitamin C content in the broccoli flower head in relation with different levels of N, P and K treatments were determined and presented in Table 1. Application of 120 kg N/ha (N_2) resulted significantly the highest Vitamin C content (79.17 mg/100g) in broccoli flower head and the lowest content of 58.87 mg/100g was recorded by the treatment N_1 (80 kg N/ha).The treatment P_2 (60 kg P_2O_5/ha) caused highest vitamin C content of 73.72 mg/100g in broccoli flower head. Application of 40 kg P_2O_5/ha (P_1) recorded significantly the lowest vitamin C content (58.28mg/100g) in broccoli flower head. The application of potash showed non-significant difference in vitamin C content of the broccoli flower head in pooled analysis. Control v/s rest analysis, in all the cases the treatment mean recorded higher vitamin c content of broccoli as compared to control.

The values of vitamin C content of broccoli flower head in various combinations arising from the integration of N, P and K treatments were observed significant (Table 2).Treatment combination $N_2P_3K_1$ recorded significantly higher vitamin C content (83.13 mg/100g) and was at par with $N_2P_1K_2$, $N_2P_2K_2$ and $N_2P_2K_1$ treatment combination (Table 2). Sorenson (1999) [11] as well as Babik and Elkner (2002) [12] who found out that increasing nitrogen application lowered the vitamin C content in broccoli and cabbage. Applied P levels increases tissue N levels and as a result, with increasing levels of P, vitamin C content also fall down.

Crude fiber content

Crude fiber content in broccoli flower head was determined and the results obtained are presented in Table 1. Results regarding crude fiber content in broccoli flower head as influenced by different levels of N showed significant difference during experimental period and in pooled analysis. The crude fiber content of 2.11 percent in the broccoli flower head was found significantly highest under the treatment N_1 (80 kg N/ha). Significantly lower value of crude fiber content (1.19 percent) was observed in treatment N_3 (160 kg N/ha). Significantly higher value of crude fiber content (2.08 percent) in broccoli flower head was recorded due to the application of 40 kg P_2O_5/ha (P_1), while its significantly lower content (1.26 percent) was associated with the treatment P_3 (80 kg P_2O_5/ha).The treatment K_1 (0 kg P_2O_5/ha) caused significantly the highest crude fiber content (1.75 percent) in broccoli flower head. Application of 60 kg P_2O_5/ha (P_1) recorded significantly the lowest crude fiber content (1.44 percent) in broccoli flower head. Control v/s rest analysis, in all the cases the treatment mean recorded higher crude fiber content of broccoli as compared to control.

The blend of various treatments of N, P and K were reached to the significant level for crude fiber content of the crop. Treatment combination $N_1P_2K_2$ recorded significantly higher crude fiber content (2.97 percent) and was at par with $N_2P_1K_1$, $N_1P_1K_1$, $N_1P_1K_2$ and $N_3P_1K_1$ treatment combination (Table 2). Increasing the rate of N application decreased the dietary fiber of broccoli, which could be related to the decrease in the cellulose, hemicellulose, lignin and pectin contents with increase in N fertilizer (Babik and Elkner, 2002) [12]. Sorenson (1984) [13] also noticed similar decrease in crude fiber content of cabbage with increased N fertilization.

Total carbohydrate content

The mean data of total carbohydrate content in broccoli are presented in Table 1. Individual levels of N, P and K were failed to produce significant effect on total carbohydrate content in flower head. Control v/s rest analysis, in all the cases the treatment mean recorded higher total carbohydrate content of broccoli as compared to control. However, treatment combination $N_2P_3K_1$ recorded significantly higher total carbohydrate content (14.68 percent) and was at par with $N_1P_2K_1$, $N_2P_1K_1$, $N_2P_2K_2$ and $N_3P_3K_1$ treatment combinations (Table 3). These results are maintained by the results of Yano *et al*., 1981[14]; Hara, 1989 [15] and Takebe *et al*., 1995 [16].

Chlorophyll content

The chlorophyll content in the broccoli flower head was determined and its data recorded under the various treatments are exhibited in Table 1. A perusal of the data presented in Table 1, indicated that different treatments of N and K on broccoli were failed to produce significant effect on chlorophyll content in flower head in the pooled results. Control v/s rest analysis, in all the cases the treatment mean recorded higher chlorophyll content of broccoli as compared to control. The values of chlorophyll content of broccoli flower head in various combinations arising from the integration of N, P and K treatments were observed significant. Treatment combination $N_1P_3K_1$ recorded significantly highest chlorophyll content (127.56mg/100g) in pooled analysis (Table 3). These results may be due to adding suitable fertilizer dose gave a good chance for the vegetative growth by the positive effect of N, P and K on the biological status, which led to rapid absorption, that improved clearly vegetative growth of plant organs by increasing chlorophyll and carbohydrates formation, increment of photosynthesis rate which reflected on the improvement of aforementioned parameters. These results are in harmony with those obtained by Islam *et al.* (2010) [17] and Giri *et al.* (2013) [18] on broccoli.

Table 1: Vitamin C and crude fiber content in broccoli head as influenced by different treatments (Pooled)

N- Levels	Vitamin C (mg/100g)	Crude fiber content (%)	Carbohydrate (%)	Chlorophyll (mg/100 g)
N1	58.87	2.13	11.57	90.64
N2	79.17	1.51	12.52	90.95
N3	61.50	1.19	11.72	85.11
S.Em ±	0.66	0.02	0.36	3.46
C.D. @ 5%	1.86	0.06	NS	NS
P-Levels				
P1	58.28	2.08	11.89	75.08
P2	73.72	1.45	12.11	87.07
P3	67.54	1.29	11.80	104.55
S.Em ±	0.66	0.023	0.36	3.46
C.D. @ 5%	1.86	0.064	NS	9.70
K-Levels				
K1	67.14	1.76	12.08	87.63
K2	65.88	1.46	11.79	90.17
S.Em ±	0.54	0.02	0.30	2.82
C.D. @ 5%	NS	0.05	NS	NS
Treatment Mean	66.51	1.61	11.94	88.90
Control	46.75	1.11	15.95	59.33
Control v/s treatment				
S.Em ±	2.75	0.10	1.60	14.52
C.D. @ 5%	7.72	0.28	4.48	40.71
C.V %	7.31	10.481	22.25	28.59
Sig. Int.	N x P, P x K, N x K, NPK	N x P, P x K, N x K, NPK	N x P, P x K, N x K, NPK	N x P, P x K, N x K, NPK

Table 2: Interaction effect of N, P and K levels on vitamin c and crude fiber content in broccoli head (Pooled)

	Ascorbic acid (mg/100g)							Crude fiber content (%)					
NPK	N1		N2		N3		NPK	N1		N2		N3	
	K1	K2	K1	K2	K1	K2		K1	K2	K1	K2	K1	K2
P1	33.98	36.31	73.20	80.31	59.79	66.10	P1	2.47	2.39	2.48	1.77	2.23	1.18
P2	75.13	66.44	80.24	81.40	73.14	65.96	P2	2.02	2.97	0.97	0.86	0.71	1.17
P3	76.10	65.29	83.13	76.71	49.60	54.41	P3	1.92	1.03	1.89	1.07	1.17	0.68
SEm±	1.62			CD at 5%		4.54	SEm±	0.06	CD at 5%		0.16		

Table 3: Interaction effect of N, P and K levels on Carbohydrate and chlorophyll content in broccoli head (Pooled)

	Carbohydrate (%)						Chlorophyll (mg/100g)					
NPK	N1		N2		N3		N1		N2		N3	
	K1	K2	K1	K2	K1	K2	K1	K2	K1	K2	K1	K2
P1	11.55	11.41	13.23	12.06	11.29	11.80	67.61	81.00	78.22	76.67	69.33	77.67
P2	13.76	11.85	10.49	13.21	11.08	12.30	62.22	94.31	76.96	114.78	92.67	81.49
P3	9.55	11.32	14.68	11.42	13.08	10.75	127.56	111.16	111.00	88.07	103.10	86.40
SEm±	0.89	CD at 5%		2.48			8.47	CD at 5%		23.76		

Conclusion

Head quality characters *viz*., vitamin C content recorded maximum with N_2 (120 kg N/ha) and P_2 (60 kg P_2O_5/ha) but not affected by K levels, crude fiber content decreased with increasing levels of N, P and K, total carbohydrate content not differed significantly under varying macronutrient levels. Chlorophyll content observed significantly superior under P_3 (80 kg P_2O_5/ha) but not affected by N and K levels. Therefore application 120 kg N, 60 kg P_2O_5 and 0 kg K_2O/ha along with bio-compost 5 t/ha can be recommended for getting better quality of broccoli head under these conditions.

Acknowledgments

We are most grateful to Research Scientist, Soil and Water Management Research Unit, NAU, Navsari for his valuable advice, keen support and interest.

References

1. Yoldas F, Ceylan S, Yagmur B, Mordogan N. Effects of nitrogen fertilizer on yield quality and nutrient content in broccoli. Journal of Plant Nutrition. 2008 Jun 18;31(7):1333-43.
2. FAOSTAT D. Crops and livestock products. Statistics Division, Food and Agriculture Organization of the United Nations: Rome, Italy. 2022 Mar 29.
3. Delvin RM. Plant physiology. Ind. Ed, Affliated East West Press, pvt. Ltd., New Delhi, 1973, 446.
4. Babik I, Elkner K. The effect of nitrogen fertilization and irrigation on yield and quality of broccoli. InWorkshop Towards and Ecologically Sound Fertilisation in Field Vegetable Production 571. 2000 Sep; 11:33-43.
5. Brahma S, Phookan DB. Effect of nitrogen, phosphorus and potassium on yield and economics of broccoli [*Brassica oleracea* (L.) var. *italica*] cv. Pusa Broccoli KTS 1. Research on Crops. 2006;7(1):261.
6. Islam MH, Shaheb MR, Rahman S, Ahmed B, Islam AT, Sarker PC. Curd yield and profitability of broccoli as affected by phosphorus and potassium. International Journal of Sustainable Crop Production. 2010 May;5(2):1-7.

7. Abdel Naby HM, Dawa KK, El-Gamily EE, El-Hameed A, Samar M. Effect of organic, bio and mineral fertilization on yield and quality of carrot plants. Journal of Plant Production. 2013 Feb 1;4(2):335-49.
8. Hassan HA, Ahmed MY, El-Magd MM, Anwar MT. Effect of different phosphorus fertilizer rates and foliar spray with some commercial nutrients on growth and yield of broccoli grown in sandy soils. Journal of Applied Sciences Research. 2013;9(3):2052-62.
9. AOAC (Association of Official Analytical Chemist). Official Methods of Analysis of the AOAC. In: Horwitiz, W. (Ed.). 18th Edn. Association of Official Analytical Chemists, Washington D.C., USA; c2006.
10. Panse VG and Sukhatme PV. Statistical Methods for Agricultural Workers, I. C. A. R., New Delhi, India; c1978.
11. Sorensen J. Nitrogen effects on vegetable crop production and chemical composition. InInternational Workshop on Ecological Aspects of Vegetable Fertilization in Integrated Crop Production 506. 1998 Jul 27:41-50.
12. Babik I, Elkner K. The effect of nitrogen fertilization and irrigation on yield and quality of broccoli. InWorkshop Towards and Ecologically Sound Fertilisation in Field Vegetable Production 571 2000 Sep 11;33-43.
13. Nygaard Sørensen J. Dietary fiber and ascorbic acid in white cabbage as affected by fertilization. In Symposium on Quality of Vegetables 163 1984 Jun 18;221-230.
14. Yano M, Ito H, Hayami A, Obama S. Effect of cultural practices on the quality of vegetables. I. Sugar contents of cabbage and carrot. Hokoku. Bulletin of the Vegetable and Ornamental Crops Research Station. Series A. 1981. HARA T. Effects of nitrogen, phosphorus and potassium in culture solution on the head yield and free sugar composition of cabbage. Journal of the Japanese Society for Horticultural Science. 1989;58(3):595-9.
15. Takebe M, Ishihara T, Matsuno K, Fujimoto J, Yoneyama T. Effect of nitrogen application on the contents of sugars, ascorbic acid, nitrate and oxalic acid in spinach (*Spinacia oleracea* L.) and komatsuna (*Brassica campestris* L.). Japanese Journal of Soil Science and Plant Nutrition (Japan). 1995;66:238-46.
16. Giri RK, Sharma MD, Shakya SM, Yubak Dhoj GC, Kandel TP. Growth and yield responses of broccoli cultivars to different rates of nitrogen in western Chitwan, Nepal.
17. Islam MH, Shaheb MR, Rahman S, Ahmed B, Islam AT, Sarker PC. Curd yield and profitability of broccoli as affected by phosphorus and potassium. International Journal of Sustainable Crop Production. 2010 May;5(2):1-7.