I J T A
© Serials Publications
National Academy of Agricultural Science (NAAS) Rating : 3.03

Effect of N and P Levels on Growth and Yield Parameters of Broccoli (*Brassica oleracea* L. Var. *italica*) under South Gujarat soil conditions

***Neethu T. M.[1], S. M. Tripathi[2], A. V. Narwade[2] and S Sreeganesh[2]**

ABSTRACT: *A field experiment was undertaken during winter2012-13 at Polytechnic College (Hort.) Farm, N.A.U., Navsari under South Gujarat heavy rainfall zone (AES-III) with four levels of nitrogen viz. 80 (N_1), 120 (N_2), 160 (N_3) and 200 (N_4) kg N ha^{-1} and three levels of phosphorus viz. 40 (P_1), 60 (P_2) and 80 (P_3) kg P_2O_5 ha^{-1} in FRBD to find out the suitable doses of N and P for higher growth and yield of broccoli.There were twelve treatments replicated three times. Application of 160 kg N ha^{-1} (N_3) as well as 80 kg P_2O_5 ha^{-1} (P_3) reported significantly higher (14.30 and 13.84 t ha^{-1}, respectively) flower head yield of broccoli which were found at par with N_4 (200 kg N ha^{-1}) and P_2 (60 kg P_2O_5 ha^{-1}) levels. Similar trend was also observed in respect to different growth parameters viz. plant height, number of leaves $plant^{-1}$, leaf area, along with size of flower head as well as fresh and dry yield of different parts of the crop.*

Key words: *Broccoli, Flower head yield, FRBD and Yield attributes*

INTRODUCTION

Broccoli (*Brassica oleracea*L.var. *Italica*) belonging to the family of Cruciferae is a delicious vegetable and more nutritious than any other vegetables of the same genus [17]. It can be easily distinguished from cauliflower by having a head composed of differentiated flower buds rather than a curd [7]. China is the top producer of broccoli and second position goes to India. It is mostly cultivated in the hilly regions of Himachal Pradesh, Uttar Pradesh, Jammu and Kashmir, Nilgiri hills and Northern plains of India. Broccoli is a heavy feeding plant that requires regular applications of fertilizer during the growing cycle. Being a heavyfeeder, it removes large amount of macro nutrients from the soil [16]. Broccoli has a great demand to nitrogenous fertilizer. The early and rapid vegetative growth of the plant is necessary for soft and succulent head as well as stem for a quality crop that is influenced by the nitrogenous fertilizer. Investigations carried out by different workers have showed that the head yield of broccoli is greatly influenced by N application [8].Balanced dose of nitrogenous, phosphate and potassium is required to increase crop productivity without any adverse effect on environment. Proper application of nitrogenous, phosphate and potassium fertilizers could materially reduce nitrate accumulation in crops [22]. The amount of applied nutrients regarded as optimal for broccoli may vary over a wide range depending on soil, climate, plant density and methods of cultivation. An adequate fertilization programme may ensure profitable and quality produces, and use of sufficient amount and proper combination of fertilizers to increase crop productivity, so that it does not harm environment. An adequate fertilization programme may ensure sufficient plant growth without any risk of nitrate levels going too high [20].

The requirement of fertilizer, which varies according to environmental conditions, has to be determined by actual field trial for any particular soil and climate. Therefore, the present study was undertaken to work out the optimum dose of N and P for yield maximization of broccoli in black soils of South Gujarat.

MATERIAL AND METHODS

For accomplishing the objectives of the study, a field experiment was conducted in winter 2012-13 at

1. Deptt. of Soil Science and Agricultural Chemistry,Navsari Agricultural University, Navsari- 396 450 (Gujarat)
2. Deptt. of Genetics and Plant Breeding, Navsari Agricultural University, Navsari- 396 450 (Gujarat)
**E-mail: neetzmadhavan90@gmail.com*

Polytechnic College (Hort.) Farm, N. A. U., Navsari. Geographically the farm is situated at 20^0 57′ N latitude and 72^0 54′ E longitude with an elevation of 10 meter above Mean Sea Level (MSL) on the western coastal belt of India. The experimental field belongs to AES-III of South Gujarat with the predominant deep black soil.

The experiment was laid out in a randomized complete block design with three replications having four nitrogen levels viz. 80 (N_1), 120 (N_2), 160 (N_3) and 200 (N_4) kg N ha^{-1}along with three levels of Pviz. 40 (P_1), 60 (P_2) and 80 (P_3) kg P_2O_5 ha^{-1}.There were 12 treatment combinations all together. The Urea, SSP and MOP were the source of N, P and K, respectively for the crop. A 50 % 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 and potassium was applied @ 10 t ha^{-1} and 60 kg ha^{-1}, respectively. The 30 days old healthy seedlings of broccoli cv. TSX-0788 F1 were purchased from Regional Horticultural Research Station, Navsari Agricultural University and 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 3.6×3.0 m (8 lines each of 10 plants) size.

BIO-METRIC OBSERVATIONS

Five plants from each net plot of each replication were selected randomly and tagged for recording periodical observations. Bio-metric observations recorded during the course of investigation are described here under:

Plant Height

The plant height (cm) of previously selected five plants from each treatment was measured at harvest and its average was worked out and recorded for each plot.

No. of Leaves $Plant^{-1}$

Number of leaves per previously selected five plants from each treatment was recorded a day before harvest. The mean number of leaves per plant was worked out and recorded for each plot.

Leaf Area

Randomly fifty leaves were collected from each replication before harvesting. The length (L) and breadth (B) of the leaves in cm were measured manually and at the same time, area (cm^2) of individual leaf (A) was measured by Area analyzer machine (ADC Biosynthetic Limited, UK) using WINDIAS software. At the time of harvesting, all the leaves from previously selected five plants of each replication were collected and measured each of their length and breadth (cm) manually. Then correlation between L Vs A, B Vs A and (L×B) Vs A was worked out and they were found positively correlated with correlation coefficient (R^2) of 0.9295, 0.9624 and 0.9827 for L Vs A, B Vs A and (L×B) Vs A, respectively. Since the correlation coefficient of (L×B) Vs A was higher (R^2 = 0.9827), the equation was derived for these two factors to calculate the leaf area $plant^{-1}$ as Y= 0.828X-9.7807 [Y= leaf area $plant^{-1}$ (cm^2), X= L×B (cm)]. Area of each leaf of the plant was calculated using this equation and their total of each plant was computed and mean value was taken as leaf area $plant^{-1}$.

Size of Flower Head

The equatorial and polar diameter (mm) of the flower heads from previously selected five plants of each plot was measured after harvest of the crop using verniercaliper. The average diameter was worked out and recorded for each plot.

Weight of Flower Head, Leaves and Stem ha^{-1}

The fresh and dry weight (g) of flower head, leaves and stems of broccoli from net area of each plot was taken at the time of harvesting and the weight $plot^{-1}$ was converted to weight ha^{-1}.

The data collected for various growth, yield and quality characters of broccoli as well as soil parameters 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[15].

RESULTS AND DISCUSSION

Growth Parameters

Plant height (cm): The differences in plant height at harvest due to various levels of N were found significant, while the effect different levels of P and interaction (N×P) showed non-significant effects (Table 1). Plant height increased significantly with increases in the nitrogen levels from N_1 (80 kg N ha^{-1}) to N_4 (200 kg N ha^{-1}). Significantly higher plant height of 24.99 cm was recorded with the N level of 200 kg ha^{-1} (N_4), however, it was at par with 160 kg N ha^{-1} (N_3) and 120 kg N ha^{-1} (N_2).It is very well theorized that N application boosts plant growth, being one of the most important nutrients with its role in plant metabolism and development. Thus, it is said that N

is responsible for the vegetative growth of broccoli plants. The changes in growth of broccoli due to N were also recorded by different researchers. Yildirim*et al.* [21] reported that soil nitrogen fertilization increased the plant height of broccoli cultivars in all experimental years. Similar finding were also reported by N koa *et al.* [14] and Babik and Elkner [2].

Number of leaves plant^{-1}: The results summarized in Table 1 revealed that No. of leaves plant^{-1} at harvest increased significantly with the application of successive doses of N, whereas the effect of P and interaction were found non- significant. Significantly the highest No. of leaves per plant of 17.87 and the lowest of 15.34 were recorded with the N level of 200 kg ha^{-1} (N_4) and 80 kg ha^{-1} (N_1), respectively. An increase in N supply induced more leaves per plant. This might be due to the fact that N had influenced the vegetative growth of the plant. Moniruzzaman*et al.* [13] found similar results in broccoli.

Leaf area (cm^2): Results of leaf area recorded at harvest as influenced by different treatments of N and P are presented in Table 1. Data pertinent to leaf area at harvest revealed its significant increase with the increasing doses of N as well as P. Significantly the highest leaf area of 5636 cm^2 and 4821cm^{2}was recorded with the treatment N_4 (200 kg N ha^{-1}) as well as P_3 (80 kg P_2O_5 ha^{-1}), respectively. Interaction effect failed to produce a significant leaf area. The observed results might be attributed due to the boosted growth of the broccoli with the increase in the level of N and P. The higher dose of nitrogen enhances the leaf area because nitrogen enhances the growth of plant. Similar results were also observed by Meena and Paliwal[12]in cabbage. Agarkar *et al.* [1] showed the same results. Increase in leaf area due to the application of increase in level of P could be ascribed to its role in photosynthesis, energy storage, cell division and enlargement [18].

Size of flower head: Effect of N and P treatments on size of flower head was computed by measuring equatorial and polar diameter (mm) of flower head and its results are presented in Table 1. The values of equatorial and polar diameter of flower head of broccoli were increased to the extent of 28.59 and 6.08 as well as 23.71 and 5.81 per cent under the treatments N_4 (200 kg N ha^{-1}) and P_3 (80 kg P_2O_5 ha^{-1}) over N_1(80 kg N ha^{-1}) and P_1 (40 kg P_2O_5 ha^{-1}), respectively. However, polar diameter of flower head at N_4 level was at par with N_3 (160 kg N ha^{-1}). The above results of increase in head diameter with increase in levels of N can be attributed to the fact that the increase in level of nitrogenous fertilizers produces more vegetative growth of the plant which in turn leads to higher leaf area and therefore, the photosynthetic area get increases and the head size also get increases. With increase in N levels, higher rate of assimilation and ultimately more synthesis of carbohydrates and their translocation to the storage organ *i.e.* flower head occurs. These results are in conformity with the findings of Brahma *et al.* [4] and Moniruzzaman *et al.* [13] in broccoli. As P has direct role in photosynthesis, increase in levels of P, the size of the flower head also

Table 1
Effect of various levels of N and P on growth parameters of broccoli

Treatments	*Plant height (cm)*	*No. of leaves Plant^{-1}*	*Leaf area (cm^{2}Plant^{-1})*	*Diameter of flower head (mm)*	
				Equatorial	*Polar*
(A) Nitrogen (kg ha^{-1}) (N)					
N_1: 80	21.98	15.34	3797	67.83	60.36
N_2: 120	23.04	16.12	4213	74.50	67.47
N_3: 160	24.19	17.17	4945	77.31	74.16
N_4: 200	24.99	17.87	5636	87.22	74.67
S.Em. ±	0.68	0.20	43	0.74	0.96
C.D. at 5%	2.00	0.59	126	2.18	2.83
(B) Phosphorus (kg P_2O_5 ha^{-1}) (P)					
P_1: 40	23.14	16.34	4489	74.13	67.34
P_2: 60	23.50	16.62	4633	77.38	68.91
P_3: 80	24.00	16.92	4821	78.64	71.25
S.Em. ±	0.59	0.17	37	0.645	0.84
C.D. at 5%	NS	NS	109	1.89	2.45
Interaction (N×P)					
S.Em. ±	1.18	0.35	74	1.29	1.67
C.D. at 5 %	NS	NS	NS	NS	NS
CV %	8.70	3.63	2.77	2.91	4.18

get increases. The P fertilization might have also influenced the head initiation and development of broccoli [9].

Weight of flower head, leaves and stem ha^{-1}: The results of present study (Table 2) clearly indicated that amongdifferent levels of N and P registered maximum fresh and dry yield of broccoli due to the application of 160 kg N ha^{-1} (N_3) and 80 kg P_2O_5 ha^{-1} (P_3) over rest of the treatments exceptfresh yield of leaves and green fodder as well as dry yield of leaves and total dry biomass.The treatments N_3 and P_3 recorded values of 23.27 and 13.44., 41.45 and 6.97., 26.59 and 11.87., 34.83 and 8.68 as well as 36.80 and 9.88 per cent higher fresh along with 24.29 and 13.90., 40.66 and 6.91., 26.73 and 12.37 as well as 29.14 and 10.70 dry yield of flower head,leaves, stem, green fodder and total green biomass than their respective lower levels (N_1 and P_1).

Thakur *et al.* [19] reported that higher N level increased the dry matter production and accumulation. The P fertilization might have influenced the head initiation and development of broccoli. Both N and P have five valence electrons and they have tendency to gain three electrons to become stable. The co-limitation of N and P nutrients can significantly influence plant productivity [9]. Phosphorus at different levels had influenced the yield and yield contributing characters of broccoli [3] and [10]. Increases in total yields from high rates of N were obtained only when an adequate rate of P was applied [5].

Table 2
Effect of various levels of N and P on fresh yield (t ha^{-1}) of different parts of broccoli plant

Treatments	*Flower head*	*Leaves*	*Stem*	*Green fodder (Leaves+Stem)*	*Total green biomass*
(A) Nitrogen (kg ha^{-1}) (N)					
N_1: 80	11.60	20.07	11.77	31.84	43.44
N_2: 120	12.39	22.30	12.77	35.07	49.46
N_3: 160	14.30	26.23	14.90	41.13	59.43
N_4: 200	13.99	28.39	14.54	42.93	56.92
S.Em. ±	0.40	0.45	0.38	0.81	1.30
C.D. at 5%	1.18	1.30	1.12	2.38	3.82
(B) Phosphorus (kg P_2O_5 ha^{-1}) (P)					
P_1: 40	12.20	23.66	12.72	36.38	48.58
P_2: 60	13.17	23.77	13.53	37.30	50.47
P_3: 80	13.84	25.31	14.23	39.54	53.38
S.Em. ±	0.35	0.39	0.33	0.70	1.13
C.D. at 5%	1.03	1.13	0.97	2.06	3.31
Interaction (N×P)					
S.Em. ±	0.70	0.77	0.66	1.40	2.25
C.D. at 5%	NS	NS	NS	NS	NS
CV %	9.26	5.50	8.47	6.44	7.17

REFERENCES

Agarkar, U. R., Dadmal, K. D., Nikas, N. S. and Piwlatkar, G. K. (2009), Effect of nitrogen levels and spacing on growth and yield of broccoli (*Brassica oleracea* var. *italica* L.).*Green farming,* 1(5): 477- 479.

Babik, I. and Elkner, K. (2002), The effect of nitrogen fertilization and irrigation on yield and quality of broccoli. *Acta Hort.,* 571: 33-43.

Brahma, S. and Phookan, D. B. (2006), Effect of nitrogen, phosphorus and potassium on yield and economics of broccoli (*Brassica oleracea* L. var. *italica*) cv. Pusa. Research on crops., 7(1): 261-262.

Brahma, S., Phookan, D. B., Gautam, B. P. and Bora, D. K. (2000), Effect of nitrogen, phosphorus and potassium on production of Broccoli (*Brassica oleracea* L. var. *italica*) cv. KTS-1.*Veg. Sci.,*29(2): 154-156.

Cutcliffe, J. A., Munro, D.C. and Mackey, D. C. (1968), Effect of nitrogen, phosphorus, potassium and manure on terminal, lateral and total yields and maturity of broccoli. *Canada J. Plant Sci.,*48: 438-439.

Delvin, R. M. (1973), Plant physiology. Ind. Ed. Affliated East West Press, pvt. Ltd., New Delhi, pp. 446.

Gray, A. R. (1982), Taxonomy and evolution of broccoli (*Brassica oleracea*Var.*italica*). *Econ. Bot.,* 36: 397.

Haque, M. E., Karim, A. J. M. S., Haider J. and Hossain, T. (1996), Effect of irrigation and nitrogen on the growth and yield of broccoli.*Bangladesh Hort.,*24 (1 & 2): 53-57.

Hong Li, H., Humin, J. and Tingxian, L. (2011), Broccoli plant nitrogen, phosphorus and water relaions at field scale and in various growth media. *Int. J. Veg. Sci.,* 17: 190-210.

Islam, M. H., Shaheb, M. R., Rahman, S., Ahmed, B., Islamand, A. T. M. T. and Sarkar, P. C. (2010), Curd yield and profitability of broccoli as affected by phosphorus and potassium. *Int. J. Sustain. Crop Prod.,*5 (2): 1-7.

Kumar, P. and Sharma, S. K. (2001), Performance of different sprouting broccoli (*Brassica oleracea* var. *italica*) cultivars under different combinations of nitrogen, phosphorus and potassium.*Indian J. Agric. Sci*.,71(8): 558-560.

Meena, K. K. and Paliwal, R. (2003), Growth and yield of cabbage (*Brassica oleracea* var. *capitata* L.) as affected by different nitrogen levels. *Annl. Agric. Res.,* 24 (4): 961-963.

Moniruzzaman, M., Rahman, S. M. L., Kibria, M. G., Rahman, M. A. and Hossain, M. M. (2007), Effect of Boron and Nitrogen on Yield and hollow stem of Broccoli. *J. Soil. Nature*., 1(3): 24-29.

Nkoa, R., Coulombe, J. Y. and Tremblay, N. (2002), Towards optimization of growth via nutrient supply phasing: nitrogen supply phasing increases broccoli (*Brassica oleracea* var. *italica*) growth and yield. *J. of Experimental-Botany,* 52: 821-827.

Panse, V. G. and Sukhatme, P. V. (1978), Statistical Methods for Agricultural Workers, I. C. A. R., New Delhi, India.

Purewal, Swarn Singh. (1975), Vegetable Cultivation in Northern India. *I. C. A. R. Bull.,* 39.

Rashid, M. M. (1999), Soil and Plant Nutrition. Rashid Publishing, pp. 241.

Singh, S. S. (1996), Soil fertilizer and nutrient management. Kalyani Publishers, New Delhi, pp. 37-38.

Thakur, O. P., Sharma, P. P. and Singh, K. K. (1991), Effect of nitrogen and phosphorus with and without boron on curd yield and stalk rot incidence in cauliflower. *Veg. Sci*.,18(2): 115-121.

Vieira, I. S., Vasconselos, E. P. and Monteiro, A. A. (1998), Nitrate accumulation, yield and leaf quality of turnip greens in response to nitrogen fertilization. *Nutr. Cycl. Agroecosys*., 51: 249–258.

Yildrim, E., Guvenec, I., Turan, M. and Karats, A. (2007), Effect of foliar urea application on quality, growth, mineral uptake and yield of broccoli (*Broccoli oleracea*L. var. *italica*). *Plant Soil Environ*., 53(3): 120-128.

Zhou, Z. Y., Wang, W. J. and Wang, J. S. (2000), Nitrate and nitrite contamination in vegetables in China. *Food Rev. Int*., 16: 61-76.