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Effect of different does of NPK and boron application on growth and yield of Broccoli (*Brassica oleracea L.* var*. italica*) in western Uttar Pradesh India

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ABSTRACT

The present investigation was undertaken with the main objective to study the effect of different doses of NPK and boron application on growth and yield of broccoli (Brassica oleracea L. var. italica) in irrigated agro-ecosystem of western Uttar Pradesh during Rabi season 2010-11 with different seven treatments including control were used in Randomized Block design (RBD). The results revealed significant effect on growth and yield of broccoli for different treatments. Application of 120 kg N+60 kg P_2O_5+40 kg K_2O+15 kg B ha^{-1} gave maximum plant height $plant^{-1}$ (65.44 cm), number of leaves $plant^{-1}$ (18.26), length longest leaf (52.99cm), width of longest leaf (17.99 cm), spread of plant (55.55cm) and stem diameter (4.72 cm), whereas in control was minimum pronounced plant height $plant^{-1}$ (58.00 cm),number of leaves $plant^{-1}$ (12.33), length longest leaf (42.70cm) width of longest leaf (14.18 cm), spread of plant (47.49cm) and stem diameter (3.04 cm). Similar, pattern on the Number of sprouts $plant^{-1}$ (6.22), weight of curd $plant^{-1}$ (286.89 g), weight of sprout $plant^{-1}$ (126.89 g), total yield Curd + sprout (148.51 qha^{-1}) was recorded with the application of 120 kg N+60 kg P_2O_5+40 kg K_2O+15 kg B $ha^{-1'}$ and minimum was under control treatment.

Key words: *NPK, Boron, growth parameters, yield parameters and Broccoli.*

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INTRODUCTION

Broccoli (*Brassica oleracea* L. var. *italica*) is a member of the Brassicaceae family as a wild form of this family, which found along the Mediterranean region [6]. Broccoli is an Italian vegetable, native to the Mediterranean region, cultivated in Italy in ancient roman times and about 1720 in England. On the other hand, the USA it first appeared in 1806, but it was commercially cultivated of broccoli was started around 1923 [6]. In Jordan, broccoli is cultivated on a limited area [3].However, due to increase in its popularity; there is a trend to increase cultivation by farmers as well as consumption by consumers. Broccoli is an important vegetable crop and has high nutritional and good commercial value [25]. It is low in sodium food, fat free and calories, high in vitamin C and good source of vitamin A,B_1, vitamin B_2 and calcium [6]. It has 130 times more vitamin A content than cauliflower and 22 times than cabbage [23].The consumption of broccoli in daily diet, it minimizes the incidence of various types of cancer disease in human beings. It has some cancer fighting substances like Phytochemicals, ß- Carotenes, Indoles and isothiocynates. It also contains sulforaphane; it checks the growth of tumors and reduces the risk of cancer. In Indian scenario, broccoli is mainly grown in hilly area of Himachal Pradesh, Uttrakhand, Jammu and Kashmir, Tamil Nadu and Northern plains. Recently, in western Uttar Pradesh it is gaining popularity due to increasing awareness of nutritional security and quality produce as well as reasonable that most of districts comes in the national capital region (NCR) and well connected with national capital Delhi as fresh supply is concerned. The area is negligible under broccoli cultivation in India. The area under the vegetable cultivation is 9205.20 thousand hectares and there production 162186.60 thousand metric tons. The productivity of vegetable is about 17.80 metric tons per hectare [3]. Similarly, 912.66 thousand hectare area is under vegetable cultivation and production 16.70 thousand metric tons with annual productivity 21.40 metric tons per hectare in Uttar Pradesh [4, 5]. Micro nutrients are essential as macro nutrients because important growth processes depend on them [2].For example, boron is essential for plant growth and development as translocation of sugar and quality production depend on boron [24]. However, the

boron deficiency in soil caused by removal of boron by crops is not fully replenished by fertilizer applications. In contrast, high concentration and unbalance ratios of both macro and micro nutrients lead to undesirable plant growth and development [8]. As reported by Ouda *et al.*,[14] that plant growth is severely depressed by boron deficiency, but high concentration of boron also reduces quality of crop [10].It was found that balance fertilization of macro and micro nutrients is essential for the production of high yield and quality products [22, 2], while foliar application of micronutrients to plant is the most effective and safest way [1].However, little information is available to show the effects of macro and micro nutrients on growth and yield parameters of crop [10, 12]. Although, broccoli is a high value vegetable crop of the world, but there is lack of research, particularly under field condition, to show the effects of nitrogen, phosphorus, potassium and boron on broccoli. Therefore, the current experiment was conducted to study the Effect of different doses of NPK and boron on growth and yield of broccoli (*Brassica oleracea* L.var.*italica.*).

MATERIALS AND METHODS

An experiment was conducted at Horticultural Research Centre, of Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh (28°40′07″N to 29°28′11″N, 77°28′14″E to 77° 44 18″E) during 2010-11.The climate of the area is semi-arid, with an average annual rainfall of 665 mm 75–80% of which is received during July to September), minimum temperature of 4^0C in January, maximum temperature of 41–45^0C in June and relative humidity of 67–83% during the year. The soil of the experimental plot was sandy and low to medium in organic matter content. Soil with a bulk density of 1.48 Mg m^{-3}, pH =7.81, Organic carbon.=0.42% g, Available N =153.49 kg ha^{-1},Available P =29.98 kg ha^{-1}, and Available K =144.60 kg ha^{-1}. Ground water pumping was the predominant method of irrigation in Western UP.

The present experiment entitled *"Effect of different doses of NPK and boron application on growth and yield of broccoli (Brassica oleracea L.var.italica.)"* was formulated in Randomized Block design (RBD) with three replications. The experiment was consisted of seven treatments with different doses of fertilizer combinations and boron applications in combinations and alone. The details of applied treatment were T_1-100 kg N+ 40 kg P_2O_5+20 kg K_2O ha^{-1}, T_2- 120 kg N+60 kg P_2O_5+40 kg K_2O ha^{-1},T_3-140 kg N +80 kg P_2O_5+60 kg K_2O ha^{-1},T_4-100 kg N+40 kg P_2O_5+20 kg K_2O+10 kg B ha^{-1},T_5-120 kg N+60 kg P_2O_5+40 kg K_2O+15 kg B ha^{-1},T_6-140 kg N +80 kg P_2O_5+60 kg K_2O+20 kg B ha^{-1},T_7- control (No fertilizer application). In present investigation, a Takki hybrid variety of broccoli was taken. The seeds of broccoli were sown in 3rd week of September in well prepared nursery beds. Thereafter, 30 days old seedlings of broccoli were transplanted in well prepared experimental field in classified plots at a 50x50 cm (plant to plant x Row to Row) distance. At the time of transplanting, half dose of nitrogen, full dose of phosphorus and potash were applied in experimental plots and thoroughly mixed in soil. Remaining half dose of nitrogen was applied after one month of transplanted crop. All the crop management practices were adopted during cropping season. The plant protection measures were also used to control of pest and diseases infestation. To find out the effect of treatments application on the three selected plants from each plot to obtain the field data according to observations on growth parameters at 30, 60 DAT & harvest and yield during the cropping periods for research purposes. The field data were analyzed statistically as suggested by Gomez and Gomez [7].

RESULTS AND DISCUSSION

Effect of NPK and boron application on growth parameters

Data exhibited from the Table-1 showed that the application of nitrogen, phosphorus, potash and boron had significant effect on the plant height of broccoli cv. Takki. Each increment of NPK and boron doses up to 120 kg N +60 kg P_2O_5 +40 kg K_2O+ 15 Kg boron ha^{-1} were obtained significantly higher plant height in the cropping seasons, thereafter a detrimental effect was noted in plant height with the higher dose of NPK + boron. The maximum plant height (65.44 cm) was recorded with an application of 120 kg N+60 kg P_2O_5 +40 kg K_2O+15 kg Boron ha^{-1} followed by T_4 (100 kg N+40 kg P_2O_5 +20 kg K_2O+10 kg B ha^{-1}) and T_6 (140 kg N+80 kg P_2O_5+60 kg K_2O+20 kg B ha^{-1}), whereas minimum plant height $plant^{-1}$ (58.00 cm) was recorded under control treatment. The maximum number of leaves $plant^{-1}$ (18.26) noted with a dose of 120 kg N+60 kg P_2O_5 + 40 kg K_2O+15 kg boron ha^{-1} and minimum number of leaves $plant^{-1}$ were recorded under control treatment. It is might be due to the nitrogen synthesizes proteins and formed the carbohydrates in crop plant; it favored plant height and number of leaves. Similarly, phosphorus also plays a vital role in plant growth and energy captures. The plant height and number of leaves relatively increased by optimum dose of potassium because, it is necessary for carbohydrate metabolism and efficient use of water. The micro element like boron is also play a significant role in terms of translocation of sugar and nitrogen element. These findings are in close conformity with earlier findings of Singh *et al*.,

[20], Supe and Marbhal [21] and Moniruzzaman *et al*., [13].The length and width of longest leaf Table-2 showed a significant effect with increasing application of NPK and boron as composed to control once. The length of longest leaves significantly increased up to a nutrients level of 120 kg N+60 kg P_2O_5+40 kg K_2O+15 kg boron ha^{-1} after that a significantly markedly decrease trend was noted in the length of longest leaf. Maximum length (52.99cm) and width (17.99) of longest leaf were recorded in treatment T_5-120 kg N+60kg P_2O_5+40 kg K_2O+15kg boron ha^{-1}, whereas minimum length (42.70 cm) and width (14.18 cm) were noted under control plots. It may be due to the optimum NPK accumulation and translocation in leaves with the help of microelement like boron. Similar finding were also reported by Magd *et al* [11] and Saha *et al*., [17]. The Table-3 indicate the significant affects on plant spread by NPK and boron application from lower level to higher level as compared to control treatment were recorded, while the each increment levels zero to 120 kg N + 60 kg P_2O_5+40 kg K_2O+15 kg boron ha^{-1} performed a significant superficial increase in plant spread after that a decreased trend was observed in plant spread. Similarly, growth trend was also recorded in respect of diameter of stem. The maximum stem diameter (4.72 cm) was recorded with an application of 120 kg N+60 kg P_2O_5+40 kg K_2O+15 kg boron ha^{-1} (T_5) and minimum (3.04 cm) stem diameter under control treatment. Similar results were obtained earlier by Prasad and Yadav [15] and Moniruzzaman *et al.,* [13].

Effect of NPK and boron application on yield parameters

The significant results on yield and yield attributing parameters were noticed with each increasing dose of NPK and boron up to a level of 120 kg N+60 kg P_2O_5+40 kg K_2O+15 kg boron ha^{-1} (Table- 4) as compared to control, therefore markedly declined in terms of weight of curd $plant^{-1}$ (g), number of sprouts and weight of sprouts $plant^{-1}$ (g), yield of curd and sprouts (qha^{-1}). The maximum weight of curd $plant^{-1}$ (286.89 g) was also found in treatment T_5-120 kg N+ 60 kg P_2O_5 +40 kg K_2O+15 kg boron ha^{-1},and minimum curd weight (142.65 g) was recorded in the unfertilized plot. Similarly, the number of sprouts, weight of sprout $plant^{-1}$ (126.89 g), weight of curd $plant^{-1}$ (286.89 g), and weight of curd & sprouts $plant^{-1}$ (0.390 kg) were recorded significantly higher by using various doges of NPK and boron combinations. The maximum number of sprouts (9.37), weight of sprouts $plant^{-1}$ (126.89 g), weight of curd $plant^{-1}$ (286.89 g), and weight of curd & sprouts $plant^{-1}$ (0.390 kg) were recorded with a dose of 120 kg N+ 60 kg P_2O_5 + 40 kg K_2O+15 kg boron ha^{-1}. However control gave the minimum number of sprouts, weight of sprout $plant^{-1}$, weight of curd $plant^{-1}$, and weight of curd & sprouts $plant^{-1}$ i.e., 6.22, 44.86 g, 142.65 g, and 0.200 g respectively. The total yield of curd and sprouts (148.51qha^{-1}) was obtained under the applied doses i.e.120 kg N +60 kg P_2O_5 +40 kg K_2O +15 kg boron ha^{-1} followed by treatments T_4 and T_6, respectively, Table 2.Whereas, minimum total yield of curd and sprout 75.27q ha^{-1} was recorded under control treatment. It might be due to proper utilization of carbohydrates, proteins and accumulation photosynthates and many functions like carbohydrate metabolism and enzyme activation and translocation of sugars and starch by the supply of optimum level of NPK and boron in broccoli. These findings are also confirmed with the earlier workers [16, 17, 18, 19].

Table –1: Effect of Different doses of NPK and boron application on growth parameters of broccoli

Treatments	Plant Height $plant^{-1}$ (cm)			Number of leaves $plant^{-1}$		
	30 DAT	60 DAT	At Harvesting	30 DAT	60 DAT	At Harvesting
T_1- 100 Kg N + 20 Kg P_2O_5 + 20 Kg K_2O ha^{-1}	8.72	17.99	60.51	7.10	11.66	13.33
T_2- 120 Kg N + 60Kg P_2O_5 + 40 Kg K_2O ha^{-1}	9.14	18.66	61.33	7.55	12.66	14.77
T_3- 140 Kg N + 80Kg P_2O_5 + 60 Kg K_2O ha^{-1}	9.99	19.33	61.87	7.89	13.44	15.22
T_4- 100 Kg N+40 Kg P_2O_5+20 Kg K_2O + 10 Kg B ha^{-1}	11.44	21.33	64.22	8.99	14.33	17.11
T_5-120 Kg N+60Kg P_2O_5+ 40 Kg K_2O+ 15 Kg B ha^{-1}	12.46	23.55	65.44	9.81	15.22	18.26
T_6-140 Kg N + 80 Kg P_2O_5 +60 Kg K_2O+20 Kg B ha^{-1}	10.22	20.55	63.00	7.99	14.22	16.44
T_7-Control	6.98	15.66	58.00	5.33	11.33	12.33
SE(m)	0.65	0.71	2.08	0.57	0.39	0.60
CD at 5%	0.65	2.20	NS	1.77	1.22	1.87

Table –2: Effect of Different doses of NPK and boron application on growth parameters of broccoli

Treatments	Length of longest leaf (cm)			Width of longest leaf (cm)		
	30 DAT	60 DAT	At Harvesting	30 DAT	60 DAT	At Harvesting
T_1- 100 Kg N + 20 Kg P_2O_5 + 20 Kg K_2O ha^{-1}	29.77	39.99	45.52	10.14	15.00	15.24
T_2- 120 Kg N + 60Kg P_2O_5 + 40 Kg K_2O ha^{-1}	32.11	42.44	46.66	11.00	15.33	16.11
T_3- 140 Kg N + 80Kg P_2O_5 + 60 Kg K_2O ha^{-1}	32.22	44.00	47.55	11.88	15.44	16.26
T_4- 100 Kg N+40 Kg P_2O_5+20 Kg K_2O + 10 Kg B ha^{-1}	34.33	45.77	49.89	12.44	16.11	17.39
T_5-120 Kg N+60Kg P_2O_5+ 40 Kg K_2O+ 15 Kg B ha^{-1}	36.33	46.14	52.99	13.66	17.11	17.99
T_6-140 Kg N + 80 Kg P_2O_5 +60 Kg K_2O+20 Kg B ha^{-1}	33.55	44.22	49.11	12.22	15.55	16.88
T_7-Control	27.81	37.15	42.70	9.48	12.89	14.18
SE(m)	1.55	2.11	1.83	0.41	0.67	0.64
CD at 5%	4.78	4.66	5.72	1.25	2.10	1.99

Table –3: Effect of Different doses of NPK and boron application on growth parameters of broccoli

Treatments	Plant spread (cm)			Stem diameter (cm).		
	30 DAT	60 DAT	At Harvesting	30 DAT	60 DAT	At Harvesting
T_1- 100 Kg N + 20 Kg P_2O_5 + 20 Kg K_2O ha^{-1}	37.26	43.83	49.66	1.70	2.50	3.48
T_2- 120 Kg N + 60Kg P_2O_5 + 40 Kg K_2O ha^{-1}	38.66	44.66	51.44	1.73	2.55	3.88
T_3- 140 Kg N + 80Kg P_2O_5 + 60 Kg K_2O ha^{-1}	39.72	46.05	51.61	1.74	2.71	4.19
T_4- 100 Kg N+40 Kg P_2O_5+20 Kg K_2O + 10 Kg B ha^{-1}	42.41	47.22	53.44	1.90	2.80	4.40
T_5-120 Kg N+60Kg P_2O_5+ 40 Kg K_2O+ 15 Kg B ha^{-1}	43.57	48.44	55.55	1.95	3.10	4.72
T_6-140 Kg N + 80 Kg P_2O_5 +60 Kg K_2O+20 Kg B ha^{-1}	41.89	47.05	52.72	1.80	2.74	4.24
T_7-Control	35.89	41.89	47.49	0.88	1.95	3.04
SE(m)	1.13	1.26	1.49	0.15	0.18	0.12
CD at 5%	3.51	3.94	4.66	0.48	0.57	0.38

Table –4: Effects of different doses of NPK and boron application on yield and yield attributing parameters in broccoli

Treatments	Weight of curd $plant^{-1}$ (g)	Weight of sprouts $plant^{-1}$ (g)	Number of sprout $plant^{-1}$	Weight of Curd and sprout $plant^{-1}$ (Kg)	Total yield of Curd & sprouts (q ha^{-1})
T_1- 100 Kg N + 20 Kg P_2O_5 + 20 Kg K_2O ha^{-1}	149.42	54.33	6.40	0.220	81.43
T_2- 120 Kg N + 60Kg P_2O_5 + 40 Kg K_2O ha^{-1}	183.77	54.85	6.77	0.250	95.44
T_3- 140 Kg N + 80Kg P_2O_5 + 60 Kg K_2O ha^{-1}	188.34	93.42	6.99	0.310	118.22
T_4- 100 Kg N+40 Kg P_2O_5+20 Kg K_2O + 10 Kg B ha^{-1}	247.39	108.55	7.77	0.370	142.55
T_5-120 Kg N+60Kg P_2O_5+ 40 Kg K_2O+ 15 Kg B ha^{-1}	286.89	126.89	9.37	0.390	148.51
T_6-140 Kg N + 80 Kg P_2O_5 +60 Kg K_2O+20 Kg B ha^{-1}	239.45	107.24	7.44	0.343	133.25
T_7-Control	142.65	44.86	6.22	0.200	75.27
SE(m)	0.14	0.09	0.54	0.003	0.39
CD at 5%	0.45	0.31	1.68	0.008	1.21

CONCLUSIONS

The effects of nitrogen, phosphorus, potassium and boron on growth and yield parameters of broccoli were investigated. These results indicated that growth and yield parameters of broccoli were significantly related to suitable combinations of nitrogen, phosphorus, potassium and boron. Interestingly, number of curd $plant^{-1}$ and total yield were maximum by combination of N, P, K and boron when plots received N at 120 kg ha^{-1}, P at 60 kg ha^{-1}, K at 40 kg ha^{-1} and boron at 15 kg ha^{-1}. However, yield started to decline from peak when P, K, and boron were kept constant but nitrogen was increased from 120 to 140 kg ha^{-1}. Therefore, to make recommendation and generalization about these combinations of N,P, K, and boron 120, 60, 40 and 15 kg ha^{-1} for highest yield and quality of broccoli in the irrigated agro-ecosystem of western Uttar Pradesh. However, cost of fertilizers and water pollutions through high fertilizations should also kept in mind when making recommendations for highest yield through high levels of

fertilizations. In general, it can be concluded that compared to control best growth and yield of broccoli for this experiment were obtained when plots received N @ 120 kg, P_2O_5 @ 60 kg, K_2O @ 40 kg and boron @15 kg ha^{-1}.

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