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Effect of levels of nitrogen with boron and zinc on quality and chlorophyll content in broccoli (*Brassica oleraceae* L. Var. *italica*) Cv. Phule Ganesh

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Abstract
The investigation was carried out in shade net of Instructional- cum- Research farm of Department of Horticulture, College of Horticulture, VNMKV, Parbhani during the year 2018-2019. The seven different treatments including control were used in Randomized Block Design (RBD). There were significant differences found in quality by the soil application of NPK and B and Zn with different treatments. Application of 130 kg N + 60 kg P_2O_5 + 15 kg B ha^{-1} gave maximum TSS (11.45 ^{0}Brix), Reducing sugar (2.96%), Non-reducing sugar (0.41%), Total sugar (3.32%), Ascorbic acid (86.72 mg^{-}100 g), Chlorophyll (a) (29.27 mg^{-}100 g), Chlorophyll (b) (4.06 mg^{-}100 g) Total chlorophyll (20.63 mg^{-}100 g).

Keywords: Broccoli, NPK, boron, and zinc, quality

1. Introduction
Broccoli (*Brassica oleracea* L. *var. italica*) Cv. Phule Ganesh" belongs to the genus *Brassica*, and family *Brassicaceae* which includes a wide range of crop plants derived from the Mediterranean sea and modified over the years by selection and breeding (Decoteau, 2000) [3]. Vegetables defined as those herbaceous plants of which some portion is eaten either cooked or raw, during the principal part of the meal, constitute an important segment of our agricultural system. Vegetables are rich source of carbohydrates, proteins, vitamins and minerals. India stands at second place in vegetable production after China. (Thamburaj and Singh, 2003) [16]. China is the top world producer of broccoli (*Brassica oleracea* L. var. *italica*) followed by India, USA, Spain, Italy, France, Mexico, Poland, Pakistan and United Kingdom (FAO, Statistics 2018) [4]. In India broccoli is under-utilized food crop, mainly confined to limited area especially near the big cities. In India annual production around 180684 million tonnes of vegetable from 10172 million hectares of land (Anonymous, 2018) [2]. However, this production does not meet the requirement of 300g of vegetables per capita per day. Thus, with the large vegetarian population, the production of vegetables in India needs to be greatly increased. Though the central and state governments have taken some steps for increasing the production of vegetable crops, it needs further boost from the research activities.

Exotic vegetables are increasingly popular in star hotels. These vegetables generally require cool temperature. The agro-climatic conditions prevailing in several part of Northern Himalayas of Jammu and Kashmir, Himachal Pradesh and Kumaon and Garhwal division of Uttaranchal are very favorable for growing these vegetables. Besides, they may also be grown during winter season in plains of North India (Pandey and Rai, 2005) [10]. The family brassicaceae is an important for horticulture because there are several commercial vegetable crops like cabbage, cauliflower, brussels sprouts, sprouting broccoli, etc. which are cultivated extensively; further the members of the brassicaceae kind are characterized by the fact that they contain sulphur which is an important constituent of a balanced human diet. Broccoli is cool season crop. The temperature of 20 °C to 25 °C is optimum for its proper growth while 15 °C to 20 °C for its heading stage. It is more sensitive to temperature. When the plants are small and tender, they are susceptible to cold injury. Warm weather is disadvantageous, since the bud clusters grow loose quickly.

In Northern India, generally, it is planted in September and October and is ready for harvest from late November to early December and may continue till early February. Broccoli needs fertile soil. Medium black soil is suitable for broccoli cultivation. Soil pH ranges from 6.5 to 7.0. In this crop, planting distance needs to be maintained properly to avoid pest problem and to get quality curds for the market. The distance can be reduced to 45 x 45 cm and 60 x 60 to avoid stem hollowness in the stem. Broccoli is an important vegetable crop and has high nutritional and good commercial value (Yoldas, *et al.* 2008) [18]. Broccoli is low in sodium food, fat free and calories, high in vitamin C and good source of vitamin A, B_1, B_2 and calcium (Decoteau, 2000) [3]. Now-a-days, broccoli attracted more attention due to its multifarious use and great nutritional value (Rangkadilok, *et al.* 2004) [12]. Broccoli is a rich source of vitamins, minerals, proteins, etc. It has about 130 times more vitamin-A contents than cauliflower and 22 times more than cabbage. It is also a rich source of sulphoraphane, a compound associated with reducing risk of cancer. It contains vitamin A (9000 mg^{-}l00 g), vitamin B (33 mg^{-}l00 g), vitamin C (137 mg^{-}l00g), minerals *viz*; Ca (1.29%), P (0.79%), K (3.5%), S (1.26%), Fe (205 ppm), I (1.965 ppm), Cu (24 ppm), protein (3.3%), total carbohydrates (5.5%), fat (0.2%), water (89.9%) and calories (36^{-}l00g) (Thamburaj and Singh, 2003) [16]. The Marathwada region is totally new area for its cultivation. However, it is need to produce better quality curds. Micronutrients like boron and zinc play the important role to improve growth, yield and quality of broccoli. Beside the crop duration and the harvesting duration, sprouting broccoli is shorter than cabbage and cauliflower. The response may differ in growth, yield and quality parameters of the broccoli. In view of above present investigation is entitled "Effect of levels of nitrogen with boron and zinc on quality parameters and chlorophyll content in broccoli (*Brassica oleracea* L. *var*. *italica*) Cv. Phule Ganesh".

2. Materials and Methods

An experiment was conducted at College of Horticulture, Parbhani. Geographically Parbhani is situated at 19° 16´ North latitude and 76° 47´ East longitude and at 408.50 meter above sea level in Marathwada division encompassed by 17° 35´ to 24° 40´ North latitude and 74° 49´ to 78° 15´ East longitude geographical boundaries. The meteorological data for corresponding period of crop season recorded at central meteorological observatory, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The perusal of data indicated that the average maximum and minimum temperatures during crop growing period were 33.04^{0}C and 14.8^{0}C, respectively. The mean relative humidity (RH) of morning (RH- I) and evening (RH- II) hours were 78.6 and 40.5 per cent. The mean sunshine hours per day were 8.6 hours day^{-1}. The mean wind velocity was 4.3 km h^{-1}. The total precipitation received during crop growth period in 2017-18 was 21.54 mm. The evaporation was 4.72 mm recorded during the crop growing season. The present experiment entitled "Effect of levels of nitrogen with boron and zinc on growth and yield of broccoli. (*Brassica oleracea* L. var. *italica*) Cv. Phule Ganesh". The field experiment was carried out in Randomized Block Design (RBD) with three replications and seven treatments *viz*; T_1 -120:60:40 NPK kg^{-ha} with boron at 10 kg^{-ha}, T_2 -130:60:40 NPK kg^{-ha} with boron at 15 kg^{-ha}, T_3-140:60:40 NPK kg^{-ha} with boron at 20 kg^{-ha}, T_4-120:60:40 NPK kg^{-ha} with zinc at 10 kg^{-ha}, T_5 -130:60:40 NPK kg^{-ha} with zinc at 15 kg^{-ha}, T_6 -140:60:40 NPK kg^{-ha} with zinc at 20 kg^{-ha} and T_7 -control. The results obtained during the course of investigation are summarized below. The seeds of earlier mentioned variety of broccoli were sown in First week of October in pro trays filled with coco peat. Thereafter, 30 days old seedlings of broccoli were transplanted in well prepared experimental field at distance 60 X 60cm. At the time of transplanting, half dose of nitrogen, full dose of phosphorous and potash were applied in experimental plots and boron and zinc later apply with 15 days after transplanting, remaining half dose of nitrogen was applied after one month of transplanted crop. The plant protection measures were also followed to control of pest and diseases. To find out the effect of treatments, five sample plants were selected to obtain field data according to observation on quality and chlorophyll content in broccoli.

3. Result and Discussion

Effect of levels of NPK with boron and zinc on TSS & sugar content in broccoli. The result showed in (Table No. 1) that the application of nitrogen, phosphorous, potash and boron had significant effect on the TSS of broccoli Cv. Phule Ganesh. Each increment of NPK, boron and zinc doses up to 130:60:40 kg/ha NPK + Boron 15kg/ha were obtained significantly (11.45 ^{0}Brix). The maximum reducing sugar (2.96%) was recorded by the application of T_2 i.e.130:60:40 NPK kg^{-ha} with boron at 15 kg$^{-ha.}$ The maximum non reducing sugar was recorded (0.41%) by the treatment T_2 i.e.130:60:40 NPK kg^{-ha} with boron at 15 kg^{-ha}. The maximum total sugar (%) of plant recorded (3.32%) was recorded by the treatment T_2 i.e. 130:60:40 NPK kg^{-ha} with boron at 15 kg^{-ha}.

Effect of levels of NPK with boron and zinc on chlorophyll & Vit. C content in broccoli was show in Table No. 2. The maximum ascorbic acid i.e. vitamin C (86.72 mg^{-}100g) of plant was recorded by the treatment T_2 i.e.130:60:40 NPK kg^{-ha} with boron at15 kg^{-ha}. The maximum chlorophyll content of broccoli was recorded by the treatment T_2 i.e.130:60:40 NPK Kg^{-ha} with boron at 15 Kg^{-ha} chlorophyll-a (29.27mg^{-}100g) and chlorophyll (b) (4.06 mg^{-}100g). Hence maximum total chlorophyll content was recorded by the treatment T_2 i.e. 130:60:40 NPK kg^{-ha} with boron at 15 kg^{-ha} (20.63 mg^{-} 100 g). The application of boron after transplanting was found significant for maximum TSS, Reducing sugar, Non-reducing sugars, total sugars, ascorbic acid and chlorophyll content in broccoli.

It might be due to the boron helps to the translocation of sugars and carbohydrates, nitrogen metabolism, formation of certain proteins, regulation of hormone levels by Moniruzzaman *et al.* (2007) [7], Saha *et al.* (2010) [13], Naher *et al.* (2014) [9] on cabbage and Singh *et al.* (2015) [14] on broccoli. Also increasing N levels, higher rate of assimilation and ultimately more synthesis of carbohydrates Patel *et al.* (2017) [11] and Singh *et al.* (2018) [15].

Potassium gives role on carbohydrate metabolism and enzyme activation in plant body and boron act as a proper translocation of sugars, starch and nitrogen compound in plant body these finding are in close conformity with earlier results obtained by Alam *et al.* (2007) [1] and Singh *et al.* (2015) [14].

The photosynthesis enhanced in the presence of B indicates that it helps to activate the synthesis of tryptophan and

precursor of indole acetic acid (IAA) which is responsible for stimulation of plant growth and accumulation of biomass. The micronutrient being a component of ferrodoxin and electron transport are also associated with chloroplast by Gilmara *et al.* (2016) [5].

The acceleration in photosynthesis is evident for better vegetative growth. Zn application were relatively high, indicating the necessity of zinc application of plant it is respective to the growth parameter as well as chlorophyll content. These results are in conformity with the above findings of and Gocher *et al.* (2017) [6]. The plant which treated with nitrogen (N) grows quickly and retains maximum vegetative growth by means of higher canopy area development, CO_2 exchange rate and photosynthetic activity Yasir *et al.* (2016) [17].

Table 1: Effect of levels of NPK with boron and zinc on TSS & sugar content in broccoli

Sr. No.	Treatment details	TSS (^{0}Brix)	Reducing sugars (%)	Non-reducing sugars (%)	Total sugar (%)
$T_{1.}$	120:60:40 NPKkg^{-ha} + B 10 kg^{-ha}	9.34	2.74	0.35	3.07
T_2	130:60:40 NPK kg^{-ha} + B 15 kg^{-ha}	11.45	2.96	0.41	3.32
T_3	140:60:40 NPK kg^{-ha} + B 20 kg^{-ha}	7.78	2.58	0.27	2.85
T_4	120:60:40 NPK kg^{-ha} +Zn 10 kg^{-ha}	9.50	2.65	0.33	2.98
T_5	130:60:40 NPK kg^{-ha} +Zn 15 kg^{-ha}	10.49	2.85	0.38	3.10
T_6	140:60:40 NPK kg^{-ha} +Zn 20 kg^{-ha}	7.73	2.47	0.26	2.73
T_7	Control	7.50	2.18	0.22	2.53
	S.E.(±)	0.30	0.09	0.01	0.09
	C. D. 5%	0.94	0.29	0.03	0.28

Table 2: Effect of levels of NPK with boron and zinc on chlorophyll & Vit. C content in broccoli

Sr. No.	Treatment details	Chlorophyll (a) (mg$^-$ 100 g)	Chlorophyll (b) (mg$^-$ 100 g)	Total chlorophyll (mg$^-$ 100 g)	Vitamin C (mg- 100 g)
T_1	120:60:40NPKkg^{-ha} + B 10 kg^{-ha}	9.34	2.74	0.35	83.54
T_2	130:60:40 NPK kg^{-ha} + B 15 kg^{-ha}	11.45	2.96	0.41	86.72
T_3	140:60:40 NPK kg^{-ha} + B 20 kg^{-ha}	7.78	2.58	0.27	81.54
T_4	120:60:40 NPK kg^{-ha} +Zn 10 kg^{-ha}	9.50	2.65	0.33	83.61
T_5	130:60:40 NPK kg^{-ha} +Zn 15 kg^{-ha}	10.49	2.85	0.38	85.25
T_6	140:60:40 NPK kg^{-ha} +Zn 20 kg^{-ha}	7.73	2.47	0.26	80.86
T_7	Control	7.50	2.18	0.22	75.64
	S.E.(±)	0.30	0.09	0.01	2.77
	C. D. 5%	0.94	0.29	0.03	8.52

Conclusion

The present findings have clearly indicated that the combined soil application of different nitrogen levels and micronutrient boron and zinc at 130:60:40 NPK Kg^{-ha} + boron at 15 Kg^{-ha} and 130:60:40 NPK Kg^{-ha} + zinc at 15 Kg^{-ha} 15 DAT may be suggested as the optimum level for improving quality parameter of broccoli.

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