

Original Research Article

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Effect of NAA and Boron Levels on Yield and Economics of Sprouting Broccoli [*Brassica oleracea* (L.) var. *Italica* Plenck]

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ABSTRACT

A field experiment was conducted to study the “Effect of NAA and boron levels on growth, yield and quality of sprouting broccoli [*Brassica oleracea* (L.) var. *italica* Plenck]”, during *rabi* season 2017-18 at Horticulture Farm, S.K.N. College of Agriculture, Jobner (Jaipur). The experiment consisted of sixteen treatment combinations including four NAA (control, NAA @ 100 ppm, NAA @ 200 ppm, and NAA @ 300 ppm) and four boron levels (control, boron @ 0.75 kg/ha, boron @ 1.5 kg/ha and boron @ 2.25 kg/ha) were under taken in randomized block design with three replications. The results of the study clearly indicated that application of NAA @ 300 ppm to the sprouting broccoli significantly increased the weight of primary curd (411.61 g), number of secondary curds per plant, weight of secondary curd (145.80 g), volume of curd (127.45 cc), yield per plant, yield per plot, yield per ha (165.19 q), net returns (₹ 263506/ha) and B:C ratio (3.92) as compared to control and found at par to NAA @ 200 ppm. Application of NAA @ 300 ppm days taken to curd formation was found minimum as compared to control. Similarly, boron levels significantly increased the weight of primary curd (384.02 g), number of secondary curds per plant, weight of secondary curd (135.61 g), volume of curd (125.95 cc), yield per plant, yield per plot, yield per ha (153.94 q), net returns (₹ 233471/ha) and B:C ratio (3.48) as compared to control and found at par to boron @ 1.5kg/ha. Application of NAA @ 300 ppm days taken to curd formation was found minimum as compared to control.

Keywords

Boron, Broccoli, Economics, NAA, and Yield

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Introduction

Sprouting broccoli [*Brassica oleracea* (L.) var. *italica* Plenck] has originated in the mediterranean region and commonly known as *Hari gobhi* in Hindi and a member of cole group, belongs to the family brassicaceae. The broccoli derived its name from the Latin word *Branchium* meaning an arm or branch. It is used as curries, soups, pickles and also

eaten as a salad and cooked as a single or mixed vegetable with potato (Thamburaj and Singh, 2001).

It is one of the most nutritious cole crop and contains vitamin A (130 times and 22 times higher than cauliflower and cabbage, respectively), thiamin, riboflavin, niacin, vitamin C and minerals like calcium, phosphorus, magnesium and iron (Hazra and

Som, 1999). It contains 4.0, 2.5 and 2.0 times more riboflavin, calcium and ascorbic acid contents, respectively as compared to cauliflower. Sprouting broccoli contains carbohydrates (5.5 %), protein (3.3 %), Vitamin-A (3500 IU), Vitamin-C (137 mg), Vitamin-B₁ (0.05 mg), Vitamin-B₂ (0.12 mg), calcium (0.80 mg) and phosphorus (0.79 mg) (Thamburaj and Singh, 2001).

Now, it is grown in an area of 1689.56 ha in India with annual production of 146855.08 q and productivity of 86.92 q per ha (Anonymous, 2016). Sprouting broccoli is mainly cultivated in hilly areas of Himachal Pradesh, Uttar Pradesh, Jammu and Kashmir, Nilgiri Hills and Northern plains of India (Chadha, 2001). In the world market, about 40 per cent sprouting broccoli is marketed as fresh and remaining 60 per cent as frozen. This crop attract very high price in urban market and can be exported to abroad. Realizing the tremendous potential of sprouting broccoli in domestic and foreign market, the cauliflower growers are gradually adopting the broccoli cultivation. But to get maximum yield, alarmed with declined soil health and chemicalization of modern day crop production renewed emphasis is given on liberal application of organic manures along with chemical fertilizers for optimum crop growth and sustainable soil health (Mal *et. al*, 2015).

In broccoli, various concentrations of auxins such as naphthaleneacetic acid (NAA), indolebutyric acid (IBA) and indoleacetic acid (IAA) have been evaluated for rooting of *in vitro* regenerated shoots of broccoli and cauliflower. This paper reports on the influence of BAP either singly or in combination with NAA, on adventitious shoot proliferation from hypocotyls and shoot-tip explants of broccoli cv. bejo. Naphthalene acetic acid (NAA) is an organic compound. This colourless solid is soluble in organic

solvents. NAA is synthetic plant hormone in the auxin family and is an ingredient in many commercial plants rooting horticultural product. This rooting agent is useful for vegetative propagation of plants, from stem and leaf cutting, plant tissue culture. NAA has been found to greatly increase cellulose fiber formation in plants when paired with another phytohormone called gibberellic acid because it is in the auxin family. It has also been understood to prevent pre mature dropping and thinning of fruits from stems. It is applied after blossom fertilization. NAA present in environment undergoes oxidation reactions with hydroxyl radicals and sulphate radicals. A radical reaction of NAA was studied by using pulses radiolysis technique. The growth substance like Naphthalene Acetic Acid (NAA) affects plants very much. It may be useful in regulation of growth development and flowering of plant and also involved in biosynthetic process of plant and works with enzymes. The application to NAA affected the physiological processes particularly respiration and photosynthesis, which ultimately lead to accumulation of dry matter, minerals and carbohydrates.

Further, more the boron is absorbed by plants in the form of boric acid (H₃BO₃), it plays an important role in the development and growth of new cells in plant meristem. It also acts as regulator of K/Ca ratio in plants and necessary for the translocation of sugar, starch, phosphors and synthesis of amino acid and proteins. Boric acid also increases the TSS content (Kotur, 1993).

Boron is concerned with the precipitation of excess cation, buffer action, maintenance of conducting tissues and help in absorption of nitrogen. Its primary role is concerned with metabolism both with its uptake and efficient use in plants. Boron also affect the cambial and phloem tissues of storage root or stem apical meristems and leaves, vascular cambia

of fruits and other organs which are capable of meristematic activities (Singh, 1991).

Materials and Methods

The experiment was conducted at Horticulture Farm, S.K.N. College of Agriculture, Jobner (Jaipur) during *Rabi* season 2016-2017 and 2017-2018. In Rajasthan, this region falls under agro-climatic zone-III A (Semi-Arid Eastern Plains). The experiment consisted of sixteen treatment combinations including four NAA (control, NAA @ 100 ppm, NAA @ 200 ppm, and NAA @ 300 ppm) and four boron levels (control, boron @ 0.75 kg/ha, boron @ 1.5 kg/ha and boron @ 2.25 kg/ha) were under taken in randomized block design with three replications. NAA was applied as foliar spray in the plots as per treatments. NAA was sprayed @ 100 ppm, 200 ppm and 300 ppm at 45 DAT. Boron was applied in the bed as per treatment combination through agriculture grade elemental borax contenting 11% boron was broadcasted before transplanting and incorporated in the soil. Each plot measured 2.40 m x 1.80 m = 4.32 m² area. The crop geometry was kept at 60 x 60 cm. All the cultural operations were followed which were necessary to raise the good crop. Five plants were randomly selected and tagged before flowering from each line to record the data on the following attributes.

The observations were recorded on weight of primary curd, Number of secondary curds, weight of secondary curd, volume of curd, curd yield per plant, curd yield per plot and curd yield per hectare in quintals was calculated on the basis of the total curd yield per plot. The net return of each treatment was calculated by deducting the cost of cultivation from the gross return of individual treatment. Least significant difference at 5% level was used for finding the significant differences among the treatment means.

The data obtained from the trial were subjected to statistical analysis and the results were documented, analysed and presented in tabular form.

Results and Discussion

Effect of NAA on yield attributes of Sprouting Broccoli

The data (Table 1) clearly indicated the significant effect of NAA on weight of primary curds (411.61g/plant), number of secondary curds per plant, weight of secondary curds (145.80 g/plant), yield (557.50 g/plant) yield per plot (6.69 kg) and yield (165.19 q/ha) of sprouting broccoli. The maximum values for all these yield attributes were found significantly superior in NAA @ 300 ppm, at par in NAA @200 ppm and minimum in control. The reason for this trend in the parameters related to yield attributes due to application of NAA increase in weight of curd and yield might be due to accumulation of carbohydrates owing to greater photosynthesis, higher food accumulation and better plant growth because the economic part of sprouting broccoli is head. The another probable reason for increasing yield attributes might be due to the increasing growth characters by cell division, cell elongation and cell expansion that might have ultimately increased in the yield. Similar trend was also observed by Yadav *et al.*, (2000); Sawant *et al.*, (2010) and Lendve *et al.*, (2010) in cabbage and Thapa *et al.*, (2013) in sprouting broccoli.

The increase in cabbage yield due to application of NAA and Nitrogen may be ascribed to improvement in growth and enhancement in the photosynthetic and other metabolic activities which led to increase in various plant metabolisms responsible for cell division and cell elongation.

Table.1 Effect of NAA and boron on yield attributes and economics of sprouting broccoli

Treatment	Weight of primary curd (g)	Weight of secondary curd (g)	Number of secondary curd	Volume of primary curd (cc)	Yield per plant (g)	Yield per plot(kg)	Yield per ha (q)	Net returns	B:C ratio
NAA Levels									
N₀ – Control	192.67	77.33	5.67	78.01	270.00	3.24	80.00	93539	1.40
N₁ - 100ppm	361.83	115.67	6.05	107.45	477.50	5.73	141.48	216366	3.23
N₂ - 200ppm	398.50	141.33	7.33	120.33	539.83	6.48	160.00	253269	3.77
N₃ - 300ppm	411.61	145.80	7.70	127.45	557.50	6.69	165.19	263506	3.92
SEm±	7.77	2.73	0.19	3.13	10.49	0.13	3.11	4917	0.07
CD (P=0.05)	22.43	7.89	0.54	9.03	30.30	0.36	8.98	14202	0.21
Boron Levels									
B₀ – Control	278.27	98.01	5.38	87.08	375.74	4.50	111.34	168152	2.51
B₁- 0.75 kg/ha	323.10	113.72	6.29	101.81	436.85	5.24	129.45	195698	2.92
B₂- 1.5 kg/ha	379.22	132.79	7.31	118.40	512.75	6.15	151.94	229358	3.42
B₃- 2.25 kg/ha	384.02	135.61	7.77	125.95	519.49	6.24	153.94	233471	3.48
SEm±	7.77	2.73	0.19	3.13	10.49	0.13	3.11	4917	0.07
CD (P=0.05)	22.43	7.89	0.54	9.03	30.30	0.36	8.98	14202	0.21

The cabbage yield under each of the treatments was exactly in accordance with their yield attributing characters responsible for the quantum of yield. The present results corroborate with, Easmin *et al.*, (2009) and Agrawal *et al.*, (2010).

Effect of INM on economics of sprouting broccoli

The A perusal of data (Table 1) revealed that application of different NAA levels had significant increasing in the net returns and B:C ratio of sprouting broccoli. The maximum net returns (263506 /ha) and B: C ratio (3.92) was recorded under treatment N₃ (NAA @ 300 ppm).

Effect of boron on yield attributes of Sprouting Broccoli

A perusal of data (Table 1) revealed that application of boron 2.25 Kg had significantly increased the average weight of primary head (384.86 g/plant), weight of secondary curd (135.61 g/plant), number of sprouts per plant (7.77), volume of terminal head (125.95cc), yield per plant (519.49 g/plant), yield per plot (6.24kg) and yield per ha (153.94 q). While, 1.50 Kg boron per hectare was found statistically at par with this treatment in all the above characters (Table 1).

The beneficial effect of boron on yield attributes and yield might be due to enhanced supply of micronutrients during entire growing season, significant increase in yield under the influence of boron was largely function of improved growth and the consequent increase in different yield attributes and yield. These results are in accordance with the findings of Hussain *et al.*, (2012), Khadka *et al.*, (2005) in cauliflower, Moniruzzaman *et al.*, (2007) in broccoli where head yield per plant and per hectare highest up to 1.5 kg boron per ha.

Effect of boron on economics of sprouting broccoli

The A perusal of data (Table 1) revealed that application of different boron levels had significant increasing in the net returns and B:C ratio of sprouting broccoli. The maximum net returns (233471 /ha) and B: C ratio (3.48) was recorded under treatment N₃ (NAA @ 300 ppm).

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