

Original Research Article

Effect of Bio-regulators on Yield and Economics Attributes of Sprouting Broccoli {*Brassica oleracea* (L.) var. *italica* Plenck}

ABSTRACT

The field experiment was conducted at Horticulture Farm, S.K.N. College of Agriculture, Jobner (Jaipur) during *Rabi* season 2016-17 and 2017-18. The experiment consisted of five bio-regulators levels [Control, Brassinoids @ 5 ppm, Brassinoids @ 10 ppm, Salicylic acid @ 100 ppm and Salicylic acid @ 150 ppm] were under taken in randomize block design with three replications. The results showed that the maximum weight of primary curd (213.17g), number of secondary curds per plant (6.20), weight of secondary curd (147g), volume of curd (114.15 cc), diameter of curd (12.18 cm), yield per plant (362.57 g), yield per plot (7.42 kg), yield per ha (183.19 q), biological yield per ha (1002.18 q), net returns (₹ 287563 /ha) and B:C ratio (3.99:1) were recorded significant with foliar application of 5 ppm brassinoids. While harvesting index was found non significant to broccoli.

Key Words: Economics, Yield, Bio-regulators and Sprouting broccoli.

Introduction

Sprouting broccoli (*Brassica oleracea* var. *italica*) 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. while the broccoli derived its name from the Latin word *Branchium* meaning an arm or branch. It is used as curries, soups, pickles, eaten as a salad and cooked as a single or mixed vegetable with potato

(Thamburaj and Singh, 2001). Sprouting broccoli is high value exotic vegetable with a kind of terminal head consisting of green buds and thick fleshy flower stalks morphologically resembles the cauliflower except secondary heads, which develop in the axil of leaves and may contribute up to 50 per cent of the total yield. 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 Ca, P, K and Fe (Hazra and Som, 1999). It 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). Broccoli has 4.0, 2.5 and 2.0 times more riboflavin, calcium and ascorbic acid contents, respectively as compared to cauliflower (Thamburaj and Singh, 2001). It is also a rich source of sulphoraphane, a compound associated with reducing the risk of cancer (Thamburaj and Singh, 2001).

Brassinosteroids are a new group of plant hormones with growth promoting activity (Mandava, 1988). Brassinosteroids are considered as plant hormones with pleiotropic effects as they influence wide array of developmental processes such as growth, seed germination, rhizogenesis flowering, senescence, abscission and maturation (Sasse, 1999). Brassinosteroids improve the resistance of plants against environmental stresses such as water stress, salinity stress, low and high temperature stress (Rao *et al.*, 2002). Brassinosteroids also enhances the crop productivity (Vardhani *et al.*, 2006). Brassinosteroids being an eco-friendly chemical, has a potential application in agriculture to increase yield by regulating defense system under field condition in *Brassica juncea* L. (Sirhindi *et al.* 2009). Mitchell *et al.* (1970) reported about promotion in stem elongation and cell division by the treatment of organic extracts of rapeseed pollen.

Similarly, Salicylic acid (SA) also a plant hormone plays an important role in induction of plant defense against a various biotic and abiotic stresses through morphological, physiological and biochemical mechanisms (War *et al.* 2011). Salicylic acid not only improved the growth and yield in no-stress condition but, also for adjusting the drought stress especially at vegetative stress is recommended in bean (*Phaseolus vulgaris* L.) (Sepehri *et al.* 2015). Salicylic acid (SA) is classified as phenolic growth regulator, a non- enzymatic antioxidant, messenger molecule in plants to induce

responses of plants to environmental stressess. SA is a monohydroxy benzoic acid, a type of phenolic acid and a beta hydroxy acid. SA is a phenolic phytohormons and is found in plant which play vital role in plant growth and development, photosynthesis, transpiration, ion uptake and transport. SA also induces specific change in leaf anatomy and chloroplast structure. SA also involved in the systemic acquired resistance (SAR) in which a pathogenic attack on one part of the plant includes resistance in other parts. SA also plays an important role in the regulation of some physiological processes in plants. It has been found that SA positively affects growth and development, ion uptake and transport, and membrane permeability (Simaei *et al.*, 2012).

Materials and Methods-

The field experiment was conducted at Horticulture Farm, S.K.N. College of Agriculture, Jobner (Jaipur) during *Rabi* season 2016-17 and 2017-18. The experiment consisted of five bio-regulators levels [Control, Brassinoids @ 5 ppm, Brassinoids @ 10 ppm, Salicylic acid @ 100 ppm and Salicylic acid @ 150 ppm] were under taken in randomized block design with three replications. Each plot measured $2.25 \times 1.8 \text{ m}^2$ area. The variety was sowed at the spacing between plants to plant as well as row to row was kept at 45 x 45 cm. Before sowing the seed were treated with Azotobactor and PSB inoculums, which was added with 5 g jiggery in 50 ml of boiled water and made in to a sticky paste. The seed were treats for half an hour and then dried in shade for 30 minutes and then sown the experimental plot immediately. These healthy seedling uniform shape and size were selected and transplanting in well prepared field. 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, diameter 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, Biological yield was calculated on the basis of total weight of plant at last harvest, harvest index was calculated on the ratio of the economic yield to the biological yield produced. It was calculated by the formula of (Singh and Stoskoff, 1971).

$$\text{Harvest index (\%)} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

The net return of each treatment was calculated by deducting the cost of cultivation from the gross return of individual treatment. Benefit– cost ratio was calculated as follows: Benefit: cost ratio = $\frac{\text{Net return}}{\text{Cost of cultivation}}$

All the parameters were collected from five randomly selected plants of each treatment. Least significant difference at 5% level was used for finding the significant differences among the treatment means. The data obtained from selected plants were subjected to analysis of variance Panse and Sukhamate (1961)

Result and discursion-

It is evident from the data (Table 1&2 and Fig. 1 & 2) that application of different bio-regulators also had significant influence on the yield parameters of sprouting broccoli. The maximum weight of primary curd per plant (213.17 g) was recorded in B₁ treatment (Brassinoids @ 5 ppm), followed by B₂ (209.33 g), while minimum (174.92 g) was recorded under control (water spray) in pooled data basis. The treatment B₂ (Brassinoids @ 10 ppm) was noted statistically at par with treatment B₁ (Brassinoids @ 5 ppm). The increase in curd yield per plant under B₁ was registered 21.86, 13.10 and 8.02 per cent higher over control, B₄ and B₃ treatments, respectively.

The pooled data showed that maximum number of secondary curds (6.20) were recorded under treatment B₁ (Brassinoids @ 5 ppm), while it was found minimum (5.12) under control. The treatment B₁ was observed as significantly superior over rest of treatments but remained statistically at par with treatment B₂ (Brassinoids @ 10 ppm). The increase in number of secondary curds in B₁ were 21.09, 6.16 and 5.77 per cent higher than B₀, B₄ and B₃ treatments, respectively.

The significantly higher value (147.36 g/plant) of the weight of secondary curds was recorded under B₁ treatment (Brassinoids @ 5 ppm). While it was remained at par with B₂ treatment (Brassinoids @ 10 ppm). However, the minimum weight of secondary

curds (117.95 g per plant) was recorded under B₀ treatment (water spray) in pooled mean analysis. The per cent increase in weight of secondary curds in B₁ treatment was noted 24.93, 11.15 and 8.22 per cent higher over B₀, B₄, and B₃ treatments, respectively.

The pooled data showed that the maximum volume of curd (114.15 cc) was found under B₁ treatment (Brassinoids @ 5 ppm). However, treatment B₂ was found statistically at par with treatment B₁. The increase in volume of curd was registered as 20.51, 6.23 and 5.22 per cent higher in treatment B₁ over control, B₄ and B₃ treatments, respectively.

The pooled data showed that the maximum curd diameter (12.18 cm) was registered in B₁ treatment (Brassinoids @ 5 ppm), while minimum curd diameter 10.12 cm was noted in control. The treatment B₁ registered 20.36, 6.65 and 5.36 per cent more curd diameters over B₀, B₄ and B₃ treatments, respectively. While B₂ was found statistically at par with treatment B₁.

The treatment B₁ (Brassinoids @ 5 ppm) recorded the maximum curd yield per plant (362.57 g) in pooled mean. This treatment remained at par with B₂ (Brassinoids @ 10 ppm) but proved significantly superior over rest of the treatments. However the minimum curd yield per plant was recorded in control (295.98 g). Application of B₁ treatment registered by 22.50, 11.94 and 8.84 per cent higher curd yield per plant over B₀, B₄ and B₃ treatments respectively, in pooled mean basis.

Application of BR @5 ppm recorded maximum curd yield (7.42 kg/plot) which was noted statistically at par with treatment B₂. The increase in curd yield per plot under B₁ was registered as 35.40, 13.28 and 10.42 per cent more over control, B₄ and B₃ treatments, respectively.

The maximum curd yield (183.19 q/ha) was recorded with the application of brassinoids @ 5 ppm (B₁) than other treatments except B₂ was found statistically at par with B₁. The increase in yield under B₁ was registered as 35.35, 13.24 and 10.43 per cent higher over control, B₄ and B₃ treatments, respectively on pooled mean basis.

Pooled data showed that the maximum biological yield 1002.18 q/ha was recorded with the application of Brassinoids @ 5 ppm (B₁), However, the minimum (847.89 q/ha) under control (B₀). The treatment B₂ found statistically at par with B₁. The

increase in biological yield under B₁ was registered as 18.20 per cent higher over control.

The harvest index of sprouting broccoli was affected non-significantly with different sources of RDF and bio-regulators during both the year and pooled mean analysis. The results showed that application of Brassinoids 5 ppm and Brassinoids 10 ppm significantly enhanced all the above yield parameters over control. The yield of sprouting broccoli was found to be strongly influenced by the application of brassinoids thus indicating the importance of brassinoids in increasing the yield potential through their effect of various physiological and biochemical traits. This could be attributed to the stimulatory effect of brassinoids on cell division and elongation. From the findings it is evident that increase in curd formation and development of sprouting broccoli there by providing more sources for the better development of sinks. The increase in yield and yield attributes with the application of brassinoids might be because of better utilization of resources in the plants received plant growth regulators. Yield is the consequence of various physiological processes and bio-regulators play an important role in reproduction of plants. These findings are in accordance with the results of Netwal (2018) who reported that brassinoids 1.0 ppm increased number of green pods per plant, green pod yield per plant and per ha (74.11 q /ha) in Indian bean. Brassinoids increased the total biomass and then might have resulted in an increase in assimilate transport from source to sink and their ultimate conversion into final reserved food by Dhall and Singh (2016) in cucumber, Bhadala (2017) in cluster bean and Matwa (2017) in green gram.

Effect of bio-regulators on Economics of sprouting broccoli:

A perusal of data (Table 2 and Fig. 2) revealed that application of different bio-regulators had significantly increased the net returns and B:C ratio of sprouting broccoli. The maximum net returns ₹ 287563 per ha was recorded with 5 ppm brassinoids (B₁) and treatment B₂ (Brassinoids @ 10 ppm) remained statistically at par with B₁. This treatment registered increase of 35.47, 13.13 and 10.42 per cent higher net returns over B₀, B₄ and B₃ treatments, respectively. While minimum net returns (₹ 212271) was recorded in B₀ treatment.

The maximum B:C ratio of (3.99:1) was recorded in B₁ treatment (Brassinoids @ 5 ppm) and minimum B:C ratio (3.28:1) was recorded under control. B₁ (Brassinoids @ 5 ppm) treatment was recorded statistically at par with B₂ (Brassinoids @ 10 ppm). The treatment B₁ registered an increase of 21.65, 7.55 and 7.25 per cent higher B:C ratio than B₀, B₃ and B₄ treatments, respectively. It was probably due to the magnificent role played by application of bio-regulators *i.e.* brassinoids in improvement of growth, yield and quality attributes of sprouting broccoli therefore, the proportional increase in yield led to ultimately resulted in significantly higher net returns and B:C ratio. Similar results have also been reported by Netwal (2018) who reported maximum net returns at 1 ppm of brassinoids in Indian bean.

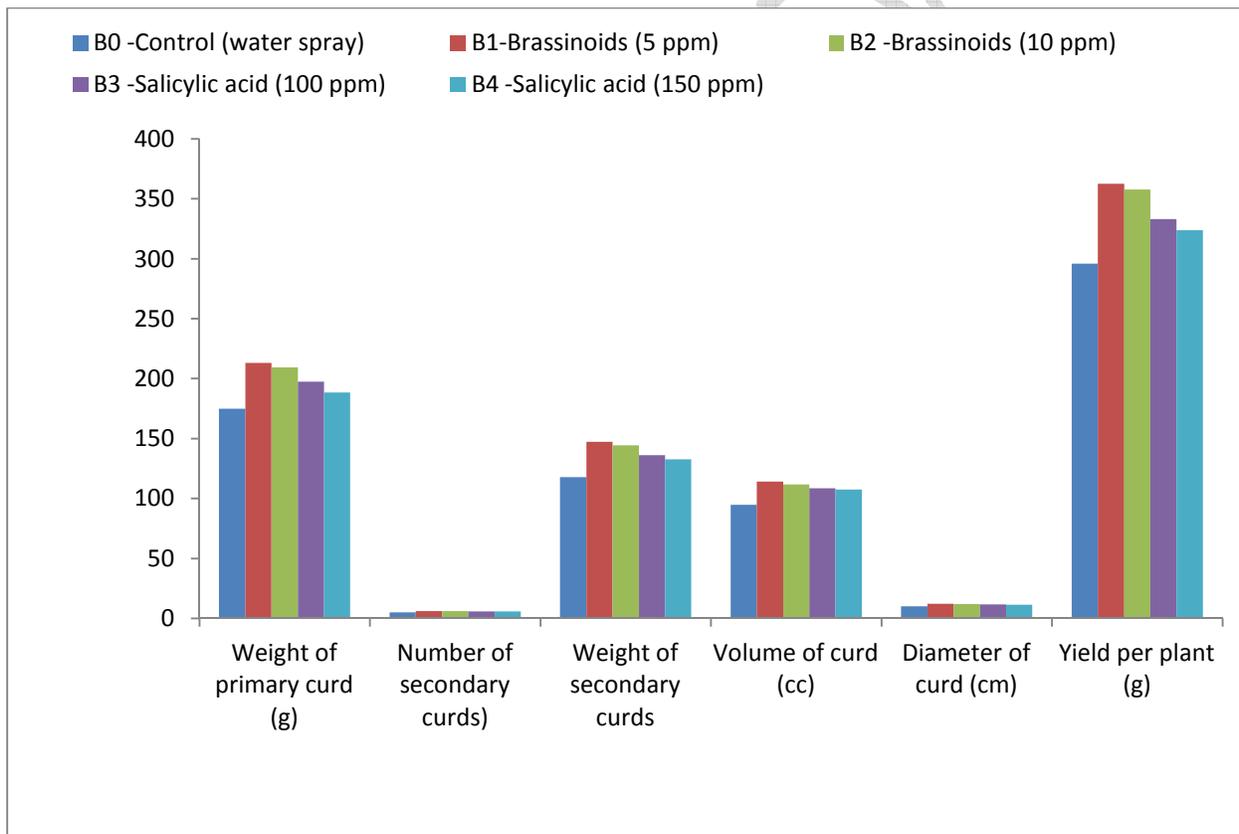


Fig.1 Effect of bio-regulators on yield attributes of sprouting broccoli

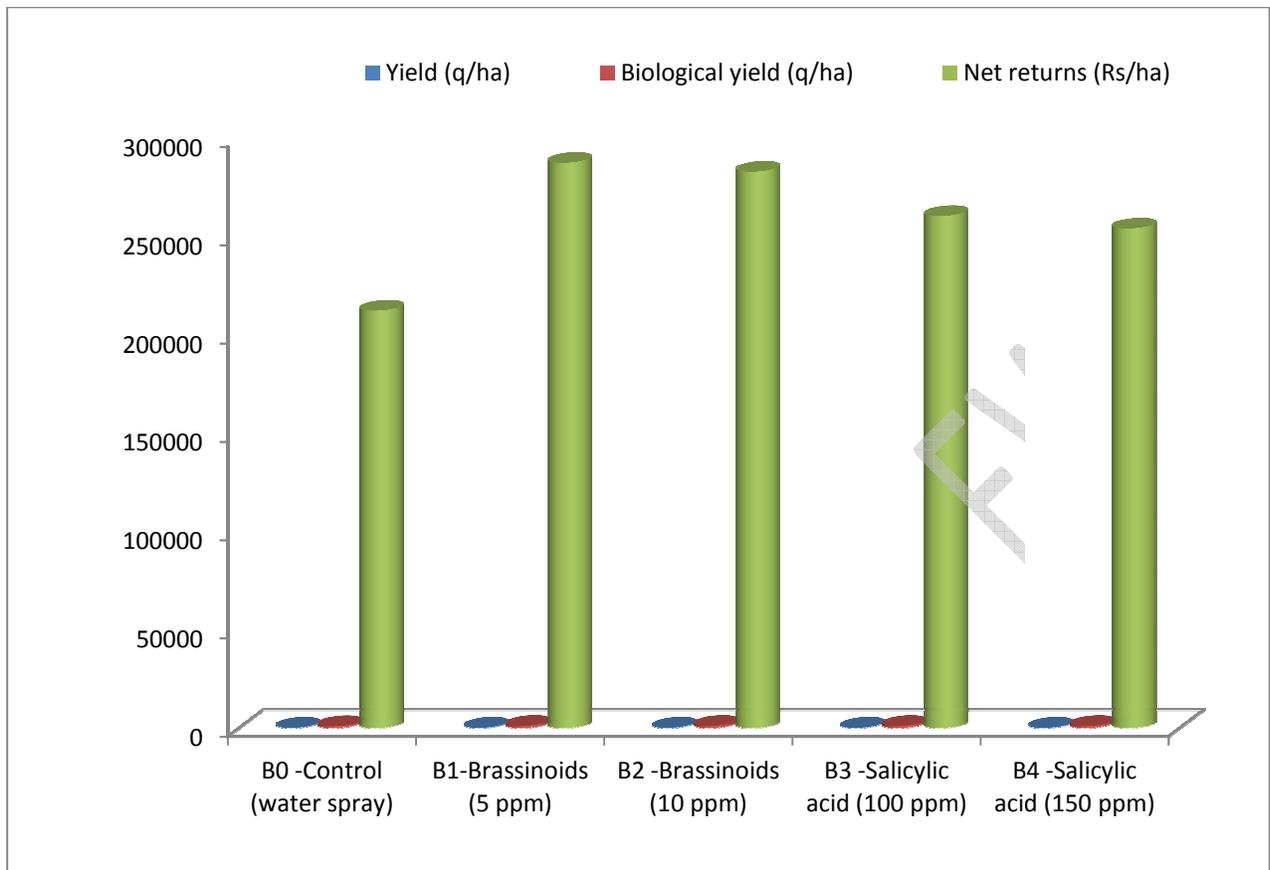


Fig.2 Effect of bio-regulators on yield attributes of sprouting broccoli

Table 1 Effect of INM on Yield attributes of sprouting broccoli.

Treatments	Weight of primary curd (g)	Number of secondary curds)	Weight of secondary curds	Volume of curd (cc)	Diameter of curd (cm)	Yield per plant (g)
B₀ -Control (water spray)	174.92	5.12	117.95	94.72	10.12	295.98
B₁ -Brassinoids (5 ppm)	213.17	6.20	147.36	114.15	12.18	362.57
B₂ -Brassinoids (10 ppm)	209.33	6.10	144.25	111.62	11.98	357.79
B₃ -Salicylic acid (100 ppm)	197.35	5.88	136.17	108.49	11.56	333.13
B₄ -Salicylic acid (150 ppm)	188.48	5.84	132.58	107.46	11.42	323.87
SEm±	2.33	0.07	1.62	1.29	0.14	3.95
CD (P=0.05)	6.54	0.20	4.53	3.63	0.39	11.07

Table 2 Effect of Bio-regulators on yield and economics attributes of sprouting broccoli.

Treatments	Yield per plot (kg)	Yield (q/ha)	Biological yield (q/ha)	Harvest index	Net returns (Rs/ha)	B:C ratio
B₀ -Control (water spray)	5.48	135.35	847.89	17.09	212271	3.28
B₁ -Brassinoids (5 ppm)	7.42	183.19	1002.18	18.19	287563	3.99
B₂ -Brassinoids (10 ppm)	7.30	180.14	982.54	17.68	283064	3.87
B₃ -Salicylic acid (100 ppm)	6.72	165.89	948.13	17.38	260416	3.71
B₄ -Salicylic acid (150 ppm)	6.55	161.77	929.12	17.36	254181	3.72
SEm±	0.07	1.72	11.34	0.21	2711.64	0.05
CD (P=0.05)	0.20	4.83	31.76	NS	7598.25	0.13

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