Original Research Article

AMMONIUM MOLYBDATE : A Potential Bioregulator for Improving Curd Yield and Quality in Broccoli

ABSTRACT

To study the influence of foliar feeding of Boric acid, Ammonium molybdate, Gibberelic acid, Zinc sulphate and Triacontanol on curd yield and quality of broccoli (*Brassica oleracea Var. Italica*) under naturally ventilated polyhouse conditions during *rabi* season of 2020-21 at College of Horticulture, Venkataramannagudem. The experiment consists of 15 treatments laid out in Randomized Block Design (RBD) with three replications. Ammonium molybdate @0.40% significantly increased the curd weight, diameter, length and total yield per plot. Foliar application of GA3@75ppm+ Boric acid @0.40% + Ammonium molybdate @0.40% increase the ascorbic acid content. High to moderately compact curds observed in the treatments T_1(Boric acid @ 0.25%), T_6(Ammonium molybdate @0.50%) and T_8(Boric acid @0.50% + Ammonium molybdate @0.50%).

Keywords: Broccoli, Foliar, Ammonium molybdate, Compact, Ascorbic acid

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INTRODUCTION

Broccoli is a prominent exotic cool season vegetable crop belongs to cruciferae family. It is believed to be originated in the Mediterranean region (Decoteau, 2000). However due to its nutritional importance and commercial value (Yoldas *et al*., 2008) its consumption and cultivation by farmers was increased significantly. The edible part consists of thick fleshy flower stalk with green buds which are terminal, loose and longer than cauliflower (Bose *et al*., 2002). Broccoli is a nutritionally rich vegetable and it contains good amount of vitamin C, vitamin A, potassium, folic acid and several phytochemicals. Compared to cauliflower and cabbage (130, 22) times higher vitamin A is observed in sprouting broccoli respectively (Singh, 2007). It contains sulphoraphane, a compound associated with reducing the risk of cancer (Singh, 2007). It has as much calcium as milk, and is therefore an important source of nutrition for those with osteoporosis or calcium deficiencies.

PGRs had extensive utilization globally for many applications like enhancing uniformity, advancing maturity and increasing yield. Bounded research is obtainable on the utility of PGRs in broccoli production. Although it was reported that GA_3 had adverse effects on the quality of the broccoli heads due to opening of florets which resulted in bringing down the marketable yield, it was also known to increase the head size (Clinton McGrath, 2016). Boron, molybdenum and zinc are the essential micronutrients required for normal growth and development in broccoli. Thus, Boric acid, ammonium molybdate, zinc sulphate, gibberelic acid and triacontanol were selected primarily in the present investigation due to the role of PGRs and micronutrients in plant growth and development**.**

MATERIAL AND METHODS

The experiment was laid out in Randomized complete block design with three replications and 15 treatments under naturally ventilated polyhouse at College of Horticulture, Venkataramannagudem during *Rabi,* 2020-2021. The observations recorded were plant height (cm), stem girth (cm), number of leaves, canopy spreading (cm^2), curd weight (g), curd diameter (cm), curd length (cm), number of fingers per main curd, compactness and vitamin-C (mg/100g). All the observations were taken following standard record and vitamin C content was determined by titration of sample against 2,6-dichlorophenol-indophenol. Scoring was given to measure the compactness of the curd from 1 to 4 where score 1- highly compact curd, 2- moderately compact curd, 3- less compact curd and 4- loose curds. Analysis of variance (ANOVA) was estimated to know the significant differences among the treatments.

Table 1 : Details of treatments

Treatments	Treatment Details
T_1	H_3BO_3 @0.25%
T_2	H_3BO_3 @0.40%
T_3	H_3BO_3 @0.50%
T_4	NH_4MoO_4@0.25%
T_5	NH_4MoO_4@0.40%
T_6	NH_4MoO_4 @0.50%
T_7	H_3BO_3 @0.40% + NH_4MoO_4 @0.40%
T_8	H_3BO_3 @0.50% + NH_4MoO_4 @0.50%
T_9	GA_3@75 ppm
T_{10}	$ZnSo_4$@0.60%
T_{11}	$ZnSo_4$ @0.60% + H_3BO_3 @0.40% + NH_4MoO_4 @0.40%
T_{12}	GA_3 @75 ppm + H_3BO_3 @0.40% + NH_4MoO_4 @0.40%
T_{13}	Triacontanol @0.5mg/l
T_{14}	Triacontanol @1.0 mg/l
T_{15}	Triacontanol @1.5 mg/l

H_3BO_3- Boric acid; NH_4MoO_4- Ammonium molybdate; $ZnSo_4$- Zinc sulphate;

RESULTS AND DISCUSSION

The trait height of the plant recorded maximum (67.333) in T_3 which was on par with T_{12} (62.333) while minimum (45.6) was found in T_{11}. The maximum stem girth was noticed in T_3 (21.867) on par with T_4 (20.2) followed by T_2 (19.2) and minimum girth in T_{11} (11.867). The data on canopy spreading recorded maximum in T_3 (89.867); minimum in T_1 (67). Foliar application of boric acid @ 0.50% has significantly

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improved the plant height, stem girth and canopy spreading in broccoli. The element boron has a major role in development of cell wall and cell differentiation which resulted in enhancing the growth of the plant. Similar results were reported by mamunur *et al.* 2015, quratul *et al.* 2016, and singh *et al.* 2017 in broccoli.

The data related to number of leaves in table 1 shows that T_7 has maximum leaves (48.867) which was on par with T_4 (45.467) and found minimum in T_8 (26) *i.e.*, highest number of leaves was recorded in plants sprayed with the combination of boric acid @ 0.40 % + Ammonium molybdate @ 0.40% which shows that plants subjected to combined effect was showing better performance than sole application regarding this trait. Boron plays an important role in transportation of carbohydrates and stimulates the activation of certain harmones. The foliar application of boric acid can protect stomata from drying and help to remain opened. These results were in accordance with those reported by quaratul *et al*. 2016 and vaibhav *et al.* 2018 on broccoli growth. Nitrate reductase activity is reduced by Mo deficiency which is needed to convert inorganic phosphates to organic forms and also involved in several enzyme systems like nitrogenous nitrate reductase, xanthene oxidase, aldehyde oxidase and sulphate oxidase. Nitrogen metabolism is adversely affected by molybdenum deficiency. Ammonium molybdate caused better nitrogen metabolism and showed higher number of leaves in the experiment. These results were in accordance with those reported by brent *et al.* 2005, ningawale *et al*. 2015 and patel *et al.* 2017 in broccoli.

Maximum curd weight observed in T_5 (488.267) followed by T_4 (454.733) and minimum in T_{11} (107). Table 1 shows that T_5 (21.4) has maximum curd diameter followed by T_4 (20.2) whereas lowest in T_{14} (7.8). The trait has its maximum and minimum curd length with T_5 (20.4) and T_9 (10.6) respectively. Maximum number of fingers per main curd observed in T_4 (13.267) followed by T_{12} (11.8) which inturn was on par with T_6 (11.733) while minimum in T_5 and T_7 *i.e.*, (8). Ammonium molybdate makes the availability of nitrogen to the plant which is proportionate to high vegetative growth and photosynthetic activity. As the food assimilates from source to sink that leads to more production of curds in terms of curd weight, diameter and length. These results were contradictory with those reported by kanase *et al*.2018 and vaibhav *et al.* 2018 in broccoli.

Table 2: Effect of different treatments on curd yield and quality characters of sprouting broccoli.

Treatment	Plant height	Stem girth	Number of leaves	Canopy spreading	Curd weight	Curd diameter	Curd length	Number of fingers/ main curd	Vit - C	Total yield per plot	Compactness
	Mean	**Mean**	**Mean**	**Mean**	**Mean**	**Mean**	**Mean**	**Mean**	**Mean**	**Mean**	**Scoring**
1	51.00	15.33	41.93	67.00	283.40	18.13	16.40	11.40	74.20	4.25	1.4
2	49.67	19.20	43.40	88.27	299.73	17.67	12.33	10.67	77.04	4.49	1.8
3	67.73	21.87	38.00	89.87	346.07	17.87	16.67	9.47	91.64	5.19	1.7
4	45.60	20.20	45.47	84.00	454.73	20.20	19.73	13.27	90.57	6.82	1.6
5	56.07	15.80	41.87	74.00	488.27	21.40	20.40	8.00	98.47	7.32	1.5
6	53.60	15.00	38.07	72.73	291.80	18.33	20.13	11.73	76.72	4.37	1.4
7	45.33	16.60	48.87	74.53	131.67	13.40	14.87	8.00	101.22	1.97	1.8
8	58.80	14.27	26.00	78.67	134.13	15.40	16.00	8.27	82.88	2.01	1.4

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9	58.60	13.07	39.33	77.73	120.00	12.93	10.60	8.33	95.45	1.80	1.6
10	61.53	12.33	33.67	74.60	111.00	12.93	11.27	8.67	97.39	1.66	1.6
11	61.07	11.87	37.60	74.33	107.00	6.33	11.60	9.33	82.48	1.60	3.8
12	62.33	12.40	43.60	77.47	308.07	19.00	20.13	11.80	104.56	4.62	3.1
13	61.47	12.27	35.47	73.27	209.33	13.60	15.13	9.07	80.87	3.13	2.3
14	60.40	12.73	39.53	78.13	284.93	7.80	15.67	10.60	86.64	4.27	4
15	58.87	12.73	45.20	76.53	292.40	9.00	17.40	9.53	96.67	4.38	4
C.D. (5%)	6.97	2.08	10.56	6.02	21.54	1.14	0.60	0.51	2.11	0.32	
SE(m)	2.39	0.71	3.63	2.07	7.40	0.39	0.21	0.17	0.72	0.11	
SE(d)	3.38	1.01	5.13	2.92	10.46	0.55	0.29	0.25	1.02	0.16	

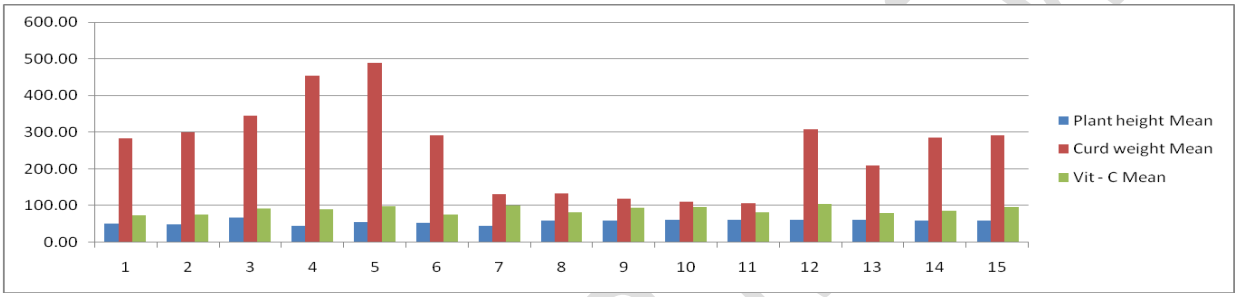

Figure 1 : Average mean performance of plant height, curd weight and vitamin-C content in sprouting broccoli among different treatments

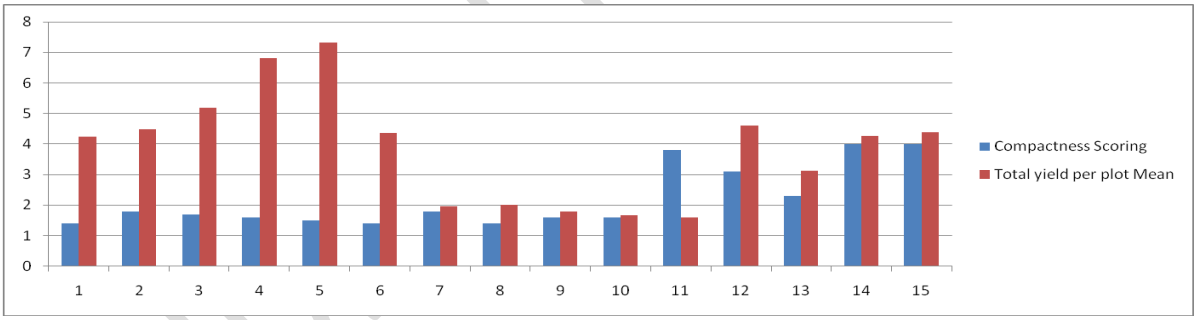

Figure 2 : Average mean performance of compactness and total yield per plot in sprouting broccoli among different treatments

The data pertaining to vitamin C found maximum in T_{12} (104.563) followed by T_7 (101.219) and minimum in T_1 (74.195). The maximum vegetative growth influence other characters which increase metabolic activities of plants due to application of PGR such as GA3 improves the vitamin-c content of broccoli head, Ultimately improving in quality of broccoli. These results are in line with manjith *et al*. 2011 and pooja *et al.* 2019 in broccoli

Total yield per plot recorded maximum in T_5 (7.32) followed by T_4 (6.82) while minimum was found in T_{11} (1.6). Total yield per plot was highest in the plants having maximum curd length, diameter and weight *i.e.*, plants subjected to foliar application of ammonium molybdate @0.40%. Based on the spearmans formulae compactness was calculated and given scoring from 1-4 ; Highly compact -1, Moderately compact- 2, less

compact-3, Loose curds-4. T_1, T_6 and T_8 treatments exhibited mean scoring of 1.4 being high to moderately compact curds whereas T_{14} and T_{15} shows loose curds with scoring 4.

CONCLUSION

The findings helped to conclude that the application of ammonium molybdate increases yield; sole and combined application of ammonium molybdate and boric acid significantly improves compactness whereas foliar spray of PGR such as GA_3 in combination with ammonium molybdate and boric acid improves quality through increased vitamin-c.

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