



Ammonium Molybdate: A Potential Bioregulator for Improving Curd Yield and Quality in Broccoli

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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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 T1 (Boric acid @ 0.25%), T6 (Ammonium molybdate @ 0.50%) and T8 (Boric acid @ 0.50% + Ammonium molybdate @0.50%).

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1. INTRODUCTION

Broccoli is a prominent exotic cool season vegetable crop belongs to cruciferae family. It is believed to be originated in the Mediterranean region [1]. However due to its nutritional importance and commercial value [2] 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 [3]. 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 [4]. It contains sulphoraphane, a compound associated with reducing the risk of cancer [4]. 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 GA₃ 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 [5]. 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.

2. MATERIALS AND METHODS

The experiment was laid out in Randomized complete block design using paraiso which is a F₁ hybrid variety of broccoli 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 (cm²), 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.

3. RESULTS AND DISCUSSION

The trait height of the plant recorded maximum (67.33) in T₃ which was on par with T₁₂ (62.33) while minimum (45.60) was found in T₁₁. The maximum stem girth was noticed in T₃ (21.87) on par with T₄ (20.20) followed by T₂ (19.20) and minimum girth in T₁₁ (11.87). The data on canopy spreading recorded maximum in T₃ (89.87); minimum in T₁ (67.00). Foliar application of boric acid @ 0.50% has significantly 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. [6]; Quratul et al. [7]; Singh et al. [8] in broccoli.

The data related to number of leaves in Table 2 shows that T₇ has maximum leaves (48.87) which was on par with T₄ (45.47) and found minimum in T₈ (26.00) 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 hormones. 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. [9] 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. [10]; Ningawale et al. [11]; Patel et al. [12] in broccoli.

Maximum curd weight observed in T₅ (488.27) followed by T₄ (454.73) and minimum in T₁₁ (107.00). Table 1 shows that T₅ (21.40) has maximum curd diameter followed by T₄ (20.20) whereas lowest in T₁₄ (7.80). The trait has its maximum and minimum curd length with T₅ (20.40) and T₉ (10.60) respectively. Maximum number of fingers per main curd observed in T₄

(13.27) followed by T₁₂ (11.80) which inturn was on par with T₆ (11.73) while minimum in T₅ and T₇ i.e., (8.00). 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. [13]; Vaibhav et al. [9] in broccoli.

Table 1. Details of treatments

Treatments	Treatment Details
T ₁	H ₃ BO ₃ @0.25%
T ₂	H ₃ BO ₃ @0.40%
T ₃	H ₃ BO ₃ @0.50%
T ₄	NH ₄ MoO ₄ @0.25%
T ₅	NH ₄ MoO ₄ @0.40%
T ₆	NH ₄ MoO ₄ @0.50%
T ₇	H ₃ BO ₃ @0.40% + NH ₄ MoO ₄ @0.40%
T ₈	H ₃ BO ₃ @0.50% + NH ₄ MoO ₄ @0.50%
T ₉	GA ₃ @75 ppm
T ₁₀	ZnSo ₄ @0.60%
T ₁₁	ZnSo ₄ @0.60% + H ₃ BO ₃ @0.40% + NH ₄ MoO ₄ @0.40%
T ₁₂	GA ₃ @75 ppm + H ₃ BO ₃ @0.40% + NH ₄ MoO ₄ @0.40%
T ₁₃	Triacantanol @0.5mg/l
T ₁₄	Triacantanol @1.0 mg/l
T ₁₅	Triacantanol @1.5 mg/l

H₃BO₃- Boric acid; NH₄MoO₄- Ammonium molybdate; ZnSo₄- Zinc sulphate

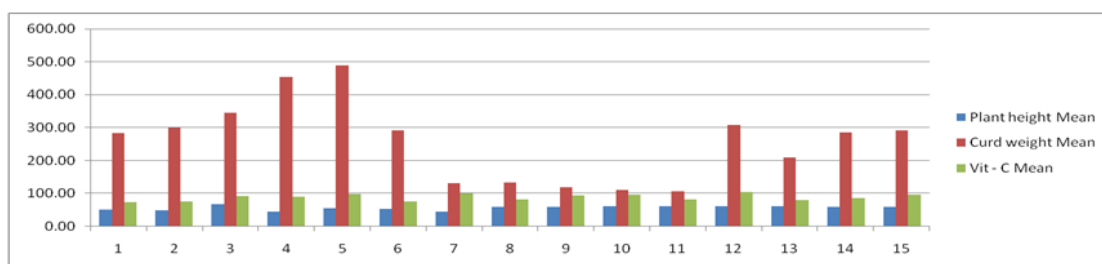


Fig. 1. Average mean performance of plant height, curd weight and vitamin-C content in sprouting broccoli among different treatments

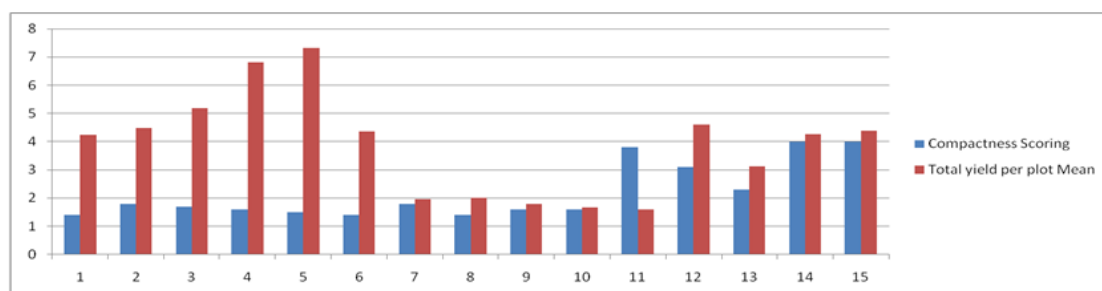


Fig. 2. Average mean performance of compactness and total yield per plot in sprouting broccoli among different treatments

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
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	4.0
15	58.87	12.73	45.20	76.53	292.40	9.00	17.40	9.53	96.67	4.38	4.0
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	

The data pertaining to vitamin C found maximum in T₁₂ (104.56) followed by T₇ (101.22) and minimum in T₁ (74.20). 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. [14]; Pooja et al. [15] in broccoli

Total yield per plot recorded maximum in T₅ (7.32) followed by T₄ (6.82) while minimum was found in T₁₁ (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 spearman's formulae compactness was calculated and given scoring from 1-4; Highly compact -1, Moderately compact- 2, less compact-3, Loose curds-4. T₁, T₆ and T₈ treatments exhibited mean scoring of 1.4 being high to moderately compact curds whereas T₁₄ and T₁₅ shows loose curds with scoring 4.

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 GA₃ in combination with ammonium molybdate and boric acid improves quality through increased vitamin-c.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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