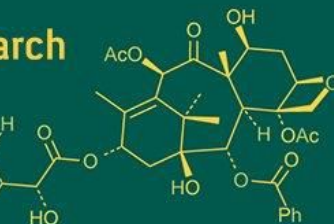
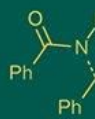
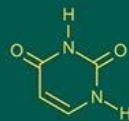
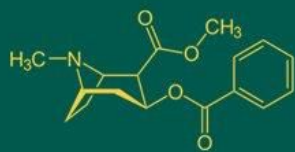


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; SP-8(10): 488-492
www.biochemjournal.com
Received: 25-07-2024
Accepted: 03-09-2024

Ranjeet Kumar Singh
Master Degree Student,
Department of Horticulture,
Naini Agricultural Institute,
SHUATS, Prayagraj, Uttar
Pradesh, India.

Samir Ebson Topno
Assistant Professor,
Department of Horticulture,
Naini Agricultural Institute,
SHUATS, Prayagraj, Uttar
Pradesh, India.

Vijay Bahadur
Professor,
Department of Horticulture,
Naini Agricultural Institute,
SHUATS, Prayagraj, Uttar
Pradesh, India

Corresponding Author:
Ranjeet Kumar Singh
Master Degree Student,
Department of Horticulture,
Naini Agricultural Institute,
SHUATS, Prayagraj, Uttar
Pradesh, India

Effect of GA₃, NAA and Ethrel on plant growth, yield and quality of broccoli (*Brassica oleracea* var. *italica*)

Ranjeet Kumar Singh, Samir Ebson Topno and Vijay Bahadur

DOI: <https://doi.org/10.33545/26174693.2024.v8.i10Sf.2524>

Abstract

An investigation was carried out to evaluate the effect of different plant growth regulators in broccoli which was in terms of growth, yield and quality. This experiment was carried out at the Horticulture research farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh, India during the Rabi season 2023-2024. This experiment consisted 10 treatments combinations and these were replicated thrice. Result showed that, at 90 days after transplanting, Treatment T₆(NAA @ 120 ppm) highest plant height (31.25 cm), number of leaves (23.73), earliest days to harvest (75.67) days, maximum head diameter (15.35 cm), highest yield (12.67 t/ha), TSS 7.40 (⁰Brix) and Vitamin C 64.07 (mg/100 g). In terms of economics also T₆(NAA @ 120 ppm) had highest B:C ratio with 3.64.

Keywords: Broccoli, NAA, GA₃ and Ethrel, growth and head yield

Introduction

Broccoli (*Brassica oleracea* var. *italica*) is a member of the cabbage or mustard family (Brassicaceae, syn. Cruciferae) 2n=18; having 330 genera and 3,500 species, including about 40 *Brassica* species. Broccoli has large flower heads usually dark green, arranged in a tree-like structure branching out from a thick stalk which is usually light green and the flower stalks are longer. The mass of flower heads is surrounded by leaves. Broccoli resembles cauliflower, which is a different but closely related cultivar group of the same *Brassica* species. Broccoli refers to green buds and thick fleshy floral stalks arising from the main stem. Both terminal head and the sprouts with bud clusters are consumed as human food. It is a cool season vegetable crop which is highly nutritious among Cole vegetables. This is not so much popular vegetable in our country. It is mostly cultivated in hilly regions of Himachal Pradesh, Uttar Pradesh, Jammu Kashmir and Nilgiris hills. Sprouting broccoli has about 130 times more vitamin A than cauliflower and 22 times more than cabbage (Singh, 2007) [13]. Broccoli is a nutritional powerhouse full of vitamins, minerals, fibre and antioxidants. Fresh broccoli comprises of 89.1% water, 2500 IU vitamin A and 113 mg vitamin C per 100 g by weight (Dhaliwal, 2012) [4]. Broccoli is high moisture content, proteins, vitamin C, vitamin A, dietary fibre and is low in fats and carbohydrates. As most of green vegetables, broccoli is a good source of minerals, such as calcium, magnesium, phosphorus, potassium, iron, zinc, sodium and selenium (Kmieciak *et al.*, 2007 [7], Vasanthi *et al.*, 2009 [16]). Besides this, edible portion of broccoli is rich source of bioactive components including isothiocyanates, glucosinolates, flavonoids, polyphenols, carotenoids, antioxidant vitamins and selenium (Vasanthi *et al.*, 2009 [16], Mahn and Reyes, 2011 [9]). Broccoli cultivars are cool-weather crops that do poorly in hot summer weather. Broccoli grows best when exposed to an average daily temperature between 18 and 23 °C. vigorous and proper growth, broccoli requires moist soil, well drained soil which contains good fertilizer content is ideal for broccoli farming pH having 5.0-6.5 is optimum for broccoli cultivation. Vegetables are recognized as the most important source of micronutrients. Vegetable consumption can play an important role for eradicating micro-nutritional deficiencies. The inadequate supply of vegetables, particularly during the off-season, higher market price and lesser awareness regarding their consumption are key factors that limit the vegetable consumption rate in India. The per capita vegetable consumption in India 86 (g/day) is far below the ICMR's recommendation 300 (g/day). (FAO, 2021). Trusted Source (g) contains 3% to 3.5% of a person's daily need for calcium, 45–54%, trusted Source of their daily need for vitamin C, and 64–86% of their daily need for vitamin K, depending on their age and sex. The fresh weight of a whole mature broccoli plant can be approximately 776 g, and its leaves constitute the largest portion of a mature plant, accounting for 47%, followed by stalks (21%), roots (17%), and florets (15%).

It is used in curries, soups, pickles, salads, and as a single or mixed vegetable in cooking (Thamburaj and Singh, 2001) [14]. Broccoli, like other non-starchy vegetables, is beneficial for weight management due to being low in calories and rich in fibre. The fibre and water content of broccoli may help you stay full longer due to slowed digestion, and adding broccoli to your diet may help crowd out higher-calorie and ultra-processed foods. On average, the total global amount of broccoli and cauliflower produced is around 25.5 million tons. Broccoli Production by country 2024 China Producing approximately 10,707,171 tons of broccoli each year, China is by far the world's biggest broccoli producer. Followed by India produces about 8.8 million tons per year., United States, Spain. Gujarat is known as a significant contributor to the nation's overall broccoli production (World Population Review, 2024). The major broccoli producing cities in India are Ahmedabad, Rajkot, and Vadodara. Broccoli is a cool-season vegetable. Therefore, it should be planted in cooler months of the year for the best result. The growth of the broccoli plant will get affected by the high-temperature of the summer months. The perfect time to grow broccoli in India is around September-November. The global nutraceutical market is growing, especially in emerging countries. In regards to influence of plant growth regulator, Naphthalene acetic acid (NAA) plays an important role in high quality of vegetable and fruits production NAA is being used to boost up the remarkable vegetable propagation. NAA helps to promotes plants growth by enhancing the cell division, cell differentiation which may initiate the developments of plants organs. It is also essentially required for the formation of roots ,cambium, epicycle which may induce the formation of lateral roots .it is interesting to note that NAA also enhance the flowering ,heavy fruit setting and check abortion of young embryo and fruit drops .plant growth regulator (PGR's) are used extensively in horticulture to enhance plant growth and improve yield by increasing fruit number , fruit set and size several research worker have studied the effect of plant growth substances on vegetable crops. Among them, gibberellins particularly GA₃ and NAA have been reported to show promising a fact on broccoli crop. Thus, it is imperative to determine their concentration, Gibberellic acid and naphthalene acetic acid both are one of the most important growths stimulating substances used in horticulture. Gibberellic acid is a chemical-substances that occur naturally in many plants. It regulates various important function such as elongation of stem, creation of proteins and germination of seed plants. The effectiveness of gibberellic acid and naphthalene acetic acid in broccoli and many other vegetable crops mainly depends on the right quantity applied, time of application, soil conditions as well as prevailing temperature. Ethrel or ethephon (2-chloroethyl phosphonic acid) is ethylene generating commercial chemical. Ethylene is important both in normal development, and for plant response to stress. During normal development, ethylene is thought to co-ordinate events such as growth and development, senescence. Germination, flowering, vegetative development, maturation senescence and response to pathogen are same of the process for which regulation involves ethylene (Bhat *et al.*, 2010) [1].

Thus, this experiment was conducted to the effect of different PGR's in terms of growth, yield and quality of broccoli and also assess the economics of various treatments.

Materials and methods

The field investigation was carried out during *Rabi* season of year 2023-2024 at Horticultural Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj (U.P.) India. The response of foliar application of PGR's, viz. GA₃, NAA and Ethrel with their different concentration. The study was carried out in a randomized block design replicated thrice, and the treatments comprised three levels of each PGR's namely GA₃ (30 ppm, 60 ppm, and 90 ppm), NAA (40 ppm, 80 ppm, and 120 ppm), and Ethrel (50 ppm, 100 ppm, and 150 ppm). Treatments were applied thrice as foliar sprays of synthetic plant hormones upon growing broccoli plants at 1, 30, and 60 days after transplanting in

2 m x 2 m sized plots and spacing 60 cm x 45 cm. The observations like Plant height, Number of leaves per plant, Days to 50% head initiation, Days to harvest, head diameters(cm), Average weight of head (g), Yield (kg/plot), Yield (t/ha), TSS (⁰Brix), Vitamin C (mg/100g). All the cultural operation were followed which necessary to raise the good crop. Apply FYM @ 20-25 t/ha, Nitrogen (N) @150 kg/ha, Phosphorus (P) @ 80 kg/ha and Potassium (K) @ 80 kg/ha were applied through Urea, SSP and MOP to the soil at the time of field preparation (ICAR, 2021-22). The remaining half quantity of an was top dressed four weeks after transplanting. The data collected from five randomly selected plants for above said parameters were subjected to analysis of variance technique (ANOVA) and least significance difference test was applied to separate different treatments means (Panse and Sukhatme, 1967) [11].

Results and Discussion

Results, presented in table 1, table 2 and table 3 revealed that all the studied traits were affected by the treatments and there was completely significant difference between control and foliar application.

Growth attributes

Plant height (cm)

It was observed that statical analysis of data on plant height of broccoli showed significant. It was observed that plant height was significantly influenced by plant growth regulator on growth stages at 30 DAT. significantly highest plant height of broccoli (17.65 cm) was recorded in T₆ NAA @ 120 ppm followed by T₈ Ethrel @ 100 ppm with (17.02 cm). The lowest plant height (12.73 cm) was recorded in T₀ control.

It was observed that plant height was significantly influenced by plant growth regulator on growth stages at 60 DAT. significantly highest plant height of broccoli (24.24 cm) was recorded in T₆ NAA @ 120 ppm followed by T₈ Ethrel @ 100 ppm with (23.39 cm). The lowest plant height (17.51 cm) was recorded in T₀ control.

It was observed that plant height was significantly influenced by plant growth regulator on growth stages at 90 DAT. The significantly highest plant height of broccoli (31.25 cm) was recorded in T₆ NAA @ 120 ppm followed by T₈ Ethrel @ 100 ppm with 30.39 cm. The lowest plant height (23.36 cm) was recorded in T₀ control.

The results obtained in the present studies indicate that plant height was significantly increased due to the treatments T₆ NAA @ 120 ppm, its effect on cell enlargement, cell growth, physiochemical properties of protoplasm, respiration, nitrogen and nucleic acid metabolism etc. NAA promoted cell division in per cycle and cortical tissue. Similar results were reported by Chanwala *et al.*, (2019) [12].

Number of leaves per plant

The data presented that the maximum number of leaves per plant at 30 DAT. It was observed significantly highest number of leaves of broccoli was recorded in T₆ NAA @ 120 ppm (10.66) followed by T₉ Ethrel @ 150 ppm with (10.05). The lowest number of leaves of broccoli was recorded in T₀ control (6.66).

The data presented that the maximum number of leaves per plant at 60 DAT. It was observed the significantly highest number of leaves of broccoli was recorded in T₆ NAA @ 120 ppm (15.22) followed by T₈ Ethrel @ 100 ppm with (14.77). The lowest number of leaves of broccoli was recorded in T₀ control (10.81).

The data presented that the maximum number of leaves per plant at 90 DAT. It was observed significantly highest number of leaves of broccoli was recorded in T₆ NAA @ 120 ppm (23.73) followed by T₉ Ethrel @ 150 ppm with (23.50). The lowest number of leaves of broccoli was recorded in T₀ control (18.96).

The results obtained in the present studies indicate the Number of leaves per plant was significantly increased due to the treatments T₆ NAA @ 120 ppm, its effect on cell enlargement, cell growth, physiochemical properties of protoplasm, respiration, nitrogen and

nucleic acid metabolism etc. NAA promoted cell division in per cycle and cortical tissue. Similar results were reported by Chanwala *et al.*, (2019) ^[2] and Mandingbam *et al.*, (2020) ^[10].

Yield attributes

Days to 50% head initiation: The minimum days to 50 % head initiation (40) days was recorded in treatment T₆ NAA @ 120 ppm. Whereas the maximum days to head initiation (49.39) was found in T₀ control.

The minimum days to 50% head initiation was recorded in treatment T₆ NAA @ 120 ppm. It might be due to their effect on cell elongation and division, increase in photosynthetic activity and better food accumulation may have contribute to the short time head formation. Similar results were reported by Dev *et al.*, (2020) ^[3] and Jakhar *et al.*, (2018) ^[6].

Days to harvesting: The data presented that the maximum number of days to harvest. It was observed significantly highest number of days to harvest of broccoli was recorded in T₀ control (80.33). The lowest number of days to harvest of broccoli was recorded in T₆ NAA @ 120 ppm (75.67).

The minimum days to harvest was obtained in the treatment in T₆ NAA @ 120 ppm. It might be due to its effect on maturity of broccoli. It may reduce the number of days it takes to harvest of broccoli. Similar results were reported by Dev *et al.*, (2020) ^[3].

Head diameter (cm): The highest head diameter of broccoli was observed in the treatment T₆ NAA @ 120 ppm (15.37 cm) followed by T₉ Ethrel @ 50 ppm (14.63 cm). The lowest head diameter of broccoli was recorded in T₀ control (10.40 cm).

The results are in agreement with the finding of Dixit *et al.*, (2020) ^[5], Mandingbam *et al.*, (2020) ^[10] in Broccoli.

Average weight of head (g): The data presented that the maximum weight of head. It was observed significantly highest weight of broccoli was recorded in T₆ NAA @ 120 ppm 342.17 (g) followed by T₉ Ethrel @ 150 ppm 324.43 (g). The lowest weight of broccoli was recorded in T₀ control 300.37 (g).

The highest head was found in the treatment T₆ NAA @ 120 ppm. They help in the synthesis of metabolites as well as translocation of nutrients and assimilation in different parts, which ultimately results in higher yield. Similar findings were found by Sawant *et al.*, (2010) ^[12] and Lendve *et al.*, (2010) ^[8] in Cabbage.

Head yield (kg/plot): The data presented that the maximum head yield. It was observed significantly highest yield of broccoli was recorded in T₆ NAA @ 120 ppm 5.07 (kg/plot) followed by

T₉ Ethrel @ 150 ppm 4.81 (kg/plot). The lowest yield of broccoli was recorded 4.45 (kg/plot) in T₀ control.

The highest head yield was obtained in the treatment in T₆ NAA @ 120 ppm. They help in the synthesis of metabolites as well as translocation of nutrients and assimilation in different parts, which ultimately results in higher head yield. Similar findings were found by Chanwala *et al.*, (2019) ^[2], Thapa *et al.*, (2016) ^[14] and Lendve *et al.*, (2010) ^[8] in cabbage.

Head yield (t/ha): The data presented that the maximum head yield. It was observed significantly highest yield of broccoli was recorded in T₆ NAA @ 120 ppm 12.16 (t/ha) followed by T₉ Ethrel @ 150 ppm 11.16 (t/ha). The lowest yield of broccoli was recorded in T₀ control 10.00 (t/ha).

The highest head yield was obtained in the treatment T₆ NAA @ 120 ppm. They help in the synthesis of metabolites as well as translocation of nutrients and assimilation in different parts, which ultimately results in higher head yield. The results are agreement with the finding of Chanwala *et al.*, (2019) ^[2], Sawant *et al.*, (2010) ^[12] and Lendve *et al.*, (2010) ^[8] in cabbage.

Quality parameters

Total soluble solids (⁰Brix): The data presented that the maximum TSS content. It was observed significantly highest TSS of broccoli was recorded in T₆ NAA @ 120 ppm 7.40 (⁰Brix) followed by T₉ Ethrel @ 150 ppm 7.03 (⁰Brix). The lowest TSS of was recorded in T₀ control 6.24 (⁰Brix). Similar results were reported by Chanwala *et al.*, (2019) ^[2] in broccoli, Thapa, *et al.*, (2016) ^[15] in sprouting broccoli, Dixit *et al.*, (2020) ^[5] reported that application of NAA @ 120 ppm increased TSS content in cauliflower.

Vitamin C (mg/100g): The data presented that the maximum Vitamin C content. It was observed significantly highest Vitamin C content of broccoli was recorded in T₆ NAA @ 120 ppm 64.07 (mg/100 g) followed by T₈ Ethrel @ 100 ppm 63.33 (mg/100 g). The lowest vitamin C content of broccoli was recorded in T₀ control 57.80 (mg/100 g). Similar results were reported by Chanwala *et al.*, (2019) ^[2] in broccoli, Sawant *et al.*, (2010) ^[12] and Jakhar *et al.*, (2018) ^[6].

Economics: Economics the data on the economics of different treatments presented in Table showed that the maximum gross return (INR.462080 /ha), net return (INR. 362560 /ha) and B:C ratio (3.64) was recorded T₆ NAA @ 120 ppm and the minimum gross return (INR. 380000 /ha), net return (INR. 281035 /ha) and B:C ratio (2.83).

Table 1: Plant height (cm) and Number of leaves per plant

Treatments	Plant Height (cm)			Number of leaves per plant		
	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT
T ₀ Control	12.73	17.51	23.36	6.66	10.81	18.96
T ₁ GA ₃ @ 30 ppm	13.69	19.40	25.84	7.00	11.33	20.70
T ₂ GA ₃ @ 60 ppm	13.85	19.59	26.14	7.37	11.26	20.87
T ₃ GA ₃ @ 90 ppm	14.88	20.54	27.21	7.67	11.41	21.37
T ₄ NAA @ 40 ppm	15.09	21.44	28.38	7.70	13.18	21.90
T ₅ NAA @ 80 ppm	15.37	21.77	28.73	8.66	13.26	22.17
T ₆ NAA @ 120 ppm	17.65	24.24	31.25	10.66	15.22	23.73
T ₇ Ethrel @ 50 ppm	16.45	23.26	30.07	9.02	14.18	23.17
T ₈ Ethrel @ 100 ppm	17.02	23.39	30.39	9.66	14.77	23.40
T ₉ Ethrel @ 150 ppm	16.54	23.07	30.03	10.05	13.52	23.50
F Test	S	S	S	S	S	S
SE. m (±)	0.52	0.56	0.53	0.22	0.33	0.29
CD (5%)	1.56	1.68	1.59	0.66	1.00	0.87
CV	5.88	4.54	3.27	4.55	4.50	2.32

Table 2: Days to 50% head initiation, Days to harvest, Average weight of head (g), Head Yield (kg/plot), Head Yield (t/ha), TSS (⁰Brix), Vitamin C (mg/100 g)

Treatments	Days to 50% head initiation	Days to harvest	Head diameter (cm)	Average weight of head (g)	Head Yield (kg/plot)	Head Yield (t/ha)	TSS (⁰ Brix)	Vitamin C (mg/100g)
T ₀ Control	49.39	80.33	10.40	300.37	4.45	10.00	6.24	57.80
T ₁ GA ₃ @ 30 ppm	45.77	76.67	12.00	305.73	4.53	10.18	6.30	58.03
T ₂ GA ₃ @ 60 ppm	42.54	79.33	12.33	308.30	4.56	10.38	6.44	58.83
T ₃ GA ₃ @ 90ppm	41.17	76.00	12.67	310.33	4.60	10.91	6.52	58.70
T ₄ NAA @ 40 ppm	45.23	77.67	12.83	316.07	4.68	11.23	6.60	59.00
T ₅ NAA @ 80 ppm	43.39	79.00	13.12	322.87	4.78	11.59	6.64	59.17
T ₆ NAA @ 120 ppm	40.00	75.67	15.37	342.17	5.07	12.16	7.40	64.07
T ₇ Ethrel @ 50 ppm	47.67	78.67	13.53	321.53	4.76	11.90	6.78	62.17
T ₈ Ethrel @ 100 ppm	45.00	76.33	14.20	324.17	4.80	11.06	6.83	63.33
T ₉ Ethrel @ 150 ppm	43.05	78.00	14.63	324.43	4.81	11.16	7.03	62.40
F Test	S	S	S	S	S	S	S	S
SE. m (±)	0.70	0.92	0.28	2.05	0.02	0.05	0.10	1.01
CD (5%)	2.08	2.73	0.83	4.31	0.06	0.16	0.29	3.1
CV	2.73	2.05	3.70	0.79	0.80	0.78	2.54	2.91

Table 3: Effect of GA₃, NAA and Ethrel on economic of broccoli

Tr. No.	Head Yield (t/ha)	Selling price (Rs/q)	Gross return (Rs/ha)	Cost of cultivation (Rs/ha)	Net return (Rs/ha)	B:C ratio
T ₀	10.00	38000	380000	98965	281035	2.83
T ₁	10.18	38000	386840	100052	286788	2.86
T ₂	10.38	38000	394440	101140	293300	2.89
T ₃	10.91	38000	414580	102227	312353	3.05
T ₄	11.23	38000	426740	99150	327590	3.30
T ₅	11.59	38000	440420	99335	341085	3.43
T ₆	12.16	38000	462080	99520	362560	3.64
T ₇	11.90	38000	452200	99281	352919	3.55
T ₈	11.06	38000	420280	99597	320683	3.21
T ₉	11.16	38000	424080	99914	324166	3.24

Conclusion

From the above experimental finding it is concluded that the T₆ NAA @ 120 ppm performed best in terms of growth attributes at 90 DAT viz. plant height 31.25 cm, number of leaves 23.73 and minimum days to 50 % head initiation 40 days yield attributes viz. head diameter 15.37 (cm) and yield 5.07 (kg/plot), yield 12.16 (t/ha), quality attributes viz. TSS 7.40 (⁰Brix), Vitamin C content 64.07 (mg/100g). The highest B:C ratio was also found with 3.64 in the same treatment.

Acknowledgement

The authors are thankful to the Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, (U.P.) India, for providing the necessary facilities to undertake the studies.

References

- Bhat M, Mir M, Khan N, Lonr NA, Bhat KA, Razui SM, et al. The role of ethrel in plant growth and development under different environmental conditions. *Int J of Curr Res.* 2010;4:4-13.
- Chanwala P, Soni AK, Sharma D, Choudhary G. Effect of foliar spray of plant growth regulators on growth and quality of sprouting broccoli (*Brassica oleracea* var. *italica* L.). *Int J Curr Microbiol Appl Sci.* 2019;8(8):1846-1852.
- Dev R, Singh VK, Raj S, Shukla KC. Effect of plant growth regulators on growth and yield of cabbage (*Brassica oleracea* var. *capitata*). *J Pharmacogn Phytochem.* 2020;9(3):1024-1026.
- Dhaliwal MS. Handbook of vegetable crops. New Delhi, India: Kalyani Publishers; c2012.
- Dixit A, Sahu TK, Bairwa PL. Effect of foliar application of plant growth regulators on yield, quality and economics of cauliflower (*Brassica oleracea* var. *botrytis* L.) cv. Pant Shubhra. *J Pharmacogn Phytochem.* 2020;9(1):1197-9.
- Jakhar RK, Singh SP, Ola AL, Jat HR, Netwal M. Effect of NAA and boron levels on growth and quality of sprouting broccoli (*Brassica oleracea* L. var. *italica* Plenck). *J Pharmacogn Phytochem.* 2018;7(5):3402-5.
- Kmiecik W, Lisiewska Z, Kourus A. Retention of mineral constituents in frozen brassicas depending on the method of preliminary processing of the raw material and preparation of frozen products for consumption. *Eur Food Res Technol.* 2007;224:573-9.
- Lendve VH, Chavan SD, Barkule SR, Bhosale AM. Effect of foliar application of growth regulators on growth of cabbage cv. Pride of India. *Asian J Hortic.* 2010;5(2):475-8.
- Mahn A, Reyes A. An overview of health-promoting compounds of broccoli (*Brassica oleracea* var. *italica*) and the effect of processing. *Food Sci Technol Int.* 2012;18(6):503-14.
- Mandingbam V, Mandal CK, Jana S. Effect of some plant growth regulators on growth, yield and quality of broccoli (*Brassica oleracea* L. var. *italica* Plenck). *Int J Curr Microbiol Appl Sci.* 2020;9(11):2437-42.
- Panse VG, Sukhatme PV. Statistical methods for agricultural workers. 2nd Ed. New Delhi, ICAR Publication; c1967. p. 381.
- Sawant VP, Naik DM, Barkule SR, Bhosale AM, Shinde SB. Effect of foliar application of growth regulators on growth, yield and quality of cabbage. *Asian J Hortic.* 2010;5(2):495-7.
- Singh NP. Basic concept of vegetable. Lucknow, India: International Book Distributing Co.; c2007. p. 444.

14. Thamburaj S, Singh N. Vegetables, tuber crops and spices. New Delhi, India: Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research; c2001. p. 137.
15. Thapa U, Prasad PH, Rai R. Studies on growth, yield and quality of broccoli (*Brassica oleracea* L. var. *italica* Plenck) as influenced by boron and molybdenum. J Plant Nutr. 2016;39(2):261-7.
16. Vasanthi HR, Mukherjee S, Das DK. Potential health benefits of broccoli-A chemico-biological overview. Mini Rev Med Chem. 2009;9(6):749-59.