

Research Article

Growth and Yield Response of *Brassica oleracea* var. *italica* to Different GA3 Application Time

Md Mamunur Reza¹, Mohidul Islam², Md Azizul Hoque³, RK Sikder⁴ and H Mehraj^{5,6*}

¹Assistant Director, Dashmina Seed Multiplication Farm, BADC, Dashmina, Patuakhali, Bangladesh

²Scientific Officer (Horticulture), Bangladesh Agricultural Research Institute, Dhaka, Bangladesh

³Department of Horticulture, BSMRAU, Salna, Gazipur-1706, Dhaka, Bangladesh

⁴Horticulture Development Division, BADC, Dhaka-1000, Bangladesh

⁵The United Graduate School of Agricultural Sciences, Ehime University, Ehime 790-8556, Japan

⁶Lab of Vegetable and Floricultural Science, Faculty of Agriculture, Kochi University, B200 Monobe, Nankoku, Kochi 783-8502, Japan

Abstract

An experiment was conducted to determine the influence of GA3 on growth, yield and yield contributing characters of broccoli to different GA3 application times. Four GA3 application times [D₁: seedling dipped in GA3 for 24 h before transplanting; D₂: 4 weeks after transplanting (foliar spray of GA3); D₃: 6 weeks after transplanting (foliar spray of GA3) and D₄: 8 weeks after transplanting (foliar spray of GA3)] were used in the experiment; all dips and sprays contained 50 ppm GA3. The maximum number of main fingers (11.9/main curd), main curd length (16.7 cm), main curd diameter (19.3 cm), main curd weight (566.0 g/plant) and yield (22.8 t/ha) was found from dipping seedlings in GA3 for 24 h before transplanting.

Key Words: Broccoli; Gibberellic Acid; Seedling Dipping; Foliar Spray

Introduction

Sprouting broccoli (*Brassica oleracea* var. *italica*) is a winter season vegetable crop, belonging to the Brassicaceae. The popularity of broccoli has increased due to its great nutritional value [1,2,3] in Bangladesh, and there is a trend for farmers to increase cultivation. Broccoli has a high nutritional and commercial value [4]. It is low in sodium, fats and calories, high in vitamin C and a good source of vitamin A, vitamin B2 and calcium [5]. The vitamin A contents in sprouting broccoli is about 130 times higher than cauliflower and 22 times higher cabbage [6].

Much research has been conducted on the uses of plant growth regulators in different crops. Plant growth regulators (PGRs) modify the physiological processes within the plant that influence the plant growth and morphogenesis, which ultimately affects the yield and quality of the crop. Among the PGRs, GA3 is mostly used for growth and yield improvement of the field crops. However, application of PGRs should be in optimal concentrations and applied at the appropriate stage of growth [7]. GA3 was applied by soaking into germination paper for wheat thus stimulates stem or coleoptiles elongation [8]. Sprouting broccoli responds significantly to the applications of GA3 at different concentrations

[9]. Application of GA3 at different times also significantly affects plant growth and yield [10]. Most of the research had been conducted on the foliar spray of different concentration of GA3 in broccoli [11]. But we thought that pre-soaking of seedlings may improve the growth and yield of broccoli more than the foliar sprays. Considering this hypothesis, this study was undertaken to determine the GA3 application time on broccoli growth and yield under the growing conditions found in Bangladesh.

Materials and Methods

The experiment was conducted at the Horticultural Research Farm of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh during the period from October 2, 2012 to January 7, 2013 using a randomized complete block design (RCBD) with three replications. Broccoli (cv. 'Premium Crop') seeds were collected from Manik Seed Company, Siddique Bazar Road, Bangshal, Dhaka, Bangladesh. Firstly seeds were sown in seedbed and then thirty days old healthy seedlings were transplanted into the main field. GA3 at 50 ppm was applied at four different growth stage viz. D₁: seedlings dipped in GA3 for 24 h before transplanting; D₂: 4 weeks after transplanting (foliar spray of GA3); D₃: 6 weeks after transplanting (foliar spray of GA3) and D₄: 8 weeks after transplanting (foliar spray of GA3). The unit plot size was 1.5 × 2.0 m with a plot to plot and replication to replication distance of 0.5 m and 1.0 m, respectively. There were four rows in each plot having three plants per row giving 12 plants per total per

***Corresponding author:** H Mehraj, Faculty of Agriculture, Kochi University, B200 Monobe, Nankoku, Kochi 783-8502, Japan, E-mail: hmehraj02@yahoo.com

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plot. Row to row and plant to plant distance was 50 cm and 50 cm, respectively. Data were collected on plant height (cm), number of leaves per plant, leaf size(cm²), canopy spread (cm), stem diameter (mm), days to curd initiation (1st and 50%), main curd diameter (cm), main curd length, main curd weight/plot, yield/plot (g) and yield (t/ha). The collected data were statistically analyzed using MSTAT-C. The means were separated by Duncan's Multiple Range Test (DMRT) at 5% level of probability [12].

Results

Plant Height, Stem Diameter, Number of Leaves and Canopy Spread

Significant variation was found among the treatments with respect to plant height. The tallest plants were in treatments D₃ (30.8 cm) and D₄ (30.6 cm), which were statistically identical with each other, while the shortest plants were in treatment D₁ (29.3 cm) (Table 1). Stem diameters and canopy spread were similar among the treatments with those from the plants in D₃ (31.3 cm) being significantly smaller than those in the other treatments (Table 1). Significant variation was found among treatments for number of leaves with a trend for leaf number to increase with the lateness of application.

Days to First Flower Initiation, 50% Flower Initiation, Harvest and 50% Harvest

Days to first flower initiation, 50% flower initiation, first harvest and 50% harvest did not vary significantly among the treatments

Number of Fingers and Hollow Stem

Significant variation was found among the treatments for the

number of fingers of broccoli. The maximum number of fingers were found in treatments D₁ (11.9/main curd) and D₃ (11.7/main curd) whereas the minimum was found from D₄ (11.2/main curd) (Table 2). The number of hollow stems did not vary significantly among the treatments.

Main Curd Length, Diameter and Weight

Significant variation was found among the treatments for main curd length, diameter and weight. The longest curds were found in treatments D₁ (16.7 cm) and D₄ (16.0 cm), whereas the shortest were found in D₂ (15.4 cm) and D₃ (15.9 cm) (Table 2). The largest main curd diameters were found in D₁ (19.3 cm) while smallest were found in D₂ (16.4 cm) (Table 2). The main curd weights of the plants in treatments D₁ (566.0 g/plot), D₃ (538.4 g/plot) and D₄ (537.0 g/plot) were similar, but those in D₂ (518.6 g/plot) were lower (Table 2).

Yield

The yield of broccoli showed significant variation among the treatments. However, maximum yield was found from D₁ (22.8 t/ha) followed by D₃ (21.7 t/ha) and D₄ (21.4 t/ha) whereas minimum yield was found from D₂ (20.8 t/ha) (Table 2).

Discussion

In this study, 50 ppm of GA3 was applied at different times. Application by dipping seedling prior to planting gave higher yields than later, foliar applications. In our previous study, we used foliar spray of GA3 at different concentrations and found the highest yield from 50 ppm [13]. We also found that application of more than 50 ppm reduced the yield of broccoli in the conditions

Table 1. Effect of time of GA3 application plant height, stem diameter, number of leaf/plot, canopy spreading, first and 50% flower initiation and first harvest^x

Time of GA3 application	Plant height (cm)		Stem diameter (cm)		Number of leaf/plot		Canopy spreading (cm ²)		Days to first flower initiation		Days to 50% flower initiation		Days to first harvest	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
D ₁	29.3	b	32.9	a	14.8	b	33.6	a	46.7	a	50.7	a	65.5	a
D ₂	30.3	b	33.7	a	15.1	ab	34.3	a	46.6	a	50.7	a	65.6	a
D ₃	30.8	a	31.3	b	15.2	ab	31.9	b	46.3	a	50.0	a	65.3	a
D ₄	30.6	ab	33.6	a	15.4	a	34.3	a	46.7	a	50.8	a	65.7	a
CV (%)	2.4		4.5		3.6		4.5		2.6		2.1		1.8	

^xWith a column, means annotated with means with different letters are significantly different at P = 0.05 according to DMRTs

Table 2. Effect of time of GA3 application on number of finger/main curd, 50% harvest, no of hollow stem/plot, main curd length, main curd diameter, main curd weight/plot and yield^x

Time of GA3 application	No of fingers/main curd		Days to 50% harvest		No of hollow stem/plot		Main curd length (cm)		Main curd diameter (cm)		Main curd weight (g)/plot		Yield (t/ha)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
D ₁	11.9	a	68.5	a	7.5	a	16.7	a	19.3	a	566.0	a	22.8	a
D ₂	11.5	bc	68.7	a	7.9	a	15.4	b	16.4	c	518.6	b	20.8	c
D ₃	11.7	ab	68.0	a	7.9	a	15.9	b	17.5	b	538.4	ab	21.7	b
D ₄	11.2	c	68.8	a	7.6	a	16.0	ab	17.3	b	537.0	ab	21.4	b
CV (%)	3.2		1.5		11.6		5.8		2.8		6.3		3.3	

^xWithin a column, mean means annotated with means with different letters are significantly different at P = 0.05 according to DMRTs.

of Bangladesh [13]. Applications of GA3 have been suggested to increase plant growth and the yield of various species [11,14,15]. In our current study, we used 50 ppm concentration of GA3 to enhance growth and yield performance of broccoli. We used different application time of 50 ppm GA3, here. Root soaking with 50 ppm GA3 has been shown to significantly increase the number of flowers, fruits and yield [16,17]. Applications of GA3 at a vegetative stage also have been shown to increase fruit weight per plant, but this effect was not found by applications of GA3 at the flowering stage [16,18]. The increase in weight of head and yield might be due to accumulation of carbohydrates due to greater photosynthesis, higher food accumulation and better plant growth also by increasing growth characters by cell division, cell elongation and cell expansion that might have ultimately increased in the yield. A similar effect was also observed by Thapa et al. [9] in sprouting broccoli and Yadav et al. [19]; Sawant et al. [20] and Lendve et al. [21] in cabbage. Milanese et al. [22] also conducted an experiment using different application time of GA3 and found variation at different application times in lentil. A significant increase in yield was also found in root treatments by auxin that promoted the root initiation of plant seedlings [23,24]. Mode of GA3 application influenced plant growth and development and, ultimately, yield. Root treatments with GA3 or IAA were also more effective than foliar sprays in promoting the growth of onions [23].

Conclusion

The results showed that the time of GA3 application significantly affected plant height, number of leaves, leaf size, canopy spread, stem diameter, plant vigor, main curd diameter, main curd length, main curd weight/plant and yield, but did not affect crop duration-related parameters. Under Bangladeshi conditions, the growth and yield of broccoli was most improved by a dip 50 ppm of GA3 given to seedlings 24 h before transplanting. Dipping of the seedling was more effective than foliar application of GA3. It is highly suggested to dip the broccoli seedlings 24 h prior to planting for better yield.

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