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Response of gibberellic acid on growth and yield of radish (*Raphanus sativus* L.) Cv. Japanese white

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Abstract
In order to study the response of Gibberellic acid on growth and yield of radish the field experiment was conducted in the year 2010 at Experimental field of Department of Horticulture, College of Agriculture, Gwalior. Observations were recorded on ten yield and yield attributing characters viz., plant height (cm), plant spread (cm), number of leaves/plant, leaf length (cm), fresh weight of leaves/plant (g), root girth (cm),root length (cm), fresh weight of root (g), dry weight of root (g) and yield (q/ha.). Five concentrations of gibberellic acid (10 ppm, 20 ppm, 30 ppm, 40 ppm, 50 pp) along with control were applied on radish and it was concluded that GA3 sprayed at 50 ppm resulted in significantly increased numbers of leaves/plant, leaf length, fresh weight and dry weight of leaves, and root yield.

Keywords: Gibberellic acid, radish, *Raphanus sativus*

Introduction

Radish (*Raphanus sativus* L.) belongs to the family Brassicaceae. Radish is a high value nutritive root crop containing vitamin C @ 15-40 mg/100 g of edible portion and supplies minerals and vitamins. It is a popular vegetable in both tropical and temperate regions. In addition to high nutrient content in root, the leaves of radish are a good source for extraction of protein on a commercial scale and the radish seeds are a potential source of non-drying fatty oils suitable for soap making. The green pods of radish contain 93.3% moisture, 1.3% protein, 0.3% fat, 1.1% fibre, 4.3%, carbohydrates and 0.7% minerals.

Japanese white is a popular variety introduced from Japan and recommended by IARI Regional station, Katrain. Its roots are cylindrical, stumpy, 22-25 cm long and 5 cm in diameter, skin snow white, flesh crisp, solid and mildy pungent. It matures in 45-50 days.

In case of vegetable crops the growth and development is rapid and uninterrupted, hence plant growth regulators are required to regulate seed germination and growth. The growth regulators are used in different ways but generally seed treatment is adapted. Seed treatment is suitable for radish.

Thus, radish being a short duration crop, judicious and proper use of plant growth regulators is very essential to get the maximum and excellent root quality and yield.

Material and methods

The experiment was conducted at Experimental field of Department of Horticulture, College of Agriculture, Gwalior in the year 2009-10. The field was well levelled with adequate irrigation and drainage facilities. The soil of experimental field was sandy loam. The experiment was laid out in Randomized block design using four replications. The plot size was kept at 3.0 X 2.40 m, the seeds of radish were sown by hand dibbling method on 22 cm high ridges to maintain row to row distance 25 cm and plant to plant 10 cm. The seeds of radish variety Japanese white was taken and soaked in prepared solution of each concentration of GA_3 for 12 hours and thereafter seeds were taken out from the solution and dried in shade for 2 hours and in this way harmonised seed were kept for sowing purpose. The data on various observations were subjected to statistical analysis by adopting appropriate method of analysis of variance as described by Fisher (1958) [4].

Results and Discussion

Growth parameters

It is revealed from Table 1 that the tallest plants (8.11, 17.97, 32.66, and 45.36 cm) were recorded with the application of GA_3 at 50 ppm at 10, 20, 30 and 40 DAS, respectively. However this treatment was found at par with GA_3 @ 40, 30 and 20 ppm at 20 DAS.

Minimum plant height (6.00 at 10 DAS, 15.63 cm at 20 DAS, 24.24 cm at 30 DAS and 34.43 cm at 40 DAS) was recorded under control.

Data presented in Table 2 reveals that the plant spread increased significantly with increase in concentrations of GA_3 from 0 to 50 ppm. The higher concentrations of GA_3 were found to be more effective than their respective lower concentrations. However, differences between GA_3 30 and 40 ppm at 10, 20 and 40 DAS; and between GA_3 30 and 40 ppm and 20 and 30 ppm at 30 DAS in respect of this character were not found statistically significant. However, the maximum plant spread i.e. 11.11, 15.52, 16.88 and 27.17 cm and minimum plant spread i.e. 8.86, 12.87, 14.51 and 23.36 cm was recorded by soaking of radish seeds for 12 hrs in the solution of GA_3 at 50 ppm and without soaking of seeds at 10, 20, 30, and 40 DAS, respectively.

Data presented in Table 3 reveals that the maximum number of leaves per plant (3.21, 5.53, 9.39, and 13.60) was obtained with the treatment G_5 (GA_3 @ 50 ppm) at 10, 20, 30, and 40 DAS, respectively. It remained at par with G_4 (GA_3 @ 40 ppm) and G_3 (GA_3 @ 30ppm) at all crop growth stages. Minimum leaves (2.10, 3.74, 7.18, and 11.70 at 10, 20, 30, and 40 DAS, respectively) was recorded under control, which was found significantly inferior to that recorded under any concentration of GA_3 at all stages of crop growth expect with 10 ppm at 40 DAS.

Longest leaf recorded at 10 and 20 DAS with GA_3 @ 50 ppm, whereas, at 30 and 40 DAS, leaf length with GA_3 @ 50 ppm was at par with GA_3 @ 20 ppm. However significantly longest leaf was recorded with the application of GA_3 @ 50 ppm, and GA_3 @ 20 ppm at 30 and 40 DAS over application of GA_3 @ 10 ppm and

All the treatments of GA_3 increased the fresh weight of leaves/plant significantly over control at all the crop growth stages except non-significant difference between 0 and 10 ppm concentrations of GA_3 at 40 DAS. Fresh weight of leaves/plant was maximum with G_5 (seed treatment with GA_3 @ 50 ppm), which was however, at par with G_4 (seed treatment with GA_3 @ 40 ppm) at 10, 20, and 30 DAS and with G_4 and G_3 (seed treatment with GA_3 @ 40 ppm and seed treatment with GA_3 @ 30 ppm) at 40 DAS. Furthermore, the differences between any two adjoining concentrations of GA_3 from 0 to 40 ppm at 10 to 20 DAS and from 0 to 30 ppm at 30 DAS were found statistically significant (Table 5).

At final stage i.e. at 40 DAS, treatments G_5 followed by G_4 gave the maximum values of all the growth parameters. This increase was attributed to the continuous supply of nutrients due to hormonal action of GA_3 by activating and enhancing the cell division, multiplication and enlargement. The findings in regards to the effect of GA_3 on growth characters confirm earlier results of Singh *et al*. (1990) [13], Yi *et al*. (1992) [14], Abdel (1996) [1], Pawar *et al*. (1997) [10], Singh and Rajodia (2001) [11], Dhariwal (2005) [3], Mishra and Pathak (2005) [8], Mukharjee and Roy (2006) [9], and Jatav (2007) [6].

Yield parameters

Girth of root differed significantly among various treatments (Table 6). Maximum girth of root (5.29 cm) was recorded with treatment G_5 and was comparable with G_4 (5.28 cm). The minimum girth of root was recorded in treatment G_0 (4.09 cm), which was at par with G_1 (4.74 cm) and was significantly lower than that recorded in rest of the treatments (Table 6).

Seed treated with GA_3 @ 50 ppm resulted in longest root (29.21 cm), which was significantly at par with treatments G_4 (GA_3 @ 40 ppm), G_3 (GA_3 @ 30 ppm). Whereas, minimum root length (26.33 cm) was recorded from control and was significantly smaller than that recorded under highest used concentration of GA_3 @ 50 ppm (Table 6).

The fresh weight of root varied significantly due to different treatments (Table 6). Maximum fresh weight of root (136.38 g) recorded with the application of GA_3 @ 50 ppm and was at par with GA_3 @ 40 ppm and GA_3 @ 30 ppm. The minimum fresh weight of root was recorded under control (96.25 g) followed by G_1 (107.18 g).

The data (table 6) in respect of dry weight of root revealed that it was significantly influenced by different treatments of GA_3. The maximum dry weight of root (28.576 g) was recorded in the treatment G_5 (seed treatment with GA_3 @ 50 ppm) closely followed by the treatment G_4 (seed treatment with GA_3 @ 40 ppm) (27.810 g) and G_3 (seed treatment with GA_3 @ 30 ppm) (27.339 g). The treatment next in order was G_2 (seed treatment with GA_3 @ 20 ppm), which was significantly superior then G_1 (seed treatment with GA_3 @ 10 ppm) (21.930 g) and control. The minimum root dry weight of 21.70 g was noted in the control.

The data (Table 6) in respect of yield of radish revealed that it was significantly increased by all the treatments of GA_3 over control except GA_3 @ 10 ppm. Maximum yield of 335.36 q/ha was recorded in the treatment G_5 (seed treatment with GA_3 @ 50 ppm). Other treatments found sequentially better were G_4 (seed treatment with GA_3 @ 40 ppm) (330.19 q/ha), G_3 (seed treatment with GA_3 @ 30 ppm) (317.43 q/ha) and which were at par with each other and both treatments were found significantly superior to G_1 (seed treatment with GA_3 @ 10 ppm) and control. The minimum yield (236.85 q/ha) was recorded in the control closely followed by G_1.

Treatment G_5 recorded maximum value of yield attributes followed by G_4. This increase in yield as well as yield attributes by GA_3 may be due to increased vegetative growth and foliage giving better opportunities for photosynthetic activities and consequently increasing carbohydrates in the roots resulting high yield.

The similar results pertaining to effect of GA_3 on yield and yield attributes of radish were obtained by Mishra (1989) [7], Singh *et al* (1989) [12], Singh *et al* (1990) [13], Deore and Bharud (1991), Nirmal *et al*. (1994), Abdel (1996) [1], Pawar *et al*. (1997) [10], Singh and Rajodia (2001) [11], Dhariwal (2005) [3], and Ganpathi *et al*. (2008) [5].

Table: 1: Plant height as influenced by different treatments of Gibberellic acid at successive crop growth stages.

Treatment (GA3 in ppm)	Symbol	Plant height (cm) at			
		10 DAS	20 DAS	30 DAS	40 DAS
0	G_0	6.00	15.63	24.24	34.43
10	G_1	6.26	15.69	24.36	35.20
20	G_2	7.20	17.00	27.61	40.70
30	G_3	7.79	17.80	30.04	42.90
40	G_4	8.09	17.92	32.48	45.10
50	G_5	8.11	17.97	32.66	45.36
S. E. (m) ±		0.21	0.52	0.93	1.47
C D. (at 5%)		0.63	1.56	.2.81	4.44

Table: 2: Spread of plant as influenced by different treatments of Gibberellic acid at successive crop growth stages.

Treatment (GA3 in ppm)	Symbol	Spread of plant (cm) at			
		10 DAS	20 DAS	30 DAS	40 DAS
0	G_0	8.86	12.87	14.51	23.36
10	G_1	9.05	13.35	14.89	23.66
20	G_2	10.12	14.28	15.83	24.95
30	G_3	10.81	15.19	16.49	26.36
40	G_4	11.07	15.41	16.76	27.12
50	G_5	11.11	15.42	16.88	27.17
S. E. (m) ±		0.27	0.41	0.36	0.60
C D. (at 5%)		0.80	1.23	1.08	1.82

Table 3: Number of leaves per plant as influenced by different treatments of Gibberellic acid at successive crop growth stages.

Treatment (GA3 in ppm)	Symbol	Number of leaves per plant at			
		10 DAS	20 DAS	30 DAS	40 DAS
0	G_0	2.10	3.74	7.18	11.70
10	G_1	2.38	4.13	8.12	12.03
20	G_2	2.72	4.76	8.67	12.75
30	G_3	3.01	5.30	9.15	13.51
40	G_4	3.21	5.48	9.32	13.54
50	G_5	3.20	5.53	9.39	13.60
S. E. (m) ±		0.08	0.13	0.21	0.25
C D. (at 5%)		0.23	0.38	0.63	0.77

Table 4: Length of leaf as influenced by different treatments of Gibberellic acid at successive crop growth stages.

Treatment (GA3 in ppm)	Symbol	Length of leaf (cm) at			
		10 DAS	20 DAS	30 DAS	40 DAS
0	G_0	6.62	15.27	24.20	32.29
10	G_1	7.11	16.11	24.92	33.20
20	G_2	7.79	17.19	26.59	35.97
30	G_3	8.42	18.97	28.56	37.67
40	G_4	8.76	19.14	28.83	37.92
50	G_5	8.78	19.31	29.20	38.15
S. E. (m) ±		0.26	0.61	0.98	0.98
C D. (at 5%)		0.78	1.85	2.95	2.95

Table 5: Fresh weight of leaves per plant as influenced by different treatments of Gibberellic acid at successive crop growth stages.

Treatment (GA3 in ppm)	Symbol	Fresh weight of leaves per plant (g) at			
		10 DAS	20 DAS	30 DAS	40 DAS
0	G_0	6.62	15.27	24.40	32.29
10	G_1	7.11	16.11	24.92	33.20
20	G_2	7.79	17.19	26.59	35.97
30	G_3	8.42	18.97	28.56	37.67
40	G_4	8.76	19.14	28.83	37.92
50	G_5	8.78	19.31	29.20	38.1
S. E. (m) ±		0.26	0.61	0.98	0.98
C D. (at 5%)		0.78	1.85	2.95	2.95

Table 6: Yield and yield attributes as influenced by different treatments of Gibberellic acid

Treatment (GA_3 in ppm)	Symbol	Girth of root (cm)	Length of root (cm)	Fresh weight of root (g)	Dry weight of root (g)	Yield (q/ha)
0	G_0	4.49	26.33	96.25	21.70	236.85
10	G_1	4.74	26.64	107.18	21.93	258.42
20	G_2	4.84	27.49	121.68	25.45	285.71
30	G_3	5.02	28.42	126.13	27.33	317.43
40	G_4	5.28	29.12	134.99	27.81	330.19
50	G_5	5.29	29.21	136.38	28.58	335.36
S. E. (m) ±		0.09	0.74	4.20	0.92	9.19
C D. (at 5%)		0.27	2.22	12.67	2.78	27.69

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