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Effect of plant growth regulators on root yield and quality of Radish (*Raphanus sativus* L.) var. Kashi Arora in Chhattisgarh plain

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Abstract

The present study entitled “Effect of plant growth regulators on root, yield and quality of Radish (*Raphanus sativus* L.) var. Kashi Arora in Chhattisgarh plain.” was carried out during Rabi season 2023-24 in the Pt. K.L.S. College of Horticulture and Research Station, Rajnandgaon (C.G.). The field experiment was laid out in Randomized Block Design with three replications and thirteen treatments consisting a control viz. (T₀) Control (Water spray), (T₁) GA₃ @ 100 ppm, (T₂) GA₃ @ 150 ppm, (T₃) GA₃ @ 200 ppm, (T₄) IAA @ 50 ppm, (T₅) IAA @ 100 ppm, (T₆) IAA @ 150 ppm, (T₇) NAA @ 100 ppm, (T₈) NAA @ 150 ppm, (T₉) NAA @ 200 ppm, (T₁₀) IBA @ 50 ppm, (T₁₁) IBA @ 100 ppm, (T₁₂) IBA @ 150 ppm. The finding of the present investigation clearly indicated that the foliar application of GA₃ 200 ppm gave significantly better performance in root yield and quality attributing character like maximum root length (23.96 cm), maximum root diameter (4.66 cm), fresh weight of the root (136.33 g), root yield per plot (9.81 kg), root yield per ha (30.26 t) and quality parameter like maximum TSS (5.50 °Brix) and maximum ascorbic acid (21.40 mg/100 g). Hence, the treatment T₃ (GA₃ 200 ppm) was found to be most suitable for higher production of radish.

Keywords: Radish, plant growth regulators, root and yield character and quality parameter

Introduction

The radish (*Raphanus sativus* L.) is diploidy (2n=18) in nature, belongs to Cruciferae family and can be considered as an annual as well as a biennial crop. It is cool season vegetable. It is preferred for its young fleshy enlarged edible roots consumed mainly as a salad. It is a cross-pollinated (entomophilous) vegetable due to saprophytic system of self-incompatibility (Alam *et al.*, 2010) [2]. Radish is a good source of vitamin-C (14.8 mg/100 gm of edible portion) and supplies types of minerals. The characteristic pungent flavour of radish is due to isothiocyanate (Kushwah, 2019) [13]. It contains glucose as the major sugar and smaller quantities of fructose and sucrose. In homoeopathy, radish is used for neuralgic headache, sleeplessness and chronic diarrhoea and the roots are said to be useful in urinary complaints, piles and gastrodynia. Radish is mainly grown in West Bengal, Madhya Pradesh, Bihar, Uttar Pradesh, Karnataka, Punjab, Maharashtra and Assam. In India, radish is cultivated an area of 206 mha with an annual production of 3304 MT. (Anon., 2022) [3]. In Chhattisgarh, Kondagaon, Korba, Surguja, Kanker, Durg, Rajnandgaon, Raipur and Korea are particularly important radish producing districts. The area and production of white radish in Chhattisgarh was 13,833 ha and 179.378 MT. (Directorate of Horticulture and Farm Forestry C.G., 2022) [4]

Plant growth regulators are known to regulate the physiological and biochemical processes of the plant. Controlling organ size, crop development and regulating nutrient input from the soil are among them. Gibberellins are plant growth hormones which promote cell division and regulate numerous physiological processes including seed germination, leaf, root and reproductive organs expansion (Achard *et al.*, 2009, Schwechheimer and Colebrook *et al.*, 2014) [1, 19]. The GA₃ increase weight of root due to activate polar transport of assimilates, promote cell multiplication and enlargement and more accumulation of food materials like sugars and water in expanded cells (Jatav 2007) [11]. IAA increases the growth of root and sometimes also shoot of plants (Chaudhary and Rasheed, 2003) [7]. Indole-3-butyric acid (IBA) is a plant growth

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promoter, used to regulate and accelerate the formation of roots of young plant and to elevate crop yields. Early rooting initiation was observed by applying IBA. NAA is basically used for vegetative growth particularly flowering but NAA at higher concentrations enhance the yield of radish (Singh *et al.*, 1989)^[21]. Synthetic auxins such as 1-naphthalene acetic acid (NAA) induce similar physiological responses as natural auxins in bioassays (Imin *et al.*, 2005)^[10]. Keeping these point in view the present investigation was undertaken with objective to study the effect of plant growth regulators on root yield and quality of Radish (*Raphanus sativus* L.) var. Kashi Ardra in Chhattisgarh plain.

Materials and Methods

The experiment was carried out at Pt. K.L.S. College of Horticulture and Research Station, Pendri, Rajnandgaon (C.G.) during Rabi season 2023-24. The field experiment was conducted in Randomized Block Design with three replications having thirteen different treatments with four plant growth regulators concentration *i.e.*, GA₃ @ 100, 150 and 200 ppm, IAA @ 50, 100 and 150 ppm, NAA @ 100, 150 and 200 ppm and IBA @ 50, 100 and 150 ppm. The soil was made to fine tilth by continuous harrowing after the area had been carefully ploughed, weeds, stubbles, stones etc., were completely removed. The chemical fertilizers (NPK) were administered at a rate of 50:100:50 kg/ha, with urea providing half of the nitrogen, single super phosphate providing the whole phosphorus and Murata of potash providing half of the potassium as the basal dose. Protective irrigations were done every five to seven days during the cropping period. The desired concentrations of plant growth regulators were prepared and 1st spraying was done at 15 days and 2nd at 30 days after the sowing of radish crop. Five plants at random were selected from each plot and tagged in order to record the observations on the root, yield and quality criteria such as length of root (cm), diameter of root (cm), fresh weight of root (g), root yield per plot (kg), root yield per ha (t), TSS (⁰Brix) and ascorbic acid (mg/100 gm).

Results and Discussion

Root and yield attributing character

Plant growth regulators GA₃ 200 ppm gave significantly better performance at root, yield and quality criteria such as length of root (cm), diameter of root (cm), fresh weight of root (g), root yield per plot (kg), root yield per ha (t), TSS (⁰Brix) and ascorbic acid (mg/100 gm). The interpretations were recorded on various Root and yield character are presented in Table 1.

Root length (cm)

The highest root length of plant (23.96 cm) was recorded under GA₃ @ 200 ppm (T3) at 45 days which was statistically at par with treatment GA₂ @ 150 ppm (T2) (22.78 cm), NAA @ 200 ppm (T9) (22.70 cm), IBA @ 150 ppm (T12) (22.38 cm) and IAA 150 @ ppm (T6) (22.26 cm) while, it was the lowest (16.86 cm) in Control (Water spray). Root length was seen to increase with higher GA₃ stimulates nutrient uptake by inducing rapid cell division and cell elongation. Similar results were finding by Kataria (2009)^[12], Sadana *et al.* (2015)^[18], Shruthi *et al.* (2016)^[20], Mishra and Nagaich (2019)^[15] and Tomer *et al.* (2021)^[22] in Radish.

Diameter of root (cm)

The highest diameter of root (4.66 cm) was observed in treatment containing GA₃ @ 200 ppm (T3) at 45 days after planting which was statistically at par with GA₃ @ 150 ppm (T2) (4.48 cm) and NAA @ 200 ppm (T9) (4.30 cm) while, it was the lowest (2.73 cm) in Control (Water spray). The GA₃ increase diameter of root might be due to improve the internal physiology of developing economic parts in terms of better supply of water, nutrients and other compounds vital for their proper growth and development which resulted in improved diameter result of the combination of cell division and expansion. These results were also in close agreement with the observations of Kutijabi (2007)^[14] in carrot and Arun (2011)^[5], Sadana *et al.* (2015)^[18] and Patel *et al.* (2017)^[16] in Radish.

Fresh weight of root (g)

The highest Fresh weight of root (136.33 g) was found in GA₃ @ 200 ppm (T3) treated radish at 45 days after sowing which was closely followed by the treatment GA₃ @ 150 ppm (T2) (132.60 g) while, it was the lowest (95.40 g) in Control (Water spray). The GA₃ increase in fresh weight of root might be due to activate polar transport of assimilates, promote cell multiplication and enlargement and more accumulation of food materials like sugars and water in expanded cells. Similar results have been reported by Jatav (2007)^[11], Uikey (2009)^[23], Kataria (2009)^[12] and Arun (2011)^[5] in Radish.

Root yield per plot (kg)

The highest root yield per plot (9.81 kg) was recorded in GA₃ @ 200 ppm (T3) at 45 days after sowing which was statistically at par with treatment GA₃ @ 150 ppm (T2) (9.53 kg), NAA @ 200 ppm (T9) (9.44 kg), IBA @ 150 ppm (T12) (9.28 kg) and IAA 150 @ ppm (T6) (9.18 kg) while, it was the lowest (6.84 kg) in Control (Water spray). The GA₃ increase root yield per plot in might be due to better carbon assimilation and accumulation of carbohydrates in the economic parts. The outcomes concur with the research conducted on radish by Singh and Rajodia (1989)^[21], Arun (2011)^[5] and Dahal *et al.* (2021)^[9] in Radish.

Root yield per ha (t)

The highest root yield per ha (30.26 t) was found in Radish which was treated with GA₃ @ 200 ppm (T3) at 45 days after sowing which was statistically at par with treatment GA₃ @ 150 ppm (T2) (29.43 t) and NAA @ 200 ppm (T9) (29.12 t ha), while it was the lowest (21.11 t) in Control (Water spray). GA₃ @ 200 ppm increased yield might be due to greater carbon absorption and carbohydrate accumulation in the economically significant sections. The outcomes concur with the research conducted on radish by Wyse (1980)^[24] and Singh and Rajodia (1989)^[21].

Qualitative parameter

TSS (⁰Brix)

The treatment containing GA₃ @ 200 ppm (T3) applied Radish recorded maximum TSS (5.50 ⁰Brix), which was statistically at par with GA₃ @ 150 ppm (T2) (5.23 ⁰Brix), while, it was the lowest (3.87 ⁰Brix) in Control (Water spray). The hydrolysis of polysaccharides, the transformation of organic acids into soluble sugars and the enhanced solubilization of insoluble starch and pectin present in the intermediate lamella and cell wall are the reasons for the increase in TSS, according to Pundir and Yadav (2001)^[17].

Ascorbic acid content (mg/100 g)**Table 1:** Effect of plant growth regulators on root yield and quality of radish.

Treatment	Length of root (cm)	Diameter of root (cm)	Fresh weight of root (g)	Root yield per plot (kg)	Root yield per ha (t)	TSS (^o Brix)	Ascorbic acid (mg/100 gm)
T ₀ Control (Water spray)	16.86	2.73	95.40	6.84	21.11	3.87	14.46
T ₁ GA ₃ @ 100 ppm	22.12	4.03	125.33	9.0	27.81	4.63	17.36
T ₂ GA ₃ @ 150 ppm	22.78	4.48	132.60	9.53	29.43	5.23	19.93
T ₃ GA ₃ @ 200 ppm	23.96	4.66	136.33	9.81	30.26	5.50	21.40
T ₄ IAA @ 50 ppm	18.82	3.35	117.66	8.42	25.98	3.93	16.36
T ₅ IAA @ 100 ppm	21.26	3.83	124.33	8.94	27.46	4.20	17.50
T ₆ IAA @ 150 ppm	22.26	4.14	127.66	9.18	27.99	4.83	18.83
T ₇ NAA @ 100 ppm	20.82	3.60	121.16	8.72	26.91	4.40	17.66
T ₈ NAA @ 150 ppm	21.86	3.85	124.66	8.96	27.53	4.70	18.40
T ₉ NAA @ 200 ppm	22.70	4.30	131.13	9.44	29.12	4.93	19.53
T ₁₀ IBA @ 50 ppm	19.62	3.50	119.66	8.56	26.41	4.05	16.06
T ₁₁ IBA @ 100 ppm	21.17	3.65	123.33	8.86	27.34	4.10	16.16
T ₁₂ IBA @ 150 ppm	22.38	4.17	129.11	9.28	28.66	4.53	18.26
SE(m±)	0.94	0.18	4.81	0.25	0.85	0.18	0.90
C.D. at 5%	2.75	0.52	14.06	0.74	2.48	0.53	2.63
CV	7.68	8.06	6.74	5.30	5.38	7.03	8.76

The results revealed that the maximum ascorbic acid was recorded in the treatment GA₃ @ 200 ppm (T₃) (21.40 mg/100 g) which was closely followed by the treatment GA₃ @ 150 ppm (T₂) (19.93 mg/100 g), while, it was the lowest (14.46 mg/100 g) in Control (Water spray). The increase in ascorbic acid content in radish might be due to the physiological influence of GA₃ on the activity of enzymes that produces more energy and food material for the strong vegetative growth. Results are in close agreement with the observations of Sadana *et al.* (2015) [18] and Yogesh in Radish and Bawkar *et al.* (2011) [6] in carrot.

Conclusion

On the basis of present investigation, it can be concluded that the application of GA₃ 200 ppm is better performed significantly for as well as root yield and quality of Radish cultivation as compared to other treatments tried in this experiment.

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