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EFFECT OF PLANT GROWTH REGULATORS ON VEGETATIVE CHARACTERS, ROOT YIELD AND QUALITY OF RADISH (*Raphanus sativus* L.) CV. JAPANESE WHITE

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ABSTRACT

The taproot of the radish is commonly used as a raw vegetable; however, the entire plant is edible, and its leaves are sometimes used as a leafy vegetable. The present experiment was conducted to evaluate the effect of plant growth regulators on root yield and quality of radish at the Horticulture Research Farm, Department of Horticulture, AKS University, Satna, (M.P.) during *Ravi* season 2025-2026. The research employed a Randomized Block Design for the experiment, which included three replications and ten treatments ($T_0 – T_9$) of plant growth regulators. The results revealed that the highest growth, yield and quality parameters *i.e.*, plant height, number of leaves, leaf length, leaf width, leaf area, root length, root diameter, average root weight, root yield, root yield, fresh weight, dry weight and Total Soluble Solids were recorded with T_3 (GA_3 25 ppm).

Key words : Plant growth regulators, Quality, radish, Taproot, yield.

Introduction

Radish (*Raphanus sativus* L.) is an important annual root vegetable that belongs to the Cruciferous vegetables under the family Brassicaceae. It is a diploid, containing two sets of 18 chromosomes (2n = 18), composed of 338 genera and some 3,700 species and a greater number of edible species in the vegetable kingdom (Britanica, 2024). The geographical origin of the cultivated radish (*Raphanus sativus* L.) is considered to be Southeast Asia, this is the area where the naturally occurring wild forms of the plant have been identified. Furthermore, India, Central China and Central Asia seem to have been secondary regions, where different varieties of the radish were cultivated. Radish is a crop particularly grown for its taproot, that varies in colour like white, pink, red, purple and black of this appetizing flavour is edible as raw as it is palatable, juicy and crunchy with a pungent peppery pleasing taste (Singh *et al.*, 2020). Radish is a short duration crop, but compared to other states of India. it‘s not potentially performing in Rajasthan even there is scope to increase the productivity and area, but with less radish cultivating area and productivity due to various reasons, which mainly includes abiotic stress and declining of soil fertility to combat with these problems by adopting sustainable agriculture practices (Baghel *et al.*, 2024).

Radish is very rich in vitamins A, B and C with little carbohydrates, iron and protein. Root contains various beneficial compounds, including nonflavonoid polyphenols, terpenes and their derivatives and glucosinolates. It serves as a nutrient rich food source (Radovich, 2018). Collectively, roots, leaves and sprouts offer an array of phytochemicals, including flavonoids (38.8%), non-flavonoid polyphenols (8.4%), terpenes and derivatives (8.2%), fats and related substances (6.4%) and glucosinolates and their degradation products (5.6%) (Anonymous, 2024).

The plant growth regulators are new-generation agrochemicals and are expected to play an important role in overcoming the hurdles in the manifestation of biological yield even in root crops. The gibberellic acid (GA_3) application brings about metabolic changes that affect both the quality and quantity of the desired product. It stimulates the synthesis of hydrolic enzymes which are secreted and act on starchy endosperm in turn affecting

seed germination and establishment of seedlings. The exogenous application of IBA, NAA and GA_3 individually and in combination (Tanwar *et al*., 2024) enhance rooting in stem cutting due to them achieve active cambium division and cell multiplication. This research aims to evaluate the impact of GA_3, NAA and IBA on vegetative growth, yield and root quality of radish. It seeks to determine the optimal concentration and timing of these hormones application to enhance crop performance and support sustainable, high-quality of root production under field conditions.

Materials and Methods

The present experiment was conducted to evaluate the "Effect of plant growth regulators on vegetative characters, root yield and quality of radish" at the Horticulture Research Farm, Department of Horticulture, AKS University, Satna, (M.P.) during *Ravi* season 2025-2026. The radish variety used in this research was "Japanese White" that sown during first fortnight of November. The experiment was laid out in Randomized Block Design with three replications and ten treatments (T_0 to T_9) *i.e.*; T_0 (Control), T_1 (GA_3 10 ppm), T_2 (GA_3 15 ppm), T_3 (GA_3 25 ppm), T_4 (NAA 10 ppm), T_5 (NAA 15 ppm), T_6 (NAA 25 ppm), T_7 (IBA 2 ppm), T_8 (IBA 4 ppm) and T_9 (IBA 6 ppm). For the crop, 120 kg of nitrogen, 80 kg of phosphorus, and 50 kg of potassium were applied in accordance with the Recommended Dose of Fertilizers (RDF). Half of the nitrogen and the full amounts of phosphorus and potassium were applied during field preparation, while the remaining nitrogen was applied 35 days after sowing. A total of four irrigations were carried out after sowing; an interval of eight days was maintained between irrigations, and the final irrigation was done seven days before harvesting. Light weeding and hoeing were performed twice using a cono-weeder—20 and 40 days after sowing. Additionally, manual weeding was carried out using a khurpi. The crop was protected against pests and diseases through the application of an insecticide (Malathion 50 EC @ 0.05%) and a fungicide (Ridomil Gold @ 2%). During the study, Five plants randomly from each plot, the observations were recorded on different growth and yield parameters like plant height (cm), number of leaves, leaf length (cm), leaf width (cm), leaf area (cm^2), root length (cm), root diameter (cm), average root weight (g), root yield (kg/plant), root yield (t/ha), fresh weight (g), dry weight (g) and Total Soluble Solids (°Brix).

Statistical analysis

The Department of Mathematics and Statistics at CCS HAU in Hisar, Haryana, developed the OPSTAT software for data analysis (Sheoran *et al*., 1998). The data was analyzed at a 5% level of significance. Through this, growth and quality data collected under field and laboratory conditions, respectively, were examined.

Results and Discussion

The growth, yield and quality parameters, significantly affected by the different treatments of different doses of plant growth regulators (Table 1 and Figs. 1 & 2). The results of growth and yield and quality parameters are given below with appropriate discussion.

For growth and yield traits, the highest height of plant (37.50 cm), number of leaves (13.98), leaf length (24.64 cm), leaf width (15.70 cm), leaf area (193.40 cm^2), root length (29.26 cm), root diameter (4.94 cm), average root weight (241.21 g), root yield (18.45 kg/plant) significantly recorded with T_3 (GA_3 25 ppm).

For quality traits, the highest fresh weight (217.21 g), dry weight (17.79 g) and Total Soluble Solids (4.45 °Brix) significantly recorded with T_3 (GA_3 25 ppm).

The use of GA_3 at 25 ppm was found to be superior to other methods for all growth-related parameters, such as plant height, number of leaves, leaf length, leaf width, leaf area, root length and root diameter. GA_3 promotes both cell division and cell elongation, leading to rapid vegetative growth in plants. It stimulates the production of hydrolytic enzymes that delay the process of senescence; this results in the formation of abundant chlorophyll molecules and enhances the rate of photosynthesis. The growth parameters of this research also supported by Ram *et al*. (2026).

Parameters such as plant height, leaf count, and leaf size are crucial for a good radish yield; these traits are directly linked to favourable economic output. This study evaluated three different concentrations of GA_3, with the best results observed at the T_3 level (GA_3 25 ppm). It was found that GA_3 at 25 ppm protects the crop from physiological imbalances and yields beneficial results; specifically, this concentration enhanced nutrients and carbohydrate accumulation in the roots and promoted vegetative growth. The similar experiment also reported by Çalýþkan *et al*. (2021) and Thalyari *et al*. (2025).

The highest values for fresh weight, dry weight and total soluble solids (TSS) were recorded with a GA_3 concentration of 25 ppm. This dosage represents the optimal balance for enhancing quality and biochemical properties. Increased water accumulation in the roots boosts fresh weight, while the accumulation of nutrients resulting from improved photosynthesis leads to the highest dry weight. Photosynthesis in plants is directly influenced

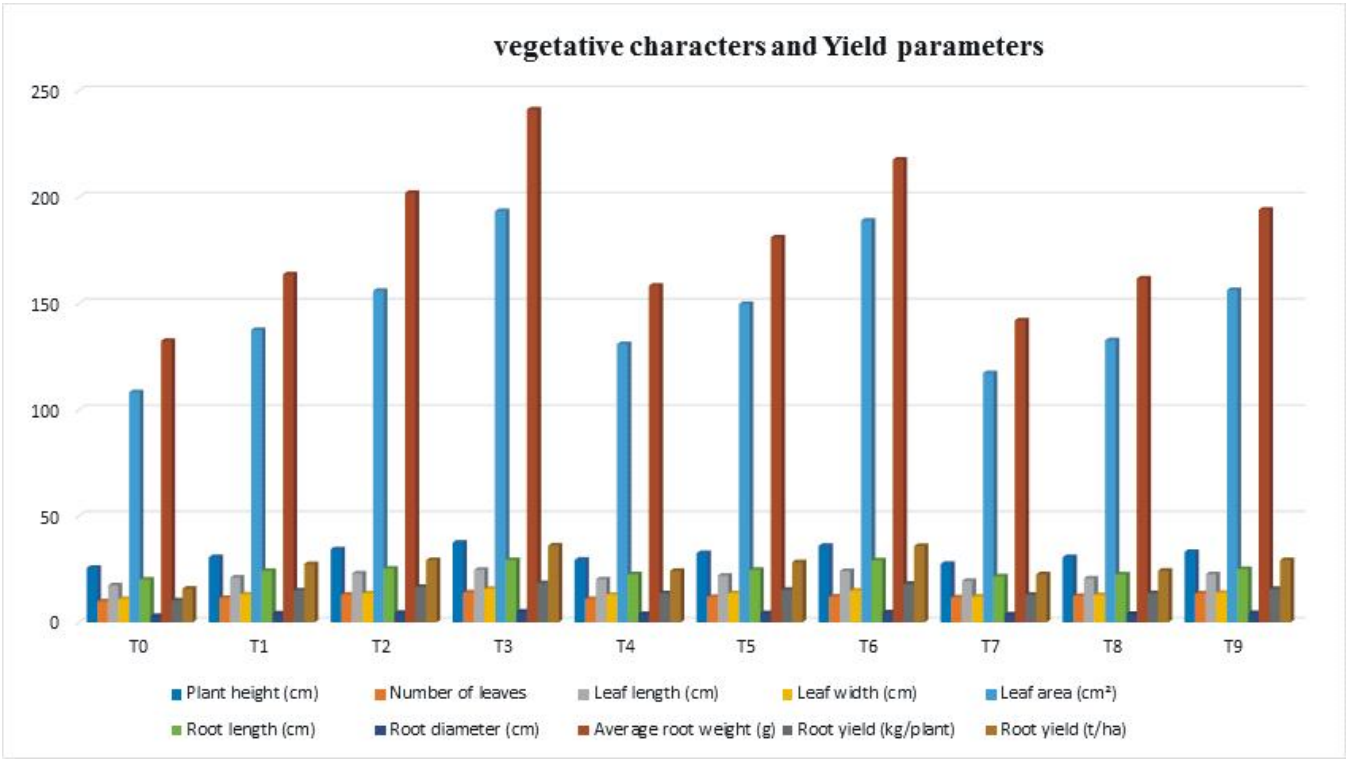


Fig. 1 : Effect of plant growth regulators on vegetative characters and yield parameters in radish.

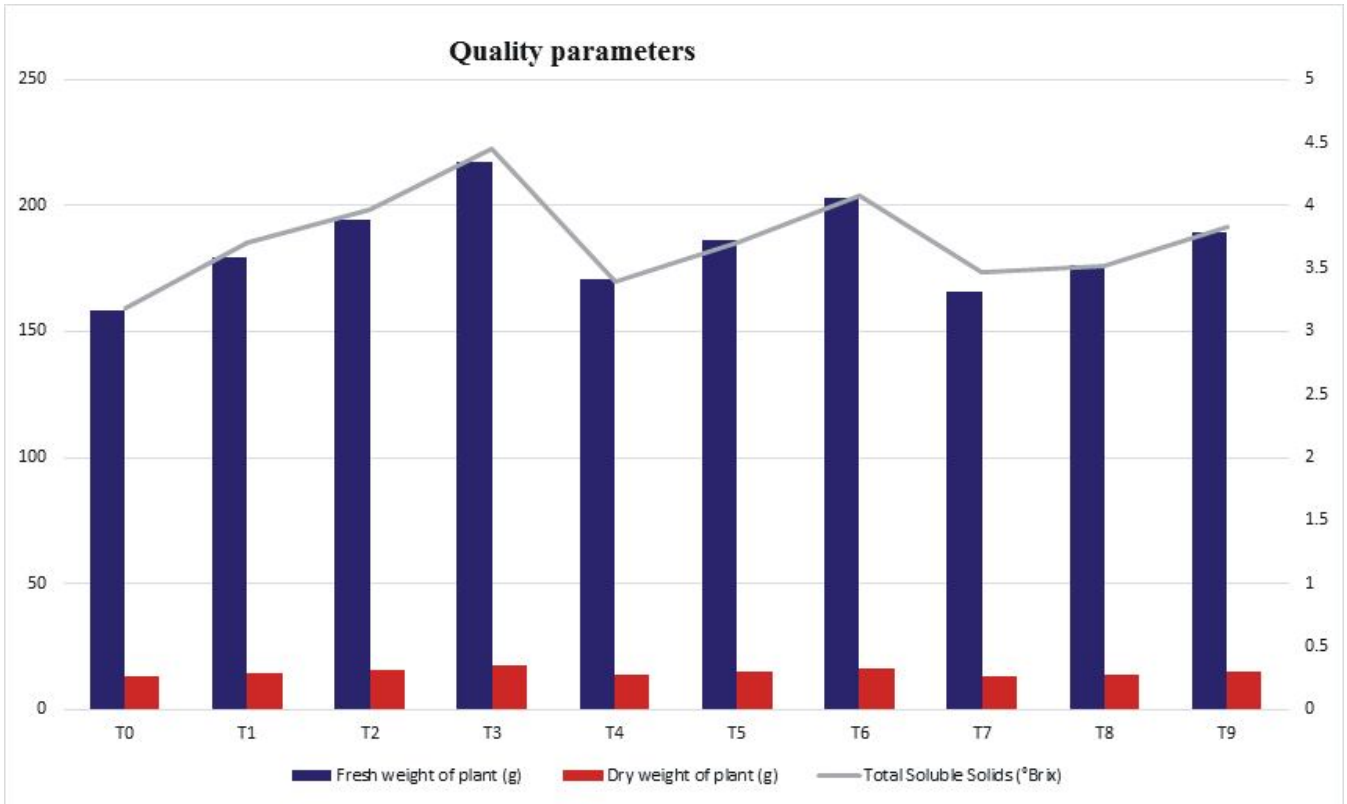


Fig. 2 : Effect of plant growth regulators on quality parameters in radish.

by the chlorophyll content in the leaves. GA_3 regulates the synthesis of soluble solids and associated enzymes; it increases mineral and sugar levels in the roots, thereby improving root quality and yielding better results compared to other treatments (Çalýþkan *et al.*, 2021 and Ram *et al.*, 2026).

Table 1 : Effect of plant growth regulators on vegetative characters, yield and quality parameters in radish.

Treatments	Plant height (cm)	Number of leaves	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Root length (cm)	Root diameter (cm)	Average root weight (g)	Root yield (kg/plant)	Root yield (t/ha)	Fresh weight of plant (g)	Dry weight of plant (g)	Total soluble solids (°Brix)
T_0	25.57	9.85	17.41	10.90	108.14	20.08	2.89	132.38	10.32	15.81	158.36	13.17	3.18
T_1	30.61	11.43	20.99	13.11	137.51	24.18	4.14	163.60	14.95	27.39	179.18	14.78	3.70
T_2	34.33	12.96	23.01	13.54	155.92	25.24	4.37	202.04	16.71	29.27	194.20	15.89	3.97
T_3	37.50	13.98	24.64	15.70	193.40	29.26	4.94	241.21	18.45	36.13	217.21	17.79	4.45
T_4	29.40	10.93	20.23	12.94	130.87	22.63	3.86	158.32	13.69	24.23	170.69	13.92	3.40
T_5	32.56	11.89	21.96	13.64	149.73	24.67	4.24	181.01	15.29	28.24	185.95	15.36	3.70
T_6	35.95	12.09	24.11	14.85	188.96	29.17	4.63	217.60	18.16	35.91	202.79	16.60	4.08
T_7	27.50	11.66	19.43	12.05	117.13	21.56	3.66	142.00	13.03	22.59	165.59	13.53	3.47
T_8	30.65	12.33	20.67	12.83	132.59	22.49	3.90	161.75	13.70	24.26	176.32	14.08	3.52
T_9	33.12	13.56	22.59	13.84	156.23	25.04	4.28	194.08	15.68	29.21	189.45	14.84	3.83
SE(m)±	**0.32**	**0.11**	**0.25**	**0.14**	**2.59**	**0.29**	**0.08**	**1.85**	**0.15**	**0.35**	**2.26**	**0.25**	**0.04**
CD (5%)	**0.96**	**0.34**	**0.77**	**0.44**	**7.75**	**0.87**	**0.24**	**5.56**	**0.45**	**1.12**	**6.77**	**0.75**	**0.12**

Conclusion

The radish is an important, quick-maturing root vegetable that is typically grown during the winter season. There are several reasons for the popularity of radish cultivation: it grows easily in diverse environments, involves low cultivation costs, matures quickly, and can be grown in almost any type of soil with minimal care. The plant growth regulators are essential for different physiological conditions result in better growth and development of plants. The GA_3 as compare to control, NAA and IBA on quantitative and qualitative traits showed superior results among the treatments. Treatments containing three types of plant growth regulators responsible for higher root yield and their quality compared to control (T_1). Therefore, effect of treatment T_3 (GA_3 25 ppm) provides better yield without much impact on the environment during *Ravi* seasons of 2025-26. This treatment is therefore useful for farmers in the *Vindhya* region of Madhya Pradesh, India.

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