ZIBELINE INTERNATIONAL™ PUBLISHING

ISSN: 2682-7786 (Online)
CODEN: BDAIDR

Big Data in Agriculture (BDA)

DOI: http://doi.org/10.26480/bda.01.2025.35.38

CrossMark

RESEARCH ARTICLE

EFFECT OF DIFFERENT CONCENTRATION OF GIBBERELLIC ACID (GA_3) ON GROWTH, YIELD AND QUALITY OF CARROT (*DACUS CAROTA* L. CV. NEW KURODA) IN PANDAM, ILAM

Manju Giri[a*], Chiranjibi Puri[b], Bishal Shrestha[b], Deepa Neupane[a], Lilam Karki[c] and Bindu Nepali[d]

[a] Nepal poly-technique Institute (NPI), Chitwan,
[b] Agriculture and Forestry University (AFU), Chitwan
[c] G.P Koirala Collage of Agriculture and Research Center (GPCAR), Morang
[d] Cardamom Development Center (CDC), Ilam
[*] Corresponding author email: manzugiree@gmail.com

ARTICLE DETAILS

Article History:

Received 10 January 2025
Revised 15 February 2025
Accepted 19 February 2025
Available online 24 March 2025

ABSTRACT

The field experiment was conducted at the Cardamom Development Centre, Ilam, to assess the effect of different concentrations of gibberellic acid (GA_3) on the growth, yield, and quality of carrots. The experiment was carried out in a randomized complete block design (RCBD). There were 5 treatments, comprising T_1 (control), T_2 (GA_3 @ 50 ppm), T_3 (GA_3 @ 100 ppm), T_4 (GA_3 @ 150 ppm), and T_5 (GA_3 @ 200 ppm), which were replicated four times. Gibberellic Acid significantly impacts growth, yield, and quality parameters, with significant effects on plant height, leaf number, leaf length, root diameter, economical yield, biological yield, and total soluble solid (TSS) among different treatments. Application of 150 ppm GA_3 found highest plant height (72.05 cm), number of leaves (11.11), leaf length (71.5 cm), and leaf breadth (39.35 cm), and minimum plant height (56.92 cm), number of leaves (9.15), leaf length (56.35 cm), and leaf breadth (35.20 cm) at control. The maximum root length (23.95 cm), maximum root diameter (13.17 cm), maximum economical yield per plant (169.25 g), maximum economical yield per hectare (42.31 tons), maximum biological yield/plant (247 gm), maximum biological yield/hectare (61.75 tons) was found in the application of 150 ppm GA_3 and the minimum root length (19.85 cm), minimum root diameter (11.35cm), minimum economical yield per plant (104.25 g), minimum economical yield per hectare (26.06 tons), minimum biological yield/plant (177.25 gm), minimum biological yield/hectare (44.31 tons). The maximum TSS of carrot was recorded in GA_3 @150 ppm (5.80 °Brix) and minimum at 100ppm (4.95°Brix). The GA_3 @150 ppm treatment in Nepal's Ilam condition showed superior growth, yield, and quality attributes compared to other treatments.

KEYWORDS

Carrot, Gibberellic Acid, Growth, Yield

1. Introduction

The Apiaceae family includes the carrot (Daucus carota L.), a popular and nutrient-dense vegetable root crop that is farmed all over the world for its tasty. With nine pairs of chromosomes (2n = 18), carrots are a diploid species. It is a crop that is cross-pollinated by bees. It belongs to the same family as parsnip, parsley, fennel, celery, celeriac, and coriander. At first, the roots were either purple or yellow, long and slender. These hues, along with orange and white, are still used today, but the most common ones are orange and orange-red (Bhattarai et al., 2017).

It is mostly a cool-season crop that grows in temperate regions of the world in the spring, summer, and fall, and in tropical and subtropical regions in the winter. According to a study, it thrives in temperatures between 15 and 20 °C (Mohanta et al., 2015). It is an annual herbaceous crop that has fleshy conical tap roots that range in length from 5 to 50 cm, alternating compound leaves, and an upright, heavily branching stem (Abbas et al., 2011). A lot of people cultivate carrots for the fresh market and for processing. Carrots were among the ten most significant vegetable crops in terms of economic importance. In addition to having significant levels of vitamins B1 and C, it is a great source of vitamin A.It is also a dietary fiber and vitamin E-rich essential oil. Moreover, carrots are low in fat and protein and high in carbohydrate. Additionally, it is a good source of antioxidants and minerals (Hernandez, 1994).

In 2021, an estimated 42 million tons of carrots will be produced globally, in tandem with an anticipated increase in the demand for veggies globally. The top carrot-producing countries in the world are China, Uzbekistan, the United States, Russia, Ukraine, and the United Kingdom (Market-Intelligence-Report-Carrots.pdf, 2022). According to reports, Nepal has 3264 hectares, produces 37176 MT, and has a productivity of 11.39 MT/ha. The area production and productivity in Ilam district and Koshi province are 8.78 and 11.43 mt/ha, 56 and 630 ha, and 5530 and 640 mt, respectively (MoALD, 2022).

The application of the Plant Growth Regulator (PGR) is a recent development in agricultural science. These compounds occur naturally in plants and can trigger a variety of physiological reactions in trace levels. Plant growth regulators are divided into two categories: those that stimulate plant development (such as auxin, cytokinins, and gibberellins) and those that inhibit it (such as ethylene and abscisic acid). These hormones can be delivered in a number of methods, such as seed treatment and foliar application (Bagri et al., 2021). The use of hormones in the production of vegetables is growing in Nepal. Research was done to determine the best gibberellic acid concentration for improved carrot growth and yield as well as the impact of gibberellic acids on carrot growth, yield, and quality.

2. Materials and Methods

Quick Response Code	Access this article online	
	Website: www.bigdatainagriculture.com.my	**DOI:** 10.26480/bda.01.2025.35.38

Cite The Article: Manju Giri, Chiranjibi Puri, Bishal Shrestha, Deepa Neupane, Lilam Karki and Bindu Nepali (2025). Effect of Different Concentration of Gibberellic Acid (Ga_3) on Growth, Yield and Quality of Carrot (*Dacus Carota* L. Cv. New Kuroda) in Pandam, Ilam. *Big Data in Agriculture, 7(1): 35-38.*

2.1 Experiment Site

The research was conducted at the horticulture farm of the Cardamom Development Center (CDC) in Pandam, Ilam, Nepal, from March, 2024 to June, 2024. The site was situated about 2.1 km northwest of Phikkal on the Pashupatinagar road of Suryodaya municipality.The geographical location of the research site was 26° 11.938 north latitude and 88° 4' to 24.120 eastern longitude, with an elevation of 1500 masl.

2.2 Experiment Design

The research includes five treatment (refer to Table 1) allocated in a RCBD research design with four replications. All the treatments were randomized separately in each replication. The size of research plot was 2m². 50 plants were sowed in each plot. 5 sample plants from inner rows were selected for observation and recording of the data.

Table 1: Treatments details used in the experiment

S.N.	Treatments	Concentrations of GA_3	Amount of GA_3used in 10 lt. of water
1.	T1	Water spray (Control)	0 gm
2.	T2	50 ppm	0.5 gm
3.	T3	100 ppm	1 gm
4.	T4	150 ppm	1.5 gm
5.	T5	200 ppm	2 gm

2.3 Cultural Practices

New Kuroda variety of carrots was used for research which were sowed in moderately acidic sandy loam soil. The land was planked and divided into small plots. Then it was divided into blocks in which small plots of 2m x 1 m were marked out as an experiment unit according to the design of the experiment Well-decomposed FYM was applied uniformly, and carrot seeds were sown on March 10, 2024. Cultural practices like irrigation, thinning, tagging, weeding, and earthing up were used. The crops were harvested at full maturity, i.e., 98 days after sowing (DAS).

2.4 Parameters Observed

2.4.1 Vegetative Character

2.4.1.1 Number of leaves per plant

Leaf numbers were recorded at 45, 60, 75, and 90 days of seed sowing, counting leaves per plant until marketable stage, with data points taken at 15-day intervals.

2.4.1.2 Plant Height (cm)

The height of the tagged plant was measured on the foliage from the ground surface to the tip with the help of a meter scale.

2.4.1.3 Length and breadth of the leaf (cm)

The same leaf used for leaf length was also used for measuring breadth. The leaf breadth was measured at the maximum broad part of the leaf.

2.4.2 Yield and yield-attributing characters

2.4.2.1 Root length(cm)

The length of the roots was measured with the help of a measuring tape.

2.4.2.2 Root diameter (cm)

The root diameter was measured using a measuring tape.

2.4.3 Biological weight (with leaves weight)

Total weight was taken after the harvesting of the whole plant from the field. It was measured in grams by using an electronic weighing balance and expressed in kilograms per plot.

2.4.4 Economical weight (without leaves weight)

The harvested roots were thoroughly cleaned by using water, and the weight of the roots was recorded in kg by using an electronic weighing balance. The average weighted of roots was calculated & expressed weight of roots was calculated and expressed in kg per plot.

2.4.5 Root yield per plot

The observation on yield was recorded at the time of root harvesting. After harvesting, the roots from each plot were weighed and expressed in kilograms per plot.

$$\textbf{Root yield/ plot (Kg)} = \frac{\text{Root yield/ plant} \times \text{Total number of plants per plot}}{1000}$$

2.4.6 Root yield per hectare

The observation on yield per hectare was recorded after harvesting the roots. After harvesting, the roots from each plot were weighed and then calculated in t/ha.

$$\textbf{Root yield /hectare (Mt)} = \frac{\text{Total no of plants in 1 ha} \times \text{Root yield/ plant}}{1000}$$

2.5 Quality Characters

2.5.1 TSS (°Brix)

The harvested roots were thoroughly cleaned with water. The root of the carrot was crushed or ground to extract the juice, and then a few drops of the extracted juice were placed on the hand refractometer's prism. It was expressed in Degree Brix units.

2.5.2 Statistical analysis

Recorded data were compiled and tabulated in MS Excel. The data was subjected to analysis of variance (ANOVA) using R-Studio (R.4.4.1). Duncan's multiple range tests (DMRT) and least significant difference (LSD) were used to compare the means within the different parameters at a 5% level of significance, according to Gomez and Gomez, (1984).

3. Results and Discussion

3.1 Growth Parameters

3.1.1 Effect of Gibberellic Acid (GA_3) on Plant Height of Carrot

The study examined the impact of gibberellic acid on carrot plant height at different growth stages. At 45 DAS, no significant variation was observed among treatments. However, at 60 DAS, 75 DAS, and 90 DAS, gibberellic acid significantly affected plant height. At 60 DAS, the maximum plant height was recorded in plants treated with GA_3 150 ppm, followed by GA_3 200 ppm, GA_3 100 ppm, and GA_3 50 ppm. At 75 DAS, GA_3 150 ppm treated plants reached maximum height (64.3 cm), followed by $GA_3$100 ppm, GA_3 200 ppm, and GA_3 50 ppm, with a minimum height of 47.27 cm and a maximum height of 72.05 cm at 90 DAS.This research was by the finding of who concluded that the foliar spray with different concentrations of GA_3 (100, 150, 200, and 250 ppm) and the control (Malek et al., 2011). The foliar spray of 150 ppm of GA_3 significantly increased the maximum plant height.

Table 2: Effect of gibberellic acid (GA_3) on plant height of carrot

Treatment	Plant height (cm)			
	45DAS	60DAS	75DAS	90DAS
Control	10.81	27.85^{c}	47.45^{a}	56.92^{c}
50 ppm	10.92	29.60^{bc}	55.75^{ab}	64^{bc}
100 ppm	10.55	31.6^{abc}	58.9^{a}	68.05^{ab}
150 ppm	11.57	35.6^{a}	64.3^{a}	72.05^{a}
200 ppm	10.92	34.10^{ab}	56.55^{a}	68.80^{ab}
Grand mean	10.95	31.75	56.55	65.96
SEM (±)	0.19	0.66	1.26	1
LSD	Ns	4.74*	8.98*	7.91*
CV (%)	7.10	9.91	10.54	7.95

* Significant at < 0.05 level of significance

3.1.2 Effect of gibberellic acid on the number of leaves of carrot

The study examined the impact of gibberellic acid on carrot leaf number at different growth stages. At 45 DAS, no significant variation was observed among treatments. However, at 60 DAS, 75 DAS, and 90 DAS, gibberellic acid significantly affected leaf number. Treatment GA_3 150 ppm had the highest leaf number (7.7) at 60 DAS, followed by GA_3 200 ppm at 75 DAS, and GA_3 150 ppm at 90 DAS. At 75 DAS, the maximum number of leaves (10.20) was recorded in treatments GA_3 150 ppm. Similarly, at 90 DAS, a maximum number of leaves per plant (11.10) was recorded at 150 ppm. This research was by the finding of a group researchers concluded that the foliar spray with different concentrations of GA_3 (100, 150, 200, and 250 ppm), along with the control (Malek et al., 2011). The foliar spray of 150 ppm GA_3 significantly increased the maximum number of leaves.

Table 3: Effect of gibberellic acid (GA_3) on the number of leaves of carrot

Treatment	No. of leaves per plant			
	45DAS	60DAS	75DAS	90DAS
Control	2.9	6.3^{c}	8.20^{a}	9.15^{b}
50 ppm	3.05	6.4^{bc}	7.65^{a}	9.25^{b}
100 ppm	3.05	6.5^{bc}	8.15^{b}	9.25^{b}
150 ppm	2.95	7.7^{a}	10.20^{a}	11.10^{a}
200 ppm	3.10	6.85^{a}	10.20^{a}	10.35^{a}
Grand mean	3.01	6.54	8.88	9.82
SEM (±)	0.047	0.059	0.22	0.16
LSD	Ns	0.39 ***	1.53 **	1.08 **
CV (%)	6.47	3.98	11.44	7.36

**significance between 0.05-0.01 level of significance; ***significant at < 0.01

3.1.3 Effect of gibberellic acid on leaf length of carrot

It was observed that leaf length varied between 9.27 cm to 9.72 cm at 45 DAS, but no significant variation was observed among treatments. At 60 DAS, 75 DAS, and 90 DAS, the maximum leaf lengths of 35 cm, 63.10 cm, and 71.5 cm respectively were recorded in treatment GA_3 150 ppm, respectively. The increase in leaf length was due to the application of GA_3 which leads to an increase the cell number, cell division, and cell size which improves the metabolic activities of plants (Malek et al., 2011).

Table 4: Effect of gibberellic acid (GA_3) on leaf length of carrot

Treatment	Leaf length (cm)			
	45DAS	60DAS	75DAS	90DAS
Control	9.57	27.25^{c}	46.55^{b}	56.35^{c}
50 ppm	9.36	28.90^{bc}	55.05^{ab}	62.75^{bc}
100 ppm	9.27	30.75^{abc}	57.65^{a}	66.75^{ab}
150 ppm	9.62	35^{a}	63.10^{a}	71.5^{a}
200 ppm	9.72	33^{ab}	55.85^{a}	68^{ab}
Grand mean	9.51	30.44	53.11	65.06
SEM (±)	0.12	0.73	0.88	1.03
LSD	Ns	5.17 *	6.50 *	7.88**
CV (%)	5.34	11.28	8.12	8.04

* significant at < 0.05 level of significance, **significance between 0.05-0.01 level of significance

3.1.4 Effect of gibberellic acid on leaf breadth of carrot

Table 5 shows gibberellic acid's effect on leaf breadth at different growth stages, with no significant variation observed. However, at 75 and 90 DAS, gibberellic acid's effect was significantly different. The study found that GA_3 150 ppm and GA_3 50 ppm treatments had the highest leaf breadth at 75 DAS and 90 DAS, respectively, with the lowest leaf breadth at 35.20 cm in the control. A group researchers finding that the GA_3 promotes leaf expansion by enhancing cell elongation and division which leads to increased leaf size (Devi et al., 2018).

Table 5: Effect of gibberellic acid (GA_3) on leaf breadth of carrot

Treatment	Leaf breadth (cm)			
	45DAS	60DAS	75DAS	90DAS
Control	4.07	11.05	23.50^{b}	35.20^{c}
50 ppm	4.10	10.30	24.50^{b}	37.15^{b}
100 ppm	4.05	10.65	28.40^{a}	37.65^{b}
150 ppm	4	11.45	29.60^{a}	39.35^{a}
200 ppm	3.95	10.55	29.10^{a}	38.20^{ab}
Grand mean	4.035	10.8	26.83	37.51
SEM (±)	0.04	0.17	0.45	0.15
LSD	Ns	ns	3.32 **	1.2 ***
CV (%)	4.46	7.09	8.21	2.12

**significance between 0.05-0.01 level of significance; ***significant at < 0.01 level of significant

3.2 Yield parameters

3.2.1 Effect of gibberellic acid on root length and root diameter of carrot

The effect of gibberellic acid on root length and root diameter at different growth stages is presented in Table 6. The maximum root length (23.95 cm) was recorded in treatment GA_3 150 ppm, followed by (21.80 cm), and the maximum root diameter (13.175 cm) was recorded in treatment GA_3 150 ppm, followed by (12.70 cm) GA_3 200 ppm. Gibberellic acid may have increased root length by promoting fast cell division and elongation, leading to improved nutrition also increased root diameter by improving the internal physiological processes of developing economic components through better water, nutrient, and others component supply (Ganapathi et al., 2008; Patel et al. 2017).

Table 6: Effect of Gibberellic Acid (GA_3) on root length and root diameter of carrot

Treatment	Root length (cm)	Root diameter (cm)
Control	19.85^{b}	11.35^{b}
50 ppm	21.10^{b}	11.62^{b}
100 ppm	21.35^{b}	11.55^{b}
150 ppm	23.95^{a}	13.17^{a}
200 ppm	21.80^{ab}	12.70^{a}
Grand mean	21.6	12.08
Sem (±)	0.34	0.13
LSD	2.25 *	0.91 **
CV (%)	6.92	5.03

* significant at < 0.05 level of significance **significance between0.05-0.01 level of significance

3.2.2 Effect of gibberellic acid on economical yield of carrot

The highest yield per hectare (42.31 tons) was recorded at 150 ppm GA_3, followed by 36.87 tons at 200 ppm GA_3, 35.56 tons at 100 ppm GA_3, and 34.53 tons at 50 ppm GA_3. The lowest yield per plant (26.06 tons) was recorded incontrol. The addition of dry matter, cell division, and expansion caused by the higher concentration of GA_3 increased the fresh weight of the root (Gopal et al., 2023). Possible explanations for the yield and yield characteristic increases due to this Gibberellic acid include increased leaf and vegetative development, which improves the likelihood of photosynthetic processes and, consequently, increases the amount of carbohydrates in the roots, resulting in a higher yield (Ganapathi et al., 2008; Mishra and Nagaich, 2019).

Table 7: Effect of gibberellic acid (GA_3) on economical yield of carrot

Treatment	Economical yield		
	Yield /plant (gm)	Yield /plot(kg)	Yield /ha (ton)
Control	104.25^{b}	5.21^{b}	26.06^{b}
50 ppm	138.15^{ab}	6.90^{ab}	34.53^{ab}
100 ppm	142.25^{a}	7.11^{a}	35.56^{a}
150 ppm	169.25^{a}	8.46^{a}	42.31^{a}
200 ppm	147.50^{a}	7.37^{a}	36.87^{a}
Grand mean	140.28	7.014	35.07
Sem (±)	4.47	0.23	1.19
LSD (0.05)	33.93 *	1.69 *	8.48 *
CV (%)	16.04	16.04	16.04

* Significant at < 0.05 level of significance

3.2.3 *Effect of gibberellic acid on biological yield of carrot*

The application of gibberellic acid GA_3 significantly affects the total yield per plant, yield per plot, and yield per hectare of carrots. The highest total yield per plant (247 g) was recorded at 150 ppm GA_3, followed by 233 g at 200 ppm GA_3, and lowest yield per plant (177.25 g) was recorded in control. The highest total yield per plot (12.35 kg) was recorded at 150 ppm GA_3, followed by 11.65 kg at 200 ppm GA_3, and lowest yield per plot (8.86 kg) was recorded in control. The highest total yield per hectare (61.75 tons) was recorded at 150 ppm GA_3, followed by (58.25 tons) at 200 ppm GA_3, and lowest yield per hectare (44.31 tons) was recorded in control.

Table 8: Effect of Gibberellic Acid (GA_3) on biological yield of carrot

Treatment	Biological yield		
	Yield/ plant (gm)	Yield/ plot (kg)	Yield/ha (ton)
Control	177.25^{b}	8.86^{b}	44.31^{b}
50 ppm	214^{ab}	10.7^{ab}	53.5^{ab}
100 ppm	207^{ab}	10.35^{ab}	51.75^{ab}
150 ppm	247^{a}	12.35^{a}	61.75^{a}
200 ppm	233^{a}	11.65^{a}	58.25^{a}
Grand mean	215.65	10.78	53.9125
Sem (±)	6.29	0.31	1.57
LSD (0.05)	46.59 *	2.32 *	11.64 *
CV (%)	14.33	14.33	14.33

* significant at < 0.05 level of significance

3.3 Quality parameter

3.3.2 *Effect of gibberellic acid on TSS of carrots*

The study found that gibberellic acid (GA_3) at 150 ppm significantly improved root TSS content, according to previous research. GA_3, a key component in plant metabolism, influences sugar synthesis and accumulation, and can also promote enzyme activity involved in carbohydrate metabolism.

Table 9: Effect of gibberellic acid (GA_3) on quality TSS of carrot

Treatment	TSS(°Brix)
Control	5^{b}
50 ppm	5.55^{ab}
100 ppm	4.95^{b}
150 ppm	5.80^{a}
200 ppm	5.70^{a}
Grand mean	5.4
Sem (±)	0.10
LSD (0.05)	0.63(.)
CV	7.79

(.)significant at >0.01 level of significance

4. Conclusion

The experiment reveals that gibberellic acid (GA_3) at 150 ppm significantly improved carrot growth, yield, and quality. The highest concentration of GA_3 resulted in the highest total soluble solids (TSS) in the root. The study suggests that a higher concentration of GA_3 is desirable for further research.

Acknowledgement

The authors would like to express sincere gratitude to whole Nepal Polytechnique Institute (NPI) team and all staff members of Cardamom Development Center, Ilam.

Reference

Bagri, M.B., 2021. Effect of Spacing and Gibberellic Acid (GA3) on Growth, Yield and Quality Attributes of Radish (Raphanus sativus L.).

Bhattarai, D.R., Subedi, G.D., Gautam, I.P., and Chauhan, S., 2017. Posthavest Supply Chain Study of Carrot in Nepal. International Journal of Horticulture. https://doi.org/10.5376/ijh.2017.07.0026

Devi, J., Singh, R., and Walia, I., 2018. Effect of foliar application of GA_3 and NAA on onion – A review. Plant Archives, 18, Pp. 1209–1214.

Ganapathi, M., Hiremath, S.M., Uppar, D.S., Chetti, M.B., and Koti, R.V., 2008. Influence of organics, plant growth regulators and micronutrients on yield and yield components in carrot (Daucus carota L.).

Hernandez, M.O., 1994. Tissue culture and Agrobacterium-mediated transformation of carrot (Daucus carota L.).

Malek, M.A., Rahim, M.A., and Begum, K., 2011. Effects of foliar application of growth regulators on quality seed yield in carrot.

Mishra, P., and Nagaich, K., 2019. Response of gibberellic acid on growth and yield of radish (Raphanus sativus L.) Cv. Japanese white.

MoALD, 2022. Government of Nepal, Ministry of Agriculture and Livestock Development

Patel, R., Tomar, B., Khan, R., and Yadav, K., 2017. Response of Radish (Raphanus sativus L.) to different concentration of Gibberellic acid.