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Effect of Fertilizers on Morphological and Yield Characteristics of Carrot (*Daucus Carota)* cv. New Kuroda in Khotang District, Nepal

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Abstract

An experiment was conducted to know the effect of organic and inorganic fertilizers on morphological and yield characteristics of carrot cv. New Kuroda in Matikore, Khotang from 10th February, 2023 to 10th June, 2023. The experiment was laid out in Randomized Completely Block Design with seven treatments and three replications. Treatment consists of Control (T1), Prangarik mal @20 t/ha + Boron (T2), Poultry manure @6 t/ha + Boron (T3), Vermicompost @4 t/ha + Boron (T4), NPK @100:100:100 Kg/ha + Boron (T5), Neem cake @5 t/ha + Boron (T6), and Goat manure @ 15t/ha + Boron (T7). The result revealed that all growth and yield parameters was significantly influenced by applied fertilizers. The highest plant height was recorded in Prangarik mal + Boron, followed by Goat manure + Boron and minimum in Control. There was a significant difference in yield parameters among the treatments. The highest root yield was found in Prangarik mal+ Boron (42.43 t/ha), followed by Goat manure + Boron (27.44 t/ha), and the lowest yield in Control (7.77 t/ha). It can be concluded that the application of organic manures in combination with Boron can be practiced for obtaining better yield of Carrot.

Keywords: Boron, carrot, fertilizers, growth, yield

Introduction

Carrot *(Daucus carota)* is one of the main vegetable crops farmed worldwide (Sikora et al., 2020). The carrot is a member of Apiaceae family with a chromosome number of 2n=18 (Yadav et al., 2021). Carrot is regarded as an annual crop for root production and biennial for seed production (Singh & Bahadur, 2015). Carrot is a crucial root vegetable grown all over the globe in spring, summer season and autumn in temperate place and during wintry weather in tropical and sub-tropical region (Dhakal et al., 2022). Carrots are a worldwide popular crop which is praised for nutritionally

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dense roots that is high in fiber and beta-carotene a necessary precursor to vitamin A (Valsikova et al., 2021). Carrot foliage is fed to animals as fodder. Carotene is used in colouring margarine and for improving the color of egg yolk when added to layer feed (Dawuda et.al, 2011). Red, orange, yellow, purple, black, and white roots are produced in carrot as a result of the variation in the pigments (Haq & Prasad, 2014). The area, production and productivity of carrot in khotang is 5 ha, 50 mt and 10.01 mt/ha respectively (MoALD, 2020/21).

The overuse of inorganic fertilizers in modern agriculture has harmed the ecology and soil (Kiran et al., 2022). The use of organic fertilizers like Farm yard manure (FYM), Vermicompost, Poultry manure, Neem cake and Goat manure for improvement of the productivity in crop and maintaining soil fertility is gaining popularity nowadays. FYM is a good source of nutrients, which is ecofriendly, maintains soil health and improve crop productivity by increasing soil fertility (Raj et al., 2014). Vermicompost is one of the most important organic manures that have macro as well as micro-nutrients, vitamins, growth hormones and enzymes. Ansari et al. (2016) reported that vermicompost is an important organic manure that is beneficial for long term sustainability and crop productivity. Neem cake is quick acting insoluble in water, provide slow and steady nourishment, improves soil structure, increases water holding capacity, protect from nematodes and improve yield and quality of produce (Ali et al., 2016). Neem seed cake boosts earthworm populations and creates organic acids that aid in lowering soil alkalinity (Korah & Shingte, 1968). Soon and Bottrel (1994) claimed that Neem cake functions as a natural fertilizer with pesticide properties. Goat manure promotes healthy, balanced nutrition to support strong root development and quality of carrot. Poultry manure (PM) is an effective source of nutrients for carrot (Kankam et al., 2014). Inorganic fertilizers deliver nutrients quickly to meet the immediate demand of crop nutrients, whereas organic fertilizers release nutrients gradually for the healthy growth of plants. For improved growth of carrots, soil nutrient supplementation from fertilizers is required to meet plant requirements. For the appropriate growth and development of carrots, it is crucial to standardize the application of chemical fertilizers and organic fertilizers (Afrin et al., 2019). The use of organic and inorganic fertilizers reduces erosion, improve water infiltration, soil aeration and plant root growth and minimizes the risk of downstream flooding (Kushwah et al., 2019). Both macronutrients and micronutrients are crucial to our agricultural system, but ignorance of farmers' due to illiteracy, the level of micronutrients has depleted in soil (Sultana et al., 2015). A crucial micronutrient for meristem growth and sugar metabolism is Boron (B). The widespread Boron deficiency is more prone in sandy soil that have pH of 6.2, and occurs after a period of rainfall (Subba et al., 2017). The field experiment was

carried out to explore the effect of organic and inorganic fertilizers on morphological and yield characteristics of Carrot.

Materials and Methods

The experiment was carried out at Matikore-1, Khotang. The area is at 2711′60 N latitude & 86°4659.99″ E longitude and elevation of about 152 to 3652 masl. The climate of the experimental area is subtropical in nature. The experiment was laid out in Randomized Completely Block Design with seven treatments and three replications. The treatment consists of Control (T1), Prangarik mal @20 t/ha + Boron (T2), Poultry manure @6 t/ha + Boron (T3), Vermicompost @4 t/ha + Boron (T4), NPK @100:100:100 Kg /ha+ Boron (T5), Neem cake @5 t/ha + Boron (T6), Goat manure @ 15 t/ha + Boron (T7). The Boron was supplied from the Borax @10 kg/ha. Prangarik mal have 2.01% N, 0.9% P, 1.85% K and 14.99% organic matter (Krishi Diary,2079). Individual plot of size 1.8m in length and 1m in breadth was prepared. The distance between blocks and the plots were kept 0.5 m respectively. The field was ploughed two weeks prior to seed sowing by using mini- tiller to bring the soil under good tilth. After tillage, levelling was done, and stubbles of previous crops and weeds were removed. The required amount of organic and inorganic fertilizers as per treatments was applied at the time of land preparation. The seed were soaked in water for 6 hours and wrapped with piece of thin cloth. The carrot seed of uniform size were sown 1-3 cm depth at a spacing 20×10 cm in 24th February, 2023. After seed sowing a light irrigation was given to each plot, to facilitate the germination of seed. Thinning was done manually to maintain the required plant population. Hand weeding was done at 30, 45 and 60 days after sowing of seed. The plants were irrigated as per requirement. The crop was protected from the attack of insect- pest by spraying Malathion. Harvesting was done manually by gently pulling the carrot from the soil by grasping the top at the base. The observation was recorded on ten randomly selected plants from each treatment. Eleven parameters; plant height (cm), number of leaves / plants, length of leaves/plant (cm), fresh weight of leaves (g), root length (cm), root diameter (cm), fresh weight of root (g), economic yield(t/ha), cracked root (%), branched root (%) and root index were recorded. The data of vegetative parameters were recorded 40 days after sowing and was continued till harvest at 20 days interval.

The number of cracked root and branched root per plot was recorded and percentage was calculated as given by (Pal, 2020).

$$\text{Cracked root (\%)} = \frac{\text{No. of cracked root/plot}}{\text{Total no. of roots/plot}} \times 100$$

$$\text{Branched root (\%)} = \frac{\text{No. of branched roots/plot}}{} \times 100$$

$$\text{Total no. of roots/plot}$$

Root index was calculated as root diameter to the root length and expressed as:

$$\text{Index} = \frac{\text{Root diameter}}{\text{Root length}}$$

The mean of all the treatments were calculated and analysis of variance for each of the characters under study was performed by F-test. The difference among the treatments mean were evaluated by Duncan's Multiple Range Test (DMRT) (Gomez & Gomez, 1984).

Table 1. Soil characteristics of experimental site

Serial number	Soil Characteristics	Properties
1.	Nitrogen	Low
2.	Phosphorus	Low
3.	Potassium	Medium
4.	Soil pH	6.0
5.	Soil texture	Sandy Loam

Results and discussion

Plant height

There was significant difference among the treatments on plant height. The maximum plant height was found in Prangarik mal+ Boron (7.78, 18.92, 41.61 & 55.48) cm followed by Goat manure + Boron with (6.37, 16.35, 34.71 & 46.62) cm at 40, 60, 80 & 100 days after sowing (DAS) respectively. The minimum plant height was found in Control (3.56, 8.63, 14.95 and 23.32) cm as shown in Table 2.

Biswas et al. (2020) also reported that 50 % vermicompost + 50 % NPK gave highest plant height than others combination in carrots. The organic manure treatments (T_3, T_4 & T_6) have similar plant height at 100 DAS which are not significantly different apar.

Table 2. Effect of fertilizers on plant height of carrot at different days after sowing in Khotang, Nepal, 2023

Treatments	**Plant height (cm)**			
	40 DAS	60 DAS	80 DAS	100 DAS
Control	3.56^{d}	8.63^{c}	14.95^{c}	23.32^{d}
Prangarik mal+ Boron	7.78^{a}	18.92^{a}	41.61^{a}	55.48^{a}
Poultry manure+ Boron	5.64^{bc}	15.09^{b}	28.11^{b}	39.53^{c}

Vermicompost+ Boron	5.26^{c}	13.24^{b}	30.67^{b}	40.07^{c}
NPK + Boron	5.39^{bc}	13.69^{b}	27.32^{b}	35.59^{c}
Neem cake + Boron	5.55^{bc}	13.30^{b}	28.42^{b}	39.74^{c}
Goat manure + Boron	6.37^{b}	16.35^{ab}	34.71^{ab}	46.62^{b}
Grand mean	5.65	14.17	29.40	40.05
SEM (±)	0.12	0.41	0.93	0.68
CV (%)	9.66	13.09	14.41	7.81
F- test	***	***	***	***

Note: *** represent 0.1% level of significance; SEm: Standard error of mean; Values with same letter(s) in a column are not significantly different at 5% level by DMRT

Number of leaves / plants

There was significant difference ($p \leq 0.001$) among the different treatments on number of leaves per plant. The maximum number of leaves per plant was found in Prangarik mal + Boron (2.73, 5.77, 10.53 & 13.07) followed by Goat manure + Boron (2.30, 4.90, 8.07 & 10.6) at 40, 60,80 & 100 days after sowing (DAS) respectively. The minimum number of leaves per plant was found in Control (2.07, 3.47, 5.57 & 6.9) as shown in Table 3. Amir (2022) also observed that different doses of chicken manure gave highest number of leaf than control in carrot.

Table 3. Effect of fertilizers on number of leaves per plant of carrot at different days after sowing in Khotang, Nepal, 2023

	Number of leaves per plant			
Treatment	40 DAS	60 DAS	80 DAS	100 DAS
Control	2.07^{e}	3.47^{e}	5.57^{c}	6.9^{e}
Prangarik mal+ Boron	2.73^{a}	5.77^{a}	10.53^{a}	13.07^{a}
Poultry manure+ Boron	2.27^{bc}	4.67^{bc}	7.83^{b}	10.17^{bc}
Vermi compost+ Boron	2.10^{de}	4.17^{cd}	7.17^{b}	9.1^{d}
NPK + Boron	2.23^{bcd}	4.30^{cd}	7.23^{b}	8.93^{d}
Neem cake + Boron	2.13^{cde}	3.93^{e}	7.53^{b}	9.3c^{d}
Goat manure + Boron	2.30^{b}	4.90^{b}	8.07^{b}	10.6^{b}
Grand mean	2.26	4.46	7.71	9.72
SEM (±)	0.02	0.07	0.93	0.12
CV (%)	3.76	6.90	7.38	5.80
F- test	***	***	***	***

Note: *** represent 0.1% level of significance; SEm: Standard error of mean; Values with same letter(s) in a column are not significantly different at 5% level by DMRT

Length of leaves per plant (cm)

The fertilizer treatments had varying effects on length of leaves in comparison to control. Length of leaves per plant (cm) was significantly different among treatments. The maximum length of leaves per plant was found in Prangarik mal+ Boron (6.97, 17.20, 39.79 & 53.31) cm followed by Goat manure + Boron (5.40, 14.97, 31.91 & 44.73) cm at 40, 60, 80 & 100 days after sowing (DAS). The minimum length of leaves per plant (3.32, 7.80, 12.80 & 21.31) cm was found in Control as shown in Table 4.

Table 4. Effect of fertilizers on length of leaves per plant of carrot at different days after sowing in Khotang, Nepal, 2023

Treatment	Length of leaves per plant (cm)			
	40 DAS	60 DAS	80 DAS	100 DAS
Control	3.32^{d}	7.80^{d}	12.80^{c}	21.31^{d}
Prangarik mal+ Boron	6.97^{a}	17.20^{a}	39.79^{a}	53.31^{a}
Poultry manure+ Boron	4.42^{c}	14.19^{bc}	25.94^{b}	37.52^{c}
Vermi compost+ Boron	4.10^{cd}	12.31^{c}	28.45^{b}	37.89^{c}
NPK + Boron	4.15^{cd}	12.66^{bc}	26.01^{b}	33.65^{c}
Neem cake + Boron	4.51^{c}	12.54^{bc}	28.05^{b}	37.61^{c}
Goat manure + Boron	5.40^{b}	14.97^{ab}	31.91^{b}	44.73^{b}
Grand mean	4.70	13.15	27.56	38.00
SEM (±)	0.10	0.07	0.89	0.70
CV (%)	9.84	10.29	14.74	8.42
F- test	***	***	***	***

Note: *** represent 0.1% level of significance; SEm: Standard error of mean; Values with same letter(s) in a column are not significantly different at 5% level by DMRT

Effect of organic and inorganic fertilizers on yield parameters

There was significant difference in the weight of fresh leaves (g) among different treatments. The maximum fresh weight of leaves was found under Prangarik mal + Boron (163g), followed by Goat manure + Boron (94.83g) at 100 DAS. The minimum fresh weight of leaves was observed under the treatment Control (40.33g) at 100 DAS. Root length was significantly different ($p \leq 0.001$) among other treatments as the maximum root length was found in Prangarik mal+ Boron (16.01cm), followed by Goat manure + Boron (13.75cm). The minimum root length was observed under Control (7.02cm). There was significant difference ($p \leq 0.001$) among other treatments.

The maximum root diameter was observed under Prangarik mal+ Boron (3.55 cm), followed by Goat manure + Boron (2.36 cm). The minimum root diameter was observed under Control (0.87cm). There was significant difference ($p \leq 0.001$) among other treatments. The maximum fresh weight of root was observed under Prangarik mal + Boron (127.33g), followed by Goat manure + Boron (106.33g). The minimum fresh weight of root was observed under Control (51g). Significant difference ($p \leq 0.001$) was found in root yield among different treatments. The highest root yield was found in Prangarik mal + Boron (42.43 t/ha) followed by Goat manure + Boron (27.44 t/ha), while the lowest yield (7.77 t/ha) was found in Control. This study resulted in 7.77 t/ha to 42.43 t/ha which was lower than the finding of (Amartey et al., 2022) who reported a total carrot yield ranging from 22.2 to 47.6 t/ha using different organic fertilizers.

Table 5. Effect of fertilizers on yield of carrot at 100 days after sowing in Khotang, Nepal, 2023

Treatment	LW (g)	RL (cm)	RD (cm)	FWR (g)	RY(kg)
Control	40.33^{c}	7.02^{e}	0.87^{d}	51.00^{e}	3.26^{d}
Prangarik mal+ Boron	163^{a}	16.01^{a}	3.55^{a}	127.33^{a}	10.58^{a}
Poultry manure+ Boron	90^{b}	10.83^{c}	1.76^{c}	74.17^{cd}	4.75^{cd}
Vermicompost+ Boron	84.83^{b}	11.18^{c}	1.37^{c}	77.00^{cd}	4.93^{cd}
NPK + Boron	67.83^{b}	9.47^{d}	1.39^{c}	78.33^{bcd}	5.01^{bcd}
Neem cake + Boron	80.33^{b}	11.89^{c}	2.26^{b}	90.17^{bc}	5.77^{bc}
Goat manure + Boron	94.83^{b}	13.75^{b}	2.36^{b}	106.33^{b}	6.81^{b}
Grand mean	88.74	11.45	1.94	91.76	5.89
SEM (±)	7.48	0.15	0.06	3.56	0.23
CV (%)	38.65	6.16	12.97	17.77	17.61
F- test	*	***	***	***	***

Note: * and *** represent 5%, 0.1% level of significance respectively; SEm: Standard error of mean; Values with same letter(s) in a column are not significantly different at 5% level by DMRT

LW= Weight of leaf, RL=Length of root, RD= Root Diameter, FWR= Fresh weight of root/ plot & RY= Root yield/plot

Table 6. Effect of fertilizers on yield parameters of carrot at 100 days after sowing in Khotang, Nepal, 2023

Treatment	Economic Yield (t/ha)	Cracked Root (%)	Branched Root (%)	Root Index
Control	7.77	2.08	2.60	0.12
Prangarik mal+ Boron	42.43	2.08	3.65	0.22
Poultry manure+ Boron	16.05	1.56	4.69	0.16
Vermicompost+ Boron	17.11	2.61	3.65	0.12
NPK + Boron	17.50	2.08	7.29	0.15
Neem cake + Boron	21.77	1.56	4.17	0.19
Goat manure + Boron	27.44	2.08	2.60	0.17

Conclusion

There were significant differences observed in morphological and yield characteristics over control among all the treatments. Based on the research, it can be concluded that the application of Prangarik mal+ Boron increased growth and yield, followed by Goat manure + Boron while the minimum was found in Control. Application of organic manures can be practiced for obtaining better yield of carrot at the rate of 20 t/ha Prangarik mal, Goat manure @ 15 t/ha. Borax @10 kg/ha should be used for enhancing the quality and quantity of carrot and avoiding the soils to become boron deficient.

Author's declaration

The authors declare that there are no conflicts of interest regarding the publication of this research paper.

Declaration of the conflict of interest

The authors declare that they have no conflict of interest.

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