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# Studies on the effect of micronutrients and their schedule of spray on growth and economic of carrot (*Daucus carota* L.) cv. new Kuroda under southern Telangana conditions

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**Abstract**
A field experiment was conducted during *rabi* 2018-2019 at College of Horticulture –SKLTS Horticultural University, Hyderabad, Telangana, India, to study on the effect of micronutrients and their schedule of spray on growth and economic of carrot (*Daucus carota* L.) cv. New Kuroda. The experiment was carried out with the 14 treatments consisting of seven levels of different combinations of nutrient concentrations with two levels of Schedule of spray in a Factorial Randomized Block Design (FRBD) with three replications. Among the treatments, Foliar application of $T_6$ (zinc, iron, magnesium each @ 0.5% + copper @ 0.2% + boron @ 0.5%) at 45 days after sowing recorded significantly maximum plant height (52.40 cm), number of leaves per plant (16.53), leaf length (38.07 cm), maximum fresh weight of leaves (49.07 g), highest gross return (Rs. 3,02,200), net return (Rs. 2,38,843) and best benefit cost ratio (3.77).

**Keywords:** Micronutrients, schedule of spray, growth and economics

## Introduction
Carrot (*Daucus carota* L.) is one of the important root vegetable crops belonging to the family Apiaceae (Peirce, 1987) [3] and is native to the Mediterranean region (Shinohara, 1984) [5]. It is an excellent source of iron, vitamin-A, Vitamin-B, Vitamin-C and sugar (Yawalker, 1985) [7]. Carrot root plays an important role in controlling the blindness of children by providing vitamin-A (Bose and Som, 1990) [1]. Economical plant part of carrot is used as a soup, stews, curries and pies. Carrot juice is a rich source of carotene and sometimes it is used for colouring butter and other food. It also has cooling effect and is beneficial for people suffering from gall stones, constipation and heart problems. Micronutrients are very much essential for plant growth and they are required in smaller quantities. They play a vital role in enhancing crop productivity. Most of the growers follow recommended doses of macronutrients to achieve more yield but they may not consider that, one or more micronutrients also be limiting the crop yield. In many situations, deficiency of certain nutrients is the major factor responsible for ineffective utilization of some secondary and micronutrients supplied in fertilizer programmes. Keeping these points in view the present investigation was designed with "Studies on the effect of micronutrients and their schedule of spray on growth and economics of carrot (*Daucus carota* L.) Cv. New Kuroda under Southern Telangana Conditions'

## Materials and Methods
The present investigation was conducted on study the effect of micronutrients and their schedule of spray on growth parameters and economics of carrot (*Daucus carota* L.) cv. New Kuroda under Southern Telangana conditions at Vegetable Research Block, College of Horticulture – Mojerla, SKLTS Horticultural University, Hyderabad (Telangana) situated at 780 29' East longitude and 170 19' North latitude with an altitude of 542.3 m above the mean sea level. The location is characterized by semi arid climate. The soil of the experimental site was sandy loam having soil pH 6.5, organic carbon 0.27% and available N, P and K content of 206, 26.00 and 220 kg $ha^{-1}$ respectively. The carrot variety new Kuroda used as experimental material and the experiment was laid out in a Factorial Randomized Block Design (FRBD) with three replications.

The whole experiment was arranged over 14 treatments consisting of seven levels of different combinations of nutrient concentrations (C) $C_1$ – Zinc, Iron, Magnesium each at 0.25%, $C_2$ – Zinc, Iron, Magnesium each at 0.5%, $C_3$ – Zinc, Iron, Magnesium each at 0.25% + Copper at 0.1%, $C_4$- Zinc, Iron, Magnesium each at 0.5% + Copper at 0.2%, $C_5$ – Zinc, Iron, Magnesium each at 0.25% + Copper 0.1% +Boron at 0.3%, $C_6$ – Zinc, Iron, Magnesium each at 0.5% + Copper at 0.2% + Boron at 0.5%, $C_7$ – Control with two levels of Schedule of spray (S) $S_1$: 30 days after sowing, $S_2$: 45 days after sowing. Seeds were sown at the spacing of 30 x 5cm and thinning was done 10 days after sowing to maintain spacing. The data were recorded on five plants per treatment per plot in each replication on growth parameters and benefit cost ratio. Observations were recorded on plant height (cm), number of leaves per plant, leaf length (cm), fresh weight of leaves (g) and economic analysis. The data was analyzed statistically by following the analysis of variance (ANOVA) technique as asserted by Panse and Sukhatme (1985) [2]. Economics of various treatments was computed on the basis of prevailing market price of inputs.

## Results and Discussion

The micronutrients and their schedule of spray had significant effect on growth parameters and economics of carrot. (Table 1 - 5) among the treatments, $T_6$ (zinc, iron, magnesium @ 0.5% + copper @ 0.2% + boron @ 0.5%) recorded significantly maximum plant height (51.97 cm), number of leaves per plant (16.07), leaf length (37.53 cm) and fresh weight of leaves (48.63 g) as compared to other treatments. Between schedules of spray of micronutrients, micronutrients spray at 45 days after sowing registered significantly higher plant height (44.96 cm), more number of leaves per plant (13.44), longer leaf length (31.91cm) and fresh weight of leaves (44.05 g) than micronutrients spray at 30 days after sowing. The interaction between treatments and schedule of spray had a significant influence on plant height, number of leaves, leaf length and fresh weight of leaves. Foliar application of $T_6$ treatment (zinc, iron, magnesium each @ 0.5% + copper @ 0.2% + boron @ 0.5%) at 45 days after sowing recorded significantly maximum plant height (52.40 cm), number of leaves per plant (16.53), leaf length (38.07 cm), maximum fresh weight of leaves (49.07 g), highest gross return (Rs. 3,02,200), net return (Rs. 2,38,843) and best benefit cost ratio (3.77).

From the (table 1) highest plant height was recorded in the $T_6$ treatment (zinc, iron, magnesium @ 0.5% + copper @ 0.2% + boron @ 0.5%) which was due to the availability of micronutrients at optimum levels, resulted in increased photosynthetic activity, chlorophyll formation, nitrogen metabolism and auxin contents, which ultimately improved the plant height. The other reason might be due to foliar spray of zinc and boron increased the plant height due to maximum cell division and cell elongation, resulted in elongation of internodes. The results are in accordance with the findings of Pongener *et al.* (2018) [4] and Subba *et al.* (2017) [6] in carrot. The data (Table 2) on number of leaves per plant revealed that $T_6$ treatment recorded significantly maximum values which might be due to luxurious vegetative growth of plant, resulted in more number of leaves per plant. The similar results were also reported by Subba *et al.* (2017) [6] in carrot.

**Table 1:** Effect of micronutrients and their schedule of spray on plant height (cm) at different growth stage of carrot Cv. New Kuroda

| Micronutrient concentration or Treatments (T) | Plant height (cm) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 30 DAS | | | 60 DAS | | | At harvest stage | | |
| | $S_1$ | $S_2$ | Mean | $S_1$ | $S_2$ | Mean | $S_1$ | $S_2$ | Mean |
| $T_1$ | 9.80 | 9.80 | 9.80 | 25.20 | 25.93 | 25.57 | 41.73 | 42.60 | 42.17 |
| $T_2$ | 9.87 | 9.93 | 9.90 | 27.27 | 28.40 | 27.83 | 43.33 | 44.27 | 43.80 |
| $T_3$ | 9.47 | 9.67 | 9.57 | 29.27 | 30.67 | 29.97 | 44.73 | 45.67 | 45.20 |
| $T_4$ | 9.87 | 9.87 | 9.87 | 32.00 | 32.87 | 32.43 | 46.93 | 47.93 | 47.43 |
| $T_5$ | 9.93 | 9.90 | 9.92 | 33.27 | 34.00 | 33.63 | 49.33 | 50.53 | 49.93 |
| $T_6$ | 9.93 | 9.77 | 9.85 | 34.80 | 35.67 | 35.23 | 51.53 | 52.40 | 51.97 |
| $T_7$ | 9.73 | 9.80 | 9.77 | 21.53 | 21.40 | 21.47 | 31.40 | 31.27 | 31.33 |
| Mean | 9.80 | 9.82 | | 29.05 | 29.85 | | 44.14 | 44.96 | |
| | S.Em ± | CD @ 5% | | S.Em ± | | CD @ 5% | S.Em ± | CD @ 5% | |
| Treatments (T) | 0.08 | 0.22 | | 0.11 | | 0.32 | 0.09 | 0.28 | |
| Schedule of spray (S) | 0.04 | N.S | | 0.06 | | 0.17 | 0.05 | 0.15 | |
| T X S | 0.11 | N.S | | 0.15 | | 0.45 | 0.14 | 0.39 | |

**Note:** $T_1$- zinc, iron, magnesium @ 0.25%, $T_2$-zinc, iron, magnesium @ 0.5%, $T_3$-zinc, iron, magnesium @ 0.25% + copper @ 0.1%, $T_4$- zinc, iron, magnesium @ 0.5% + copper @ 0.2%, $T_5$- zinc, iron, magnesium @ 0.25% + copper @ 0.1% + boron @ 0.3%, $T_6$- zinc, iron, magnesium @ 0.5% + copper @ 0.2% + boron @ 0.5%, $T_7$- control $S_1$- Spraying at 30 days after sowing and $S_2$- Spraying at 45 days after sowing

**Table 2:** Effect of micronutrients and their schedule of spray on number of leaves per plant at different growth stages of carrot Cv.New Kuroda

| Micronutrient concentration or Treatments (T) | Number of leaves per plant | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 30 DAS | | | 60 DAS | | | At harvest stage | | |
| | $S_1$ | $S_2$ | Mean | $S_1$ | $S_2$ | Mean | $S_1$ | $S_2$ | Mean |
| $T_1$ | 5.73 | 5.93 | 5.83 | 7.80 | 8.60 | 8.20 | 10.60 | 11.40 | 11.00 |
| $T_2$ | 5.80 | 6.00 | 5.90 | 9.27 | 9.80 | 9.53 | 12.33 | 12.93 | 12.63 |
| $T_3$ | 5.73 | 6.27 | 6.00 | 10.07 | 10.40 | 10.23 | 13.20 | 13.87 | 13.53 |
| $T_4$ | 5.93 | 5.60 | 5.77 | 10.60 | 11.00 | 10.80 | 14.00 | 14.27 | 14.13 |
| $T_5$ | 5.73 | 6.27 | 6.00 | 11.47 | 12.07 | 11.77 | 14.80 | 15.07 | 14.93 |
| $T_6$ | 5.73 | 5.87 | 5.80 | 12.80 | 13.73 | 13.27 | 15.60 | 16.53 | 16.07 |
| $T_7$ | 6.07 | 5.80 | 5.93 | 7.47 | 7.33 | 7.40 | 10.07 | 10.00 | 10.03 |
| Mean | 5.82 | 5.96 | | 9.92 | 10.42 | | 12.94 | 13.44 | |

| | S.Em± | CD at 5% | S.Em± | CD at 5% | S.Em± | CD at 5% |
|---|---|---|---|---|---|---|
| Treatments (T) | 0.17 | N.S | 0.08 | 0.25 | 0.10 | 0.30 |
| Schedule of spray (S) | 0.09 | N.S | 0.04 | 0.13 | 0.06 | 0.16 |
| T X S | 0.25 | N.S | 0.12 | 0.35 | 0.15 | 0.43 |

**Note:** $T_1$- zinc, iron, magnesium @ 0.25%, $T_2$-zinc, iron, magnesium @ 0.5%, $T_3$-zinc, iron, magnesium @ 0.25% + copper @ 0.1%, $T_4$- zinc, iron, magnesium @ 0.5% + copper @ 0.2%, $T_5$- zinc, iron, magnesium @ 0.25% + copper @ 0.1% + boron @ 0.3%, $T_6$- zinc, iron, magnesium @ 0.5% + copper @ 0.2% + boron @ 0.5%, $T_7$- control $S_1$- Spraying at 30 days after sowing and $S_2$- Spraying at 45 days after sowing

From the data (Table 3) it is revealed that the maximum leaf length was recorded in $T_6$ treatment which might be due to availability of all nutrients to the plant, resulted in luxurious vegetative growth with better photosynthetic activity led to more leaf length of this treatment than others. The present investigation was in consistent with reports of Singh *et al.* (2017) in carrot.

**Table 3:** Effect of micronutrients and their schedule of spray on leaf length (cm) at different growth stages of carrot Cv. New Kuroda

| **Micronutrient concentration or Treatments (T)** | **Leaf length (cm)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **30 DAS** | | | **60 DAS** | | | **At harvest stage** | | |
| | **$S_1$** | **$S_2$** | **Mean** | **$S_1$** | **$S_2$** | **Mean** | **$S_1$** | **$S_2$** | **Mean** |
| $T_1$ | 6.40 | 6.20 | 6.30 | 19.80 | 20.47 | 20.13 | 29.00 | 29.47 | 29.23 |
| $T_2$ | 6.20 | 6.47 | 6.33 | 21.07 | 21.80 | 21.43 | 30.33 | 31.00 | 30.67 |
| $T_3$ | 5.80 | 5.73 | 5.77 | 22.53 | 23.13 | 22.83 | 31.80 | 32.80 | 32.30 |
| $T_4$ | 6.20 | 6.27 | 6.23 | 24.00 | 25.00 | 24.50 | 33.80 | 34.53 | 34.17 |
| $T_5$ | 6.60 | 6.80 | 6.70 | 25.80 | 26.67 | 26.23 | 35.27 | 36.07 | 35.67 |
| $T_6$ | 6.67 | 6.53 | 6.60 | 27.73 | 28.67 | 28.20 | 37.00 | 38.07 | 37.53 |
| $T_7$ | 6.07 | 6.00 | 6.03 | 13.93 | 13.87 | 13.90 | 21.53 | 21.47 | 21.50 |
| Mean | 6.28 | 6.29 | | 22.12 | 22.80 | | 31.25 | 31.91 | |
| | S.Em± | CD at 5% | | S.Em± | | CD at 5% | S.Em± | CD at 5% | |
| Treatments (T) | 0.13 | 0.37 | | 0.07 | | 0.19 | 0.06 | 0.18 | |
| Schedule of spray (S) | 0.07 | N.S | | 0.04 | | 0.10 | 0.03 | 0.10 | |
| T X S | 0.18 | N.S | | 0.09 | | 0.27 | 0.09 | 0.26 | |

**Note:** $T_1$- zinc, iron, magnesium @ 0.25%, $T_2$-zinc, iron, magnesium @ 0.5%, $T_3$-zinc, iron, magnesium @ 0.25% + copper @ 0.1%, $T_4$- zinc, iron, magnesium @ 0.5% + copper @ 0.2%, $T_5$- zinc, iron, magnesium @ 0.25% + copper @ 0.1% + boron @ 0.3%, $T_6$- zinc, iron, magnesium @ 0.5% + copper @ 0.2% + boron @ 0.5%, $T_7$- control $S_1$- Spraying at 30 days after sowing and $S_2$- Spraying at 45 days after sowing

From the (table 4) the maximum fresh weight of leaves was recorded in $T_6$ treatment might be due to maximum leaf area of this treatment as compared to rest of the treatments. Our results are comparable with those of Subba *et al.* (2017) [6] in carrot who reported that abundant supply of nutrients causes less retention in the roots and more translocation in aerial parts for synthesis of protoplasmic protein and other metabolites responsible for cell division and cell elongation thus enabling the expansion of photosynthetic area, helped in increasing the weight of leaves.

**Table 4:** Effect of micronutrients and their schedule of spray on fresh weight of leaves (g) at different growth stages of carrot Cv. New Kuroda

| **Micronutrient concentration or Treatments (T)** | **Fresh weight of leaves (g)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **30 DAS** | | | **60 DAS** | | | **At harvest stage** | | |
| | **$S_1$** | **$S_2$** | **Mean** | **$S_1$** | **$S_2$** | **Mean** | **$S_1$** | **$S_2$** | **Mean** |
| $T_1$ | 2.27 | 2.40 | 2.33 | 31.53 | 31.87 | 31.70 | 42.20 | 42.60 | 42.40 |
| $T_2$ | 2.27 | 2.47 | 2.37 | 32.40 | 33.00 | 32.70 | 43.33 | 43.87 | 43.60 |
| $T_3$ | 2.53 | 2.40 | 2.47 | 34.00 | 34.80 | 34.40 | 44.80 | 45.20 | 45.00 |
| $T_4$ | 2.53 | 2.47 | 2.50 | 35.47 | 36.00 | 35.73 | 45.80 | 46.53 | 46.17 |
| $T_5$ | 2.60 | 2.47 | 2.53 | 36.60 | 37.00 | 36.80 | 47.00 | 47.60 | 47.30 |
| $T_6$ | 2.53 | 2.60 | 2.57 | 37.67 | 38.47 | 38.07 | 48.20 | 49.07 | 48.63 |
| $T_7$ | 2.20 | 2.40 | 2.30 | 24.20 | 24.40 | 24.30 | 33.20 | 33.47 | 33.33 |
| Mean | 2.42 | 2.46 | | 33.12 | 33.65 | | 43.51 | 44.05 | |
| | S.Em± | CD at 5% | | S.Em± | | CD at 5% | S.Em± | CD at 5% | |
| Treatments (T) | 0.09 | N.S | | 0.065 | | 0.19 | 0.06 | 0.18 | |
| Schedule of spray (S) | 0.05 | N.S | | 0.035 | | 0.10 | 0.03 | 0.10 | |
| T X S | 0.14 | N.S | | 0.092 | | 0.27 | 0.09 | 0.26 | |

**Note:** $T_1$- zinc, iron, magnesium @ 0.25%, $T_2$-zinc, iron, magnesium @ 0.5%, $T_3$-zinc, iron, magnesium @ 0.25% + copper @ 0.1%, $T_4$- zinc, iron, magnesium @ 0.5% + copper @ 0.2%, $T_5$- zinc, iron, magnesium @ 0.25% + copper @ 0.1% + boron @ 0.3%, $T_6$- zinc, iron, magnesium @ 0.5% + copper @ 0.2% + boron @ 0.5%, $T_7$- control $S_1$- Spraying at 30 days after sowing and $S_2$- Spraying at 45 days after sowing

**Table 5:** Effect of micronutrients and their schedule of spray on economics of carrot Cv. New Kuroda

| Treatments | Common cost (Rs/ha) | Treated cost (Rs/ha) | Total cost of cultivation (Rs/ha) | Yield (t/ha) | Gross return (Rs/ha) | Net return (Rs/ha) | B: C ratio |
|---|---|---|---|---|---|---|---|
| $T_1$ | 62141 | 516 | 62657 | 6.72 | 134400 | 71743 | 1.15 |
| $T_2$ | 62141 | 1032 | 63173 | 7.61 | 152200 | 89027 | 1.41 |
| $T_3$ | 62141 | 564 | 62705 | 8.56 | 171200 | 108495 | 1.73 |
| $T_4$ | 62141 | 1128 | 63269 | 10.61 | 212200 | 148931 | 2.35 |
| $T_5$ | 62141 | 617 | 62758 | 11.89 | 237800 | 175042 | 2.79 |
| $T_6$ | 62141 | 1216 | 63357 | 15.11 | 302200 | 238843 | 3.77 |
| $T_7$ | 62141 | | 62141 | 5.33 | 106600 | 44459 | 0.72 |

**Market price of carrot – Rs 20/kg**

Evident from the data (Table 5) maximum gross return, Net return and B: C ratio was recorded in $T_6$ treatment (zinc, iron, magnesium @ 0.5% + copper @ 0.2% + boron @ 0.5%) which might be due to higher root yield per hectare as compared to other treatments

## Conclusion

It could be concluded from the present investigation that, the micronutrients and their schedules of spray significantly influence the growth and economic of carrot Cv. New Kokoda. Among the micronutrient concentration treatments, $T_6$ treatment (zinc, iron, magnesium @ 0.5% + copper @ 0.2% + boron @ 0.5%) spray at 45 days after sowing showed positive effect on growth and benefit cost ratio over other treatments.

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