Effect of potassium and micronutrients on growth and quality of carrot (Daucus carota L.)

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Abstract
Carrot cultivated with limited nutrition will produce low yields and would require different nutrient combination for increased nutrition availability for higher productivity. The potassium and micronutrients was expected to increase and improve the growth and quality of carrot. A research experiment was conducted at Horticulture farm, SKNCOA, Jobner, Rajasthan, India to study the effect of potassium and micronutrients on growth and quality of carrot. The study revealed that the application of potassium @ 150 kg/ha and ZnSO₄ @ 0.5% significantly increased the plant height, number of leaves per plant, chlorophyll content in leaves, potassium and carotene content in roots of carrot over control.

Keywords: Carotene content, number of leaves per plant, potassium and micronutrients

Introduction
Carrot belongs to the family Apiaceae is a biennial but usually cultivated as an annual crop in the tropics. It is considered to be a native of Mediterranean region (Peirce, 1987) [6]. The most commonly consumable part of carrot is a tap root, although the greens are edible as well. It is taken raw as well as cooked in curries along with peas and is very commonly used in preserves, salads and tender roots as pickles. ‘Gajar Halwa’ is a delicious dish prepared from the carrot flesh. Carrot juice is a rich source of carotene and sometimes used for coloring and other foods. Black carrot is used for the preparation of a beverages called ‘Kanjji’ considered to be a good appetizer. Carrot (Daucus carota L.) is grown all over the India and an essential root vegetable commonly used in the diet of human beings. It is greatly treasured as food mostly because it is the best source of carotene; a precursor of Vitamin A (Zeb and Mahmood, 2004) [9]. Carotene is extracted from the roots is used in colouring margarine and for improving the colour of egg yolk when added to layer feed. Carrot seeds are used as aromatic, stimulant and carminative. They are also useful in the kidney diseases, in dropsy, nerving tonic, aphrodisiac and given in uterine pain.

Materials and Methods
The experiment was conducted at Horticulture Farm, S.K.N. College of Agriculture, Jobner (Jaipur) during Rabi season 2018-19. In Rajasthan, this region falls under agro-climatic zone-III A (Semi-Arid Eastern Plains). The experiment was laid out in Randomized Block Design with four levels of potassium (control, potassium @ 50 kg, potassium @ 100 kg and potassium @ 150 kg) and four micronutrients (control, FeSO₄ @ 0.5%, Borax @ 0.5%, ZnSO₄ @ 0.5%) with three replications. Potassium fertilizer was applied as basal dose and micronutrients were applied as foliar spray as per treatment combinations. The crop geometry was kept at 30 x 10 cm and all the required cultural operations were followed to raise the good crop. The observations like plant height (cm), number of leaves per plant, chlorophyll content (mg/100g) in leaves, potassium content (%) and carotene content (mg/100g) in roots of carrot were taken manually. The data obtained from the trial were subjected to statistical analyses which are presented in tabular form.
Results and Discussion

Growth attributes

It is evident from data (Table 1) that application of potassium and micronutrients had significant effect on the growth attributes. Results showed that application of potassium @ 150 kg/ha significantly increased the plant height, number of leaves per plant and chlorophyll content in leaves over control and potassium @ 50 kg/ha. The observed variation in overall growth of carrot might be due to role of potassium element in metabolism and many processes needed to sustain and promote plant vegetative growth and development. Moreover, K plays a major role in many physiological and biochemical processes such as cell division and elongation and metabolism of carbohydrates and protein compounds (Marschner, 1995) [3]. The applied K is attributable to its role in cell multiplication and photosynthesis which gave rise to increase chlorophyll content of leaves (Liu, 2013) [4]. Further, the plant height, number of leaves per plant and chlorophyll content in leaves were also observed significantly maximum with the foliar application of different micronutrients. The application of ZnSO₄ @ 0.5% significantly increased the growth attributes of carrot over control. The application of Zinc is essential micronutrient which play a vital role in various enzymatic and physiological activities such as protein metabolism, gene expression, structural and functional integrity of biomembranes and photosynthetic carbon metabolism (Catmak, 2000) [5]. It also regulate the auxin concentration in plants and is an essential component of enzymes viz. Alcohol dehydrogenas, carbonic anhydrase, super oxide dismutase which are needed for root development and increasing the absorption of CO₂ per leaf area unit and thus increasing the chlorophyll content and photosynthesis. Similar findings have also been reported by Marschner, 1995 [5] and Sharma 2002 [8].

Quality attributes

It is evident from data (Table 2) that potassium and carotene content in roots of carrot were significantly increased with application of Potassium @ 150 kg/ha. The increase in potassium and carotene content might be clear to better availability of desired and required quantity of potassium for longer period and mode of action of potassium in enhancing the photosynthetic activity and enzymes of carbohydrates transformation. (El-Tohamy et al., 2011) [3]. The increase in quality parameters of carrot might also be due to improved nutrition environment in the rhizosphere as well as its readily utilization in the plant system, leading to enhanced and translocation of nutrients in developing cell of the plant. Further, the carotene content in carrot root was significantly increased with the application of ZnSO₄ @ 0.5% as compared to control. The increase in potassium and zinc content in roots of carrot might be due to improved nutritional environment and their readily utilization by plant enhanced translocation of nutrient in developing cell of the plant. Application of micronutrients increasing the sugar yield due to increased glucose level in roots and phloem sap (Al-Mohammad and Al-Geddawi, 2001) [1]. Foliar application of zinc and other micronutrients also play a role to increase the activity of nitrate educate enzyme and enhanced synthesis of certain amino acids and protein (Ramesh et al. 2006) [7].

Table 1: Effect of potassium and micronutrients on growth attributes of Carrot

| Treatments          | Plant height (cm) | Number of leaves per plant | Chlorophyll content (mg/100g) |
|---------------------|-------------------|-----------------------------|-------------------------------|
|                     | 60 DAS            | 75 DAS                      | 60 DAS                        | 75 DAS                        |
| Potassium           |                   |                             |                               |                               |
| K₀ (control)        | 29.75             | 38.93                       | 5.21                          | 9.22                          |
| K₁ (50 kg K₂O/ha)   | 35.81             | 47.21                       | 7.11                          | 12.63                         |
| K₂ (100 kg K₂O/ha)  | 40.42             | 54.33                       | 8.35                          | 14.75                         |
| K₃ (150 kg K₂O/ha)  | 41.52             | 56.07                       | 8.72                          | 15.11                         |
| SE±                 | 0.99              | 1.16                        | 0.20                          | 0.36                          |
| CD (P=0.05)         | 2.87              | 3.35                        | 0.58                          | 1.04                          |
| Micronutrients (Foliar spray) |                   |                             |                               |                               |
| M₀ (control)        | 29.46             | 37.77                       | 5.25                          | 10.16                         |
| M₁ (FeSO₄ @ 0.5%)   | 41.24             | 54.92                       | 8.37                          | 14.14                         |
| M₂ (borax @ 0.5%)   | 35.40             | 46.99                       | 7.20                          | 12.45                         |
| M₃ (ZnSO₄ @ 0.5%)   | 41.40             | 56.85                       | 8.58                          | 14.97                         |
| SE±                 | 0.99              | 1.16                        | 0.20                          | 0.36                          |
| CD (P=0.05)         | 2.87              | 3.35                        | 0.58                          | 1.04                          |

Table 2: Effect of potassium and micronutrients on quality attributes of Carrot.

| Treatments      | Potassium content (%) | Carotene content (mg/100g) |
|-----------------|-----------------------|---------------------------|
| K₀ (control)    | 0.339                 | 1.82                      |
| K₁ (50 kg K₂O/ha) | 0.368                 | 2.10                      |
| K₂ (100 kg K₂O/ha) | 0.392                 | 2.22                      |
| K₃ (150 kg K₂O/ha) | 0.399                 | 2.29                      |
| SE±             | 0.008                 | 0.04                      |
| CD (P=0.05)     | 0.022                 | 0.11                      |
| M₀ (control)    | 0.366                 | 1.88                      |
| M₁ (FeSO₄ @ 0.5%) | 0.377                 | 2.14                      |
| M₂ (borax @ 0.5%) | 0.370                 | 2.10                      |
| M₃ (ZnSO₄ @ 0.5%) | 0.385                 | 2.31                      |
| SE±             | 0.008                 | 0.04                      |
| CD (P=0.05)     | NS                    | 0.11                      |

Conclusion

On the basis of the results emerged out from one year experiment, it can be concluded that application potassium @ 150 kg/ha recorded maximum plant height at 60 & 75 DAS (41.52 cm and 56.07 cm), respectively, number of leaves per plat at 60 and 75 DAS (8.72 and 15.11), respectively, chlorophyll content (1.12 mg/100g), potassium content (0.399%) and carotene content (2.29 mg/100g). Which were significantly superior than control and potassium @ 50 kg/ha. However, treatment potassium @ 100 kg/ha remained statistically at par to it. Further, The maximum plant height at 60 & 75 DAS (41.40 cm and 56.85 cm), respectively, number of leaves per plat at 60 and 75 DAS (8.58 and 14.97), respectively, chlorophyll content at 60 DAS (1.11 mg/g) and carotene content (2.31 mg/100g) were recorded with foliar application of ZnSO₄ @

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0.05% which was significantly better than rest of the treatments except FeSO₄ @ 0.05% which was statistically at par with ZnSO₄ @ 0.05%.

Thus, application of potassium @ 100 kg/ha and foliar spray of ZnSO₄ @ 0.5% (K₂M₃) to carrot is recommended for high root yield, economic returns in carrot growing areas of semi arid Eastern Plains of Rajasthan.

The results are only indicative and require further experimentation to arrive at more consistent and final conclusion.

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