Mineral Nutrients Management for Carrot (Daucus carota L.) Production: A Review

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Abstract: Carrot is the most root vegetable crop grown worldwide and in Ethiopia, it is the source of both foreign currency and cash for smallholder farmer. Yield of carrot is mainly affected by inappropriate mineral nutrients. Appropriate use of mineral nutrient in carrot production is related with soil character that can improve production, productivity and quality of the crop. Almost 30 to 70% increase in yields of crops has been achieved through the use of optimum and balanced mineral fertilizers. A number of growth and yield parameters (length of root, diameter of root, fresh weight of root, dry matter content of root, fresh weight of leaves, dry matter content of leaves, gross yield and marketable yield) of carrot were affected by different rates of mineral nutrients application. Different investigation revealed that the highest marketable yields of carrot were obtained by the combined application of N-P-K fertilizers at the rate of 140-40-80kg/ha respectively. There is also another report which indicates the application of nitrogen at 200kg/ha produced the tallest plant, maximum number of leaves, cracked roots, branched roots and fresh shoot weight, whereas nitrogen at rate of 150kg/ha produced the maximum root length, root diameter, fresh root weight and the highest yield of 53.37t/ha. Therefore, in view of the above points, the aim of this paper is to review on the major mineral nutrients management practices in Carrot (Daucus carota L.) root crop production.

Keyword: Carrot, mineral nutrient, management, production.

1. Introduction
Carrot (Daucus carota L.) belongs to the Umbeliferae family and is one of the major root vegetable used as fresh, salad and cooked vegetable, which is a rich source of beta carotene (Chadha, 2003). It provides 17% of the total vitamin A consumption, making it the single major source of beta carotene among the vegetables (Arscott and Tanumi 2010). Carrots are becoming more popular as they contain a high amount of beta carotene; a precursor to vitamin A which prevents infection, some forms of cancer and improves vision. They also contain vitamin C, thiamin B1 and riboflavin B2 (Fritz, V.A., 2013). Carrots are a good source of carbohydrates and minerals like Ca, P, Fe, Na, Cu, Zn and Mg.
The world carrot production is not only in restoring soil fertility and soil quality, thereby are successfully light and the highest yield of 53.37t/ha (Haque, et al., 1999). Therefore, in view of the above points that give a grey green appearance (Arscot, Tanumihardjo 2010; Sharma et al., 2012). Central Asia is considered as the origin of carrot and the center of its diversity (Simon, 2000). Carrot were expanded both eastward and westward since its domestication and roots consumption began in 700 A.D. The world carrot production is continuously increasing (FAO, 2015).

The root color and flavor are the most important qualitative factors for selection of varieties (Kreutzmannet al., 2007). Continuous market research and parallel breeding programs are successfully delivering carrot in a range of colors and flavors meeting the requirements of the specific consumer groups (Surleset al., 2004). Root size and shape are also considered important selection parameters (Cardello, 1994). Besides these factors, the medicinal value of carrot has always been acknowledged (McNutt, 1994; Pieroniet al., 2007).

Carrot plants fulfill it is nutritional requirements by the uptake of minerals largely through the soils (Cakmak, 2002). Soils of the cultivated areas have an ability to minimally sustain the plant growth with the nutrients held from previous crop rotation, but these nutrients are insufficient for higher production (Havlin, 2005). Nutrients applied to a growing crop are mainly consumed by the plants for the growth and development. Left over nutrients in the soil leach down (Grattan and Grieve, 1998) and become unavailable to the next crop. Resultantly, soils in the commercial crop growing areas do not hold sufficient quantity of nutrients as required for sustainable production and yield of plants.

Balanced fertilization is one of the most important factors in maximizing the yield potential of carrot crops. The nutrients are either added to the soil by using chemical fertilizers or by incorporating natural organic manures. The use of mineral fertilizers is the quickest way of increasing crop production; almost 30 to 70% increase in yields of crops has been achieved through the use of optimum and balanced mineral fertilizers (Ahmad, and Hamid, 1998).

High output from limited resources and intensive farming results in the accelerated use of chemical fertilizers, which pose certain threats to the environment and to humans (Zhu, and Chen, 2002). The yield and yield contributing characters of carrot were influenced by the application of N-P-K fertilizers. Hossain (2005) reported that the highest marketable yields of carrot were obtained by the application of N-P-K fertilizers at the rate of 140-40-80kg/ha respectively. There is also another research report that as application of nitrogen at 200kg/ha produced the tallest plant, maximum number of leaves, cracked roots, branched roots and fresh shoot weight, whereas nitrogen at rate of 150kg/ha produced the maximum root length, root diameter, fresh root weight and the highest yield of 53.37t/ha (Haque, 1999).

Similarly, now a days, the growers are showing interest in utilizing organic manures, primarily due to the exorbitant price of imported chemical fertilizers and their freely availability. Organic wastes serve not only as a source of plant nutrients but also in restoring soil fertility and soil quality, thereby improving the chemical, physical and biological properties of soil (Tennakoon, et al., 1995). A major component of organic production is providing organic sources of nutrients to promote plant growth as well as sustain soil quality (Havlin, et al., 2005). The organic sources improve physic-chemical characteristics and fertility of soil by different ways such as use of balanced amount of all nutrients and availability of the water for plant (Warman and Havard, 1997). Therefore, in view of the above points the main objectives of this paper is to review on the effect of mineral nutrients management for carrot (Daucus carota L.) production.

2. Mineral Nutrient Management in Carrot Production

2.1. The Carrot Crop

Carrot (Daucus carota L.) is belongs to the family Umbeliferae. It is related to celery, celeriac, coriander, fennel, parsnip and parsley, which are all members of this family. The carrot originated in Asia. It is a root vegetable, usually orange in colour, though purple, black, red, white, and yellow cultivars exist. Many shapes of roots also exist, from rather long and thin roots to shorter and thick (Salo, 1996). The two cultivated types of carrots are eastern (Asiatic) and western carrots. Eastern (Asiatic) carrots have reddish purple or yellow roots, young leaves that give a grey green appearance for the crop possess tendency for early flowering. Western carrots have orange, yellow, red or white roots, less juvenile green leaves (Rubatzkyet al., 1999).
Soon after germination, carrot seedlings show a distinct demarcation between taproot and stem: the stem is thicker and lacks lateral roots. At the upper end of the stem is the seed leaf. As the plant grows, these bases of the seed leaves, near the taproot, are pushed apart. The stem, located just above the ground, is compressed and the internodes are not distinct. When the seed stalk elongates for flowering, tip of the stem narrows and becomes pointed, and the stem extends upward to become a highly branched inflorescence up to 60-200cm tall (Rubatsky et al., 1999).

Carrots do best under cool conditions (10° to 25°C), and their seeds also germinate quite well, though slowly, under cool conditions. Temperature and soil moisture influence the shape, colour and quality of carrots. The best quality carrots are obtained when weather conditions favour regular uninterrupted growth. Plant growth is optimal between temperatures of 15° to 20°C, and the roots also develop the best colour and flavour at such temperatures. At temperatures below or above the optimum, poorer colour develops. The objective in growing carrots is a high yield of straight, smooth roots. Deep, well drained, sandy loam soils with a friable texture are most desirable. Heavy, stony, compacted and poorly drained soil is less desirable at it interferes with the development of the roots. Carrots do not grow well in acidic soils below a pH of 5. A pH of 6.5 to 7.0 is ideal for carrot production. Carrots are also very sensitive to saline soils and brackish soils should be avoided. Carrots are most sensitive to moisture stress during root enlargement and seed germination. In general, carrots require approximately 900 mm of water per crop cycle (140 days).

2.2. Importance and Production Perspective of Carrot in Ethiopia

According to the reports of (Radics et al. 2002), among the vegetables Umbeliferæ family carrot is a highly valued vegetable owing to its high nutritive value. It is an important contributor to the world food consumption. It has carotenoids, flavonoids, poly-acetylenes, vitamins, and minerals, all of which possess numerous nutritional and health benefits. Besides lending truth to the old adage that carrots are good for eyes, carotenoids, poly-phenols and vitamins present in carrot act as antioxidants, anti-carcinogens, and immune enhancers. It has Anti-diabetic, cholesterol and cardiovascular disease lowering, anti-hypertensive, hepato-protective, and wound healing.

Simon, (1992); Salunkhe and Kadam, (1998) reported that carrot is rich in beta-carotene, which is a source of vitamin A, essential for the growth and development of human organ, especially of children and young people. It is also an excellent source of iron, calcium, phosphorus, and folic acid and vitamin B and it is also rich in sugar content and some important medicinal values.

Getachew and Mohammed, (2012) reported that in Ethiopia, carrot production has been expanding mainly due to increasing urbanization and the recognition of carrots as an income and nutrition. CSA, (2015/16) reported that currently, about 12345.8 t of carrot is produced in Ethiopia on 2215 ha of land. Similarly, Tamirat Leamo, (2018) reported that farmers in and around Kombolcha in Ethiopia are mainly engaged in vegetable crops production as a major source of income, primarily, because of its proximity to Djibouti and Somalia markets which it is important to save foreign currency and farmers are in using new released variety with low cost as compared to imported seed.

2.3. Nutrient Requirements of Carrot Crop

According to the reports of Win (2010) the yield and quality of carrot are affected by the fertilizers and varieties. The potential quality of fruit is dependent on the cultivar type. Different cultivars are characterized by different quality parameters, making some more desirable to the producers and consumers. Further, the varieties may respond differently with different nutrient sources.

According to the reports of Sunanadarani and Mallareddy (2007) carrot is a heavy feeder of nutrients, and very sensitive to nutrient and soil moisture. Similarly, Nadaf (2007) also reported that major mineral nutrients like Nitrogen, Phosphorus and Potassium play an important role in vegetative and reproductive phase of crop growth. Mostly carrot growers use chemical fertilizers as the major supply of nutrients in order to achieve higher yields and growth. Even though an inorganic fertilization plays a vital role for the healthy plant growth and development, it does affect the soil health (Dauda et al., 2008).
2.4. Nitrogen in Carrot Plant Growth and Development

2.4.1. Roles of Nitrogen in Carrot

According to the reports of (Gray, 1983), nitrogen is a key nutrient for growth and is available naturally in the soil. Of the three major nutrients, plants require nitrogen in the largest amounts. Nitrogen promotes rapid growth, increases leaf size and quality, promotes fruit and seed development. Nitrogen is biologically combined with C, H, O, and S to create amino acids, which are the building blocks of proteins. Amino acids are used in forming protoplasm, the site for cell division and thus for plant growth and development. Since all plant enzymes are made of proteins, N is needed for all of the enzymatic reactions in a plant. N is a major part of the chlorophyll molecule and is therefore necessary for photosynthesis.

Kansal (1981) also argued that nitrogen is not the only important element for the growth and development of carrot but it affects the nutritional quality of the carrot roots. Haque (1999) also reported that application of nitrogen fertilizers at rate of 200kg/ha produced the tallest plant, maximum number of leaves, cracked roots, branched roots and fresh shoot weight whereas the application of nitrogen at a rate of 150kg/ha were produced the maximum root length, root diameter, fresh root weight and the highest yield of 53.37t/ha.

However, up to 130kg/ha nitrogen may be applied, particularly where the soil phosphorus and potassium status is high and where excessive leaching on sandy soils occurs. High rates of nitrogen should be avoided, as this stimulates leaf growth at the expense of root development and yield, and also delays harvesting. It is generally better to under- rather than over-apply nitrogen. Very lush leaf growth may also promote the development of diseases, such as Sclerotinia white mould, especially in the dense plantings used for baby carrot production. Most of the nitrogen is applied at planting, except on the sandier soil types, where leaching is likely. The remainder is applied, usually at 4 to 8 weeks, when more rapid leaf growth starts. Due to the high potassium requirement of the crop, potassium nitrate is often favored; for top-dressing.

According to the reports of (Salo, 1996; Warncke, 1996; Raynal-Lacroix, 1994), Carrot demand for additional nitrogen fertilizer varies between 0-110 kg/ha. As to (Bishop, 1973) argued that nitrogen application above 110 kg/ha decreases the yield and quality due to root cracking (Balvoll, 1995). Large nitrate concentration in soil tends to improve shoot: root ratio has been reported (Raynal- Lacroix, 1994). Warncke (1996) also recommended as great variation in nitrogen uptake may be related to different climatic conditions, soil type, nutrient concentration, and well-developed root system which enable the plants to absorb nitrogen efficiently from the soil.

About 85-90% of nitrogen is absorbed by carrot during the growth stage of plant; while in the first and last quarter of its growth only 10 -15% of nitrogen is absorbed has been reported (Raynal- Lacroix, 1994). Balvoll (1995) also reported that split applications of fertilizers, especially nitrogen, improve carrot yield. Similarly, (Kansal, et.al., 1981,) argued that Carrot yield and nutritional quality are affected by the types of fertilizers applied. There is also another reports by Rani, et.al, (2007) indicated that, carrot root yield were improved by hundred percent recommended dose of N, P and K fertilizers compared to application of organic fertilizer alone or combined application of mineral and organic fertilizer.

However, there is also another report by (Chessin and Hicks 1987; Cserni, et al., 1989) indicated that, high N rate up to 336kg/ha increased the nitrate level above the recommended dose for baby food whereas Shuval and Gruener (1997) and Mirvish (1997) also reported that as increasing nitrogen would increases nitrate content in carrot roots.
Table 1. Effect of nitrogen fertilizers applications on growth and yield of Carrot

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Length of root (cm)</th>
<th>Diameter of root (cm)</th>
<th>Fresh weight of leaves (g/plant)</th>
<th>Fresh weight of root (g/plant)</th>
<th>Dry matter content of root (%)</th>
<th>Dry matter yield leaves (%) (t ha⁻¹)</th>
<th>Gross yield leaves (%) (t ha⁻¹)</th>
<th>Cracked root (%)</th>
<th>Branched root (%)</th>
<th>Marketable yield (t ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N₀ = Control</td>
<td>15.39</td>
<td>6.30</td>
<td>128.50</td>
<td>38.33</td>
<td>9.87</td>
<td>8.55</td>
<td>12.65</td>
<td>5.45</td>
<td>10.24</td>
<td>5.84</td>
</tr>
<tr>
<td>N₁ = 70 kg N/ha</td>
<td>17.12</td>
<td>9.26</td>
<td>135.50</td>
<td>51.00</td>
<td>14.18</td>
<td>9.61</td>
<td>16.83</td>
<td>2.26</td>
<td>15.46</td>
<td></td>
</tr>
<tr>
<td>N₂ = 100 kg N/ha</td>
<td>17.19</td>
<td>10.40</td>
<td>145.10</td>
<td>68.33</td>
<td>15.90</td>
<td>11.66</td>
<td>22.55</td>
<td>2.05</td>
<td>20.67</td>
<td></td>
</tr>
<tr>
<td>LSD (₀.₀₅)</td>
<td>1.031</td>
<td>0.674</td>
<td>14.87</td>
<td>8.141</td>
<td>1.429</td>
<td>0.8346</td>
<td>1.668</td>
<td>0.002</td>
<td>0.5301</td>
<td>2.636</td>
</tr>
<tr>
<td>CV %</td>
<td>6.35</td>
<td>7.75</td>
<td>11.14</td>
<td>8.62</td>
<td>10.86</td>
<td>8.71</td>
<td>5.35</td>
<td>8.93</td>
<td>8.66</td>
<td>9.28</td>
</tr>
</tbody>
</table>


2.5. Potassium in Carrot Plant Nutrition

2.5.1. Roles of Potassium in Carrot

Lester et al. (2005) has reported that, Potassium plays a vital role in carrot crop production and quality metabolism. It acts on many physiological processes of the plant such as photosynthesis and carbohydrates translocation, the energy status, and maintenance of the tissue water. Increased amounts of K enhance the ability of plants to resist diseases, insect’s attacks, cold and drought stresses and other adverse conditions. Potassium fertilization was associated with the increase in the carotene concentration in the carrot root. An optimum dose of K is necessary to produce a maximum yield and a good quality. Shikha et al., (2016) also reported that, the yield, quality, and shelf life of carrot were increased gradually with K fertilization. In the similar way, (El-Tohamy et al., 2011) reported as potassium fertilization maintains the soil fertility and there is necessities for its continuous use for carrot production were argued. Kwiatkowski, et al., (2013) also concluded that, the global trends to healthy food production and the environmental protection have increased an interest in ecology-oriented agricultural practices such as foliar spray fertilization of macro and micronutrients and different bio stimulators has been stated.

Nagrea M., et al, (2012) has also reported that high potassium ensures a better quality Crisper, better colored roots and also enhances keeping quality after harvesting; wilting is retarded. Similarly, Beattie, et al, (1992) argued that as carrots are frequently grown on lighter textured soils, where leaching is more prevalent, about half the potash is often supplied in side-dressings during growth, usually at 4 and 8 weeks after planting.

Table 2. Effect of different levels of potassium fertilizers on growth and yield of carrot

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Fresh weight of leaves (g)</th>
<th>Dry matter of leaves(%)</th>
<th>Root Length/plant (cm)</th>
<th>Diameter of root/plant (cm)</th>
<th>Dry matter of root(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>K₀</td>
<td>75.49 c</td>
<td>8.24 b</td>
<td>11.75 d</td>
<td>5.23 c</td>
<td>8.24 b</td>
</tr>
<tr>
<td>K₁</td>
<td>82.59 b</td>
<td>8.99 a</td>
<td>13.43 c</td>
<td>5.60 b</td>
<td>8.99 a</td>
</tr>
<tr>
<td>K₂</td>
<td>87.49 a</td>
<td>4.17 a</td>
<td>15.32 b</td>
<td>5.98 a</td>
<td>9.17 a</td>
</tr>
<tr>
<td>K₃</td>
<td>88.40 a</td>
<td>9.35 a</td>
<td>16.78 a</td>
<td>6.05 a</td>
<td>9.35 a</td>
</tr>
<tr>
<td>LSD (₀.₀₅)</td>
<td>4.396</td>
<td>0.224</td>
<td>1.032</td>
<td>0.146</td>
<td>0.224</td>
</tr>
<tr>
<td>CV (%)</td>
<td>9.36</td>
<td>8.85</td>
<td>9.97</td>
<td>10.32</td>
<td>7.72</td>
</tr>
</tbody>
</table>

Source: Lobnayesmin, (2014)

Hint: In the above table K₀: 0 kg/ha, K₁:150 kg/ha, K₂: 175 kg/ha and K₃: 200 kg/ha
2.6. Phosphorus in Carrot Plant Nutrition

2.6.1. Roles of Phosphorus in Carrot

Brady and Weil (2002) reported that normal plant growth cannot be achieved without phosphorus. It enhances seed germination and early growth, stimulates blooming, enhances bud set, aids in seed formation, hastens maturity, and provides winter hardness to crops planted in late fall and early spring. Seeds have the highest concentration of P in a mature plant, and P is required in large quantities in young cells, such as shoots and root tips, where metabolism is high and cell division is rapid.

Carrots require adequate available P for satisfactory growth. Broadcast P and work into the seed bed before planting. Phosphorus is essential for numerous metabolic processes. Among the significant function and qualities of plants on which phosphorus has an important effect in many aspects of plant physiology includes the fundamental processes of photosynthesis, reproduction, nitrogen fixation, flowering, fruiting and maturation has been reported (Brady and Weil, 2002).

Carrot requires rapid and continuous growth of the vegetative parts, at early stages of growth, so as to enhance high bulking rate in the root, it should, therefore, be supplied with adequate amounts of nutrients. Phosphorus fertilizer stimulates the diameter growth of root and increase the rate of growth.

According to the reports of Rao (1998), the deficiency of phosphorus causes reduction in yield, with a concomitant increase in dry matter, sugar and carotene contents of carrot root. Similarly, Thompson and Kelly (1957) reported that, Carrot plants require about 134.3 kg K₂O/ha, 35.8 kg N/ha and 46.2 kg P₂O₅/ha from the soil to produce 24.7 tons of roots per hectare in one season.

Halland (1975) also reported that as carrot root yield increased significantly in response to normal or high levels of nitrogen, phosphorus and potassium, but the higher doses were less effective and caused bolting and root splitting. In the other way, Green (1973) reported that the interaction between phosphorus and nitrogen at their highest levels was significant and the relationship between nitrogen levels and root yield was quadratic. He also reported that as phosphorus deficiency caused a reduction in carrot yield whereas Nesa (2007) also reported that the maximum marketable yield (38.53t/ha) was recorded from the treatment of N₉₈P₇₂K₈₇S₁₄ kg/ha and again the lowest marketable yield (19.40t/ha) were found in the control treatment (no fertilizer applied).

Table 3. Effect of different levels of phosphorus fertilizers on growth and yield of carrot

<table>
<thead>
<tr>
<th>Phosphorus</th>
<th>Fresh weight of leaves(g)</th>
<th>Dry matter of leaves(%)</th>
<th>Root Length per plant(cm)</th>
<th>Diameter of root per plant(cm)</th>
<th>Fresh weight of root per plant(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P₀</td>
<td>78.17 c</td>
<td>6.57 c</td>
<td>11.40 c</td>
<td>5.12 c</td>
<td>103.27 c</td>
</tr>
<tr>
<td>P₁</td>
<td>83.27 b</td>
<td>6.87 bc</td>
<td>14.04 b</td>
<td>5.42 b</td>
<td>112.89 b</td>
</tr>
<tr>
<td>P₂</td>
<td>84.88 b</td>
<td>7.16 ab</td>
<td>14.43 b</td>
<td>5.84 b</td>
<td>114.44 b</td>
</tr>
<tr>
<td>P₃</td>
<td>87.48 a</td>
<td>7.37 a</td>
<td>16.27 a</td>
<td>5.94 a</td>
<td>119.52 a</td>
</tr>
<tr>
<td>LSD(0.05)</td>
<td>2.012</td>
<td>0.441</td>
<td>0.990</td>
<td>0.133</td>
<td>4.235</td>
</tr>
<tr>
<td>CV (%)</td>
<td>9.36</td>
<td>8.85</td>
<td>9.97</td>
<td>10.32</td>
<td>8.56</td>
</tr>
</tbody>
</table>

Source: lobnayesmin, (2014)

Hint: P₀:0 kg/ha, P₁: 65 kg/ha, P₂: 80kg/ha and P₃: 95 kg/ha

2.7. Sulfur in Carrot Plant Nutrition

2.7.1. Roles of Sulfur in Carrot

Deruiter and Martin (2001) indicated that as sulfate is susceptible to leaching on sandy soils and deficiency is most common on sandy low organic matter soils. Soil tests for sulfur are only accurate for low or medium organic matter soils. If deficiency is known or suspected use 3-6kg/ha of sulfur for sulfur soil test 0-6 ppm, because it is relatively low, it is better to not use sulfur if the soil test of sulfur is ≥ 12.1ppm. The amount of sulfur in the aboveground portion of a mature carrot seed crop is similar to the amount of phosphorus (11.5 to 35kg/ha). Sulfur accumulation parallels biomass production. (Nesa, 2007) has reported that, the maximum uptake rate occurs during the third week. Annual sulfur application may not be necessary. For many crops, application in 3 of 4 years or every other year is sufficient. Application of 7 to 12kg/ha sulfur in the sulfate form meets the needs of most crops.
3. Summary and Conclusions
Carrot (Daucus carota L.) belongs to the Umbeliferae family and is one of the major root vegetable used as fresh, salad and cooked vegetable, which is a rich source of beta carotene. Carrots are becoming more popular as they contain a high amount of beta carotene; a precursor to vitamin A which prevents infection, some forms of cancer and improves vision. They also contain vitamin C, thiamin B1 and riboflavin B2. Root color and flavor are the most important qualitative factors for selection of varieties. Root size and shape are also considered important selection parameters. Carrot’s yield and yield components are affected greatly with mineral nutrient managements and other environmental factors such as soil fertility and moisture stresses. Generally, the yield and yield contributing characters of carrot were influenced by different levels of N-P-K fertilizer applications. In this review there are some of investigation reports. The highest marketable yields were obtained by the application of N-P-K fertilizers at 140- 40-80kg/ha respectively. Another research report indicated that, Nitrogen application at rate of 200kg/ha produced the tallest plant, maximum number of leaves, cracked roots, branched roots and fresh shoot weight whereas nitrogen applications at 150kg/ha produced the maximum root length, root diameter, fresh root weight and the highest yield 53.37t/ha. So, to improve the influence of mineral nutrient management on yield and yield quality, balanced fertilization is one of the most important factors in maximizing the yield potential of carrot crops. The use of mineral fertilizers is the quickest way of increasing crop production; almost 30 to 70% increase in yields of crops has been achieved through the use of optimum and balanced mineral fertilizers.

4. Recommendations
✓ Use of appropriate and balanced mineral nutrients that affects production and productivity.
✓ Use of integrated (both organic and inorganic) fertilizer is necessary
✓ Location specific research and recommendations is necessary

5. Acknowledgment
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6. Conflict of Interest
Regarding the publication of this manuscript, there is no any conflict of interest.

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