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Short communication

Effect of iron spray on growth and nutrient contents of *karonda* (*Carissa carandas* L.)

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Plant nutrition is necessary for the productivity and quality improvement of different fruit crops. The fruit crops being perennial in nature are quite different from other seasonal crops in their nutritional requirements due to their density, rate of root growth and the fruit bud differentiation in previous season and it relationship with yield in the following year. Determination of nutritional needs of the *karonda* (*Carissa carandas* L.) has to be made prior to the renewed growth or determination of the potential yield. However, reliable information is needed to decide, how much manures and fertilizers should be given to fruit trees for an economic response (Bhargava and Singh, 3). *Karonda* is an important fruit crop yet its production has not been satisfactory due to some constraints in its cultivation. One of the most important factors which limit the production is nutrition. If it is not maintained at proper level, higher yield and better fruit quality can not be achieved.

The present investigation was carried out at Department of Horticulture, GBPUA&T, Pantnagar, Uttarakhand. Two-month-old *karonda* seedlings grown in sand were transplanted in plastic pots filled with thoroughly washed quartz sand-free from any nutrient and the pots were kept in polyhouse (temperature ± 5°C higher than the outside and relative humidity 80-85%). Stock solution of macro- and micro-nutrients were prepared according to the Hoagland and Arnon (13) method. Plants were supplied with nine different types of solution as under T_1 (without iron), T_2 (1/4th of total iron), T_3 (1/2 of total iron), T_4 (3/4th of total iron), T_5 (full amount of iron), T_6 (1.25 times of total iron), T_7 (1.5 times of total iron), T_8 (1.75 times of total iron) and T_9 (2 times of total iron).

The experiment was laid out in completely randomized design with nine treatments replicated three times. In each treatment 18 seedlings were transplanted in three plastic pots (size 25 cm) each pot containing six seedlings. Fifty ml nutrient solution was supplied to each pot on alternate days throughout the experimental period. Leaching was done fortnightly by washing the sand with distilled water to avoid the accumulation of increased salts at the bottom and pH (6.4) of leachates was measured frequently. The data on the seedling height, number of leaves per seedling, size of leaf (length and breadth), fresh and dry weight of leaf, leaf area per seedling, stem girth, length of primary root, leaf chlorophyll 'a', 'b' and total chlorophyll contents were recorded by standard methods. Leaf from the middle portion of shoot were taken for the nutrient analysis. Total nitrogen content was determined by micro-Kjeldhal method (AOAC, 1). Phosphorus content of leaf samples was determined by vandomolybdo-phosphoric yellow colour method (Jackson, 13). Total potassium in the leaf samples was determined by flame photometry method (Chapman and Pratt, 4). Calcium and magnesium content of the leaves were determined by titratable method (AOAC, 1) and sulphur content was determined by spectrophotometer (Jackson, 13). Leaf copper, iron, manganese and zinc contents were determined by atomic absorption spectrophotometer.

Karonda seedlings began to show the effect of different treatments in terms of vegetative growth after three months of age. An increase in the substrate levels of iron increased the number of growth flushes per plant (Table 1). As the level of iron reduced in the nutrient solution, there was a corresponding reduction in the seedling height. Maximum seedling height was obtained with T_5 (control) and minimum with T_1 (without iron). Similar results were also found in apple by Udris (15). For each individual treatments, as the age of seedling advanced, the number of leaves per seedling increased significantly (Table 1). Highest number of leaves were recorded with T_5 (control) and lowest with T_1 (without iron). The data were in conformation with the finding of Banik and Sen (2) who reported that iron sprays increased spread of mango crop.

Different iron levels application influenced the fresh and dry weight of leaf significantly. Maximum fresh and dry weight of leaf were found when seedlings were supplied with complete nutrient solution (T_5) and minimum when iron was excluded from the solution (T_1). Reduction in fresh and dry weight of leaf might be due to reduction in leaf size due to limitation of cell division and expansion under deficient iron conditions. The results are in conformity with the findings of Morales *et al.* (14) in peach and pear. Leaf area per seedling, stem

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Table 1. Effect of variable iron application on growth attributes of *karonda* seedlings.

Treatment	Height (cm)	No. of leaves per seedling	Leaf length (cm)	Leaf breadth (cm)	Leaf FW (mg)	Leaf DW (mg)	Leaf area per seedling (cm^2)	Stem girth (cm)	Length of primary root (cm)	Chlorophyll 'a' content (mg/g)	Chlorophyll 'b' content (mg/g)	Total chlorophyll content (mg/g)
T_1	14.20	17.86	2.24	1.37	59.00	13.90	2.76	0.185	10.03	0.475	0.045	0.045
T_2	14.66	19.60	2.30	1.38	61.00	14.20	2.77	0.216	10.99	0.638	0.596	1.597
T_3	19.20	23.33	2.34	1.40	61.00	16.80	2.80	0.227	12.90	0.679	0.601	1.601
T_4	22.00	32.66	2.51	1.59	65.00	22.10	2.86	0.249	14.45	0.709	0.604	1.603
T_5	25.66	58.33	2.66	1.65	71.00	24.50	2.88	0.302	19.71	0.956	0.825	1.814
T_6	23.50	57.00	2.65	1.61	70.00	24.60	2.82	0.299	19.89	0.959	0.829	1.821
T_7	19.23	48.00	2.56	1.59	61.00	22.40	2.86	0.284	16.25	0.955	0.816	1.815
T_8	19.63	44.50	2.44	1.59	61.00	21.00	2.77	0.276	14.31	0.952	0.813	1.811
T_9	17.70	45.33	2.34	1.52	61.00	20.90	2.76	0.268	12.23	0.933	0.676	1.693
CD (P = 0.05)	0.667	1.099	0.039	0.0150	1.300	0.150	0.0306	0.00712	0.170	0.0048	0.0031	0.0075

T_1 = Without iron; T_2 = 1/4th of total iron; T_3 = 1/2 of total iron;
T_4 = 3/4th of total iron; T_5 = Full amount of iron; T_6 = 1.25 times of total iron;
T_7 = 1.5 times of total iron; T_8 = 1.75 times of total iron; T_9 = 2 times of total iron

girth and length of primary root of seedlings increased with the increase in iron application. Maximum leaf area and seedling stem girth were found under control (T_5) and minimum under deficient iron level (T_1). It is due to the fact that increasing iron levels upto certain limit helped to facilitate the growth processes in the plant system. Similar results were also obtained by Morales *et al.* (14). Chlorophyll 'a', 'b' and total chlorophyll content of leaves increased as the levels of iron increased in the nutrient solution. Iron is closely associated with the formation of chlorophyll in plants and is an essential component of catalyst involved in chlorophyll production (Childers, 6).

The values of nitrogen, phosphorus and potassium content were affected significantly by various iron levels in nutrient solution. Maximum nitrogen content was recorded in T_5 (complete nutrient solution) treatment as supported by Gupta and Joshi (9) in *ber* and Hassan (11) in sweet orange. Various levels of iron significantly influenced the leaf phosphorus content. As the level of iron increased, the phosphorus content decreased significantly. This show the antagonism between iron and phosphorus. These findings are in conformity with the results of by Bindra (4) in peach. Potassium level in leaf was increased with the increase in iron level. Maximum potassium content was found in T_4 (3/4th total ioron) closely followed by T_5 (control) and T_6 (1.25 times of total iron). Eissa (8) in pear also reported the similar effect on the uptake of potassium. As the iron content increased, the calcium content starts decreasing from T_6 to T_9. It might be due to reason that by $CaSO_4$, the pH of the media increased upto 8.5, which coincides with the greatest incidence of lower iron. In accordance to these result, Havlin *et al.* (11) reported same relationship between iron and calcium. Leaf magnesium content was found to be increasing significantly by different levels of iron treatments because the Mg is a constituent of chlorophyll, hence as the iron level increases, the chlorophyll content increased (Table 2). Leaf sulphur, copper, manganese and boron contents were not affected by different levels of iron in *karonda*. The leaf iron content increased significantly with increasing dose of iron in nutrient solution. Maximum leaf iron content was obtained when two times of total iron (T_9) was applied in nutrient solution. The results are in accordance with the findings of Gupta and Joshi (9) in *ber*, and Devi *et al.* (7) in sweet orange. The zinc content decreased significantly when the iron doses were increased. Similar results were obtained by Havlin *et al.* (11) as they reported that iron and zinc show antagonistic effect to each other.

On the basis of visual symptoms, the critical level of iron was worked out. Visual symptom of iron deficiency just noticeable when chlorosis on upper leaves were first observed. Iron content in leaves of *karonda* (Table 2) significantly decreases with advancement of iron deficiency symptoms. It may be assumed that hidden hunger for iron must have come a few days before actual manifestation of the deficiency symptoms. The iron deficiency just noticeable with treatment T_4 (3/4th of the total iron) after 90 days of the treatment. Therefore, the critical level of iron was 137 ppm for *karonda*. Thus, the seedling height, number of leaves, leaf length and breadth, leaf fresh and dry weight, leaf area, stem girth and chlorophyll 'a', 'b' and total chlorophyll content showed significant effect by the iron treatment. However, iron levels affected leaf nitrogen, phosphorus, potassium, calcium, magnesium, iron and zinc content significantly.

Table 2. Effect of variable iron application on uptake of nutrients in *karonda* seedlings.

Treatment	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	S (%)	Cu (ppm)	Fe (ppm)	Mn (ppm)	Zn (ppm)
T_1	1.24	0.42	1.07	2.23	0.64	0.66	39	131.33	81	91
T_2	1.26	0.34	1.07	2.23	0.65	0.66	39	132.67	79	89
T_3	1.27	0.31	1.07	2.23	0.65	0.70	35	135.67	77	88
T_4	1.31	0.28	1.09	2.24	0.64	0.70	35	138.00	77	86
T_5	1.36	0.28	1.08	2.28	0.66	0.71	32	150.00	76	84
T_6	1.30	0.20	1.08	2.26	0.66	0.71	32	157.33	75	83
T_7	1.30	0.21	1.07	2.27	0.67	0.70	30	156.00	73	81
T_8	1.29	0.19	1.04	2.25	0.68	0.70	30	160.67	73	80
T_9	1.26	0.15	1.03	2.25	0.69	0.70	30	164.67	72	79
$CD_{0.05}$	0.02	0.02	0.02	0.01	0.01	NS	NS	4.91	NS	3.01

T_1 = Without iron; T_2 = 1/4th of total iron; T_3 = 1/2 of total iron;
T_4 = 3/4th of total iron; T_5 = Full amount of iron; T_6 = 1.25 times of total iron;
T_7 = 1.5 times of total iron; T_8 = 1.75 times of total iron; T_9 = 2 times of total iron

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