Journal of
Agriculture and Biology
ISSN: 3007-1755 (Print), 3007-1763 (Online)

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Research Article

Biofortification of Cilantro (*Corriandrum sativum*) in Relation to Calcium, Iodine and Selenium Application

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ABSTRACT

Micronutrients and macronutrients are the key elements of a healthy diet. The micronutrient iodine and selenium are essential trace elements which are mostly obtained by food or supplements and Calcium is the 5th most abundant macro element important for proper functioning of body. The purpose of this research focused to identify the appropriate the dose and application way of these mineral elements for improving the nutrient status of vegetables for improving the human diet. Certified seeds of cilantro were obtained from an authorized nursery and sown in trays at the depth of 2 inches. The study consisted of four treatment conditions; iodine, selenium, calcium and control treatment. Three replications of each treatment were planned, comprised of one tray. The harvested produce was evaluated for different morphological (plant fresh and dry weight, shoot and root length, number of leave and leaf diameter), biochemical parameters (Total soluble solids, Vitamin c, acidity, carotenoids, chlorophyll contents, lipophilic antioxidant(LPA), starch contents, amino acids, carotenoids, flavonoids, phenolic contents) and ionic contents (I, Se and calcium**).** The results demonstrated that supplementation with iodine @2.5mg/L, selenium @1mg/L and Calcium @200ppm were optimal doses for maintaining the plant health and increased the accumulation in edible parts of cilantro plants. Iodine application @2.5mg reached maximum 205.76µg in foliar parts and 254.43µg in roots while selenium @1mg concentrations reached 230µg and 220mg in foliar and basal plant parts. However, highest calcium contents were quantified in Ca @200ppm concentration. These levels are sufficient to meet the world health organization's daily recommended doses of I, Se and Ca.

Keywords: Micronutrients, Macronutrients, Iodine, Selenium, Calcium, Cilantro, Nutrient Biofortification, Plant Morphology, Biochemical Parameters, Ionic Contents.

OPEN ACCESS

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Article History
Received: September 13, 2025
Accepted: December 06, 2025
Published: December 30, 2025

INTRODUCTION

People who are living in iodine deficient area have health problems so to reduce their health problems iodine biofortification is an essential strategy which can increase iodine intake in the affected peoples. One of the good method to intake iodine is iodine biofortification (Topcuoğlu, 2023).

Leafy vegetable crops have good iodine content and are suitable to be biofortified so that iodine deficient humans can obtain this important mineral. Moreover, the dose of iodine to be applied depends on plant species assimilation capacity and toxicity limit of plants. Foliar and soil application of iodine biofortification vary according to soil condition. Both of these application methods can enhance iodine content in the plants and improve the human health. However there are also some difficulties in iodine applications such as high dose of iodine can cause chlorosis, toxicity in the plant tissues and even death of the plant (Mohiuddin et al., 2019).

Biofortification of Se in the plants has gained a global focus for better human diet and increase the agricultural productivity. If the concentration of Se is increased in the crops, crops can tolerate biotic and abiotic stresses as well as improve nutritional value. Selenium is a source to fight against lethal diseases such as cancer, infections and different types of allergies. In addition, Se biofortification in both edible and non-edible plant parts (biomedicine) is significant. Selenium is an important element for human diet (Kieliszek M and Serrano, 2023)

Bioavailability of Se depends on different factors such as solubility, chemical form of Se, its amount to be ingested, other dietary components present in it and physiological condition. Plants take selenium from the soil in different forms such as SeO_4^{-2} and SeO_3^{-2} but mostly soils are selenium deficient. Moreover, there are many crops biofortified with Se such as cauliflower, broccoli, tomato, Brussel sprouts that can successfully improve human health and fight against lethal diseases (Abdullah et al., 2009). However, there are few challenges in way to biofortification of plants with Se such as it is cost effective, required proper legislation for Se biofortification practice and consolidating the acceptance of Se biofortification in the public and farmers (Estarriaga et al., 2025). Calcium bio fortification is important for human health, and it is a wonderful strategy to increase the calcium content in vegetables/plants. This strategy has no more production cost and it works without affecting the development and growth of plants (White & Broadley, 2009). The study focused to determine the influence of Iodine, Selenium and Calcium on plant performance and nutrient profile of cilantro (coriander). It also aimed to improve the phytonutrient availability through biofortification, thus becoming economical access in human diet. It is important to identify specific dose of nutrients as well as its way of application to plants to ensure their availability through biofortification.

MATERIALS AND METHODS

In this experiment, seeds of cilantro (*Corrianderum sativum* L.) collected from a certified agency was directly sown in the trays (2 inches deep) which were lined with foil in order to prevent leaching of water and mineral nutrients from the media (35% sand, 28% silt and 37% clay with a mean organic matter content), under optimal growing temperature (14-18 ◦C) conditions, in growth room of Department of Horticulture, University of Layyah, Layyah. The treatments included three doses of each tested nutrient (I, Se and Ca), as well as control, which were replicated thrice, comprised of one tray per replication. There were 27 trays (for each foliar and basal) in this experiment. Plants were supplied with water as per their need. Following that, basal and foliar applications were applied on given stages.

1^{st} Application of nutrients (foliar and basal) was provided on germination stage, followed by 2^{nd} Application one week after germination. A subsequent 3^{rd} Application of nutrients (foliar and basal) followed one week before harvesting.

Table 1. Treatment details of nutrients applied to cilantro

Nutrient	Application method	Concentration
No nutrient	Foliar & Basal	Control (distilled water)
I	Foliar & Basal	I_1 (2.5mg/L)
		I_2 (5mg/L)
		I_3 (10mg/L)
Se	Foliar & Basal	Se_1 (1mg/L)
		Se_2 (1.5mg/L)
		Se_3 (2mg/L)
Ca	Foliar & Basal	100 ppm
		150ppm
		200ppm

Plant Analysis of Fresh Samples of Spinach

Plant morphology, assessed in terms of shoot length and root length (cm), using measuring scale. Plant fresh and dry weight (g) was noted using weighing balance (PA-413 manufactured by Chaus Corporation, USA). Number of leaves per plant were counted and averaged. Leaf area was product of leaf length and width. Total soluble solid (TSS) were determined using digital refractometer and ascorbic acid concentration was measured using titration method.

Total carotenoid contents was determined by noticing absorbance of sample using UV-VIS spectrophotometer (WE6000), prepared by grinding leaf sample and centrifuging with 80% acetone (10 mL) at 12000 rpm for 5 min. Same sample were read at 645 nm and 663 nm for estimation of chlorophyll a and b.Total flavonoid contents were measured, following aluminum chloride colorimetric method involving UV-Vis spectrophotometer (WE6000). The calibration plot (Y = 0.0162x + 0.0044, $R2$ = 0.999) was used to calculate total flavonoid contents. Sample and standard readings were made using a spectrophotometer (WE6000) at 765 nm, to measure total phenolic compounds. Absorbance was recorded with help of UV-VIS spectrophotometer (WE6000) for amino acid estimation using ninhydrin reagent. The lipophilic antioxidant activity (LAA) was measured with the 2,20 -azinobis 3-ethylbenzothiazoline-6-sulfonic acid ABTS method by UV–Vis spectrophotometry. After measuring absorbance at 734nm for 30mints, ABTS % were calculated by using formula

ABTS %= (AB-AA/AB) X 100

AB =absorbance of ABTS radical + methanol

AA= absorbance of ABTS radical + sample extract

Plant Analysis of Dry Samples of Cilantro

The iodine contents of various plant organs (roots, stems, leaves, and fruits) were measured using an alkaline ashing technique. Total Se concentrations Total Se was measured in samples using 500 mg dried ground plant material from each replicate digested with HNO3, H2O2 and HCl, and analyzed by spectrophotometer.

RESULTS

The vegetative growth of cilantro showed a significant influence, when supplemented with Iodine (I), Selenium (Se) and Calcium (Ca). Statistically significant differences were observed in plant fresh and dry weight, shoot and root length, number of leaves, and leaf area among different treatments and application methods, as analyzed by Tukey's test at a 1% probability level.

Iodine applied with 2.5 mg/L induced more growth in terms of morphological parameters as well as biochemical attributes. The highest TSS (8.40 °Brix), ascorbic acid (12.33 mg), phenolic content (46 mg/100g), LAA (25.68 µM trolox), amino acids (31.91 nmol/g), carotenoids (5.13 µg/g), chlorophyll a (0.90 mg/g), and chlorophyll b (0.58 mg/g) (Table 2) was exhibited by cilantro plants, when treated with 2.5 mg/L Iodine concentration. Foliar application surpassed basal concentration in most of the biochemical attributes, except phenolic content.

Table 2. Effect of Iodine supplementation on cilantro vegetative and biochemical analysis.

Parameters (Vegetative)	Treatment Means				Application Methods Means	
	(control)	T1(2.5mg/L)	T2(5mg/L)	T3(10mg/L)	Foliar	Basal
Fresh weight (g)	3.96 (b)	6.36 (a)	3.56 (bc)	3.10 (c)	4.35	4.15
Dry weight (g)	0.44 (b)	0.60 (a)	0.35 (c)	0.23 (d)	0.43	0.38
Shoot length (cm)	4.06 (b)	5.33 (a)	3.63 (b)	2.98 (c)	4.10	3.90
Root length (cm)	2.93 (ab)	3.18 (a)	2.85 (ab)	2.56 (b)	3.00	2.76
No. of leaves	2.33 (b)	3.83 (a)	2.83 (b)	2.16 (b)	2.91	2.66
Leaf area (cm^2)	15.8	17.4	15.26	12.43	15.8	14.6
Bio chemical						
TSS (◦Brix)	6.43 (b)	8.40 (a)	6.25 (b)	5.00 (c)	7.05 (a)	5.99 (b)
Ascorbic acid (mg)	7.00 (c)	12.33 (a)	9.30 (b)	6.76 (c)	8.66	9.03
Phenols (mg /g f.w)	34.00 (b)	46.00 (a)	34.00 (b)	28.00 (c)	33.33 (b)	38.50 (a)
LAA (µM trolox g-$^{1)}$)	22.90(ab)	25.68 (a)	21.56 (b)	17.48 (c)	21.34	22.47
Amino acids (nmol/g)	24.23 (b)	31.91(a)	21.16 (b)	16.33 (c)	23.85	22.97
Flavonoids (mg)	10.70 (b)	14.18(a)	9.55 (bc)	8.73 (c)	11.23 (a)	10.35 (b)
Carotenoids (µg g$^{1)}$)	4.21 (bc)	5.13 (a)	4.25 (b)	4.08 (c)	4.48 (a)	4.36 (b)
Chlorophyll a (mg/g/F. wt)	0.35 (bc)	0.90 (a)	0.41 (b)	0.29 (c)	0.49	0.48
Chlorophyll b (mg/g/F. wt)	0.28 (c)	0.58 (a)	0.22 (c)	0.21 (c)	0.30 (b)	0.35 (a)

Selenium supplementation also had a notable effect on cilantro growth. Se applied as 1 mg/L improved average plant fresh weight as 11.43 g, plant dry weight as 2.38 g, longest shoot and root length as10.28 cm and 5.58 cm, number of leaves per plant as 4.66, and leaf area as 18 cm² (Table 3). Interaction effects between treatment and application method (foliar vs basal) showed that basal application of Se @1 mg produced maximum vegetative growth for most parameters, except shoot length and leaf area. Lower or higher Se concentrations produced suboptimal growth compared to the 1 mg/L treatment.

Table 3. Effect of Se supplementation on cilantro vegetative and biochemical analysis.

Parameters (Vegetative)	**Treatment Means**				**Application Methods Means**	
	(control)	T1(1mg)	T2(1.5mg)	T3(2mg)	Foliar	Basal
Fresh weight (g)	3.96 (c)	11.43 (a)	7.06 (b)	4.01 (c)	6.55	6.69
Dry weight (g)	0.44 (c)	2.38 (a)	1.41 (b)	0.51 (c)	1.14	1.23
Shoot length(cm)	4.06 (c)	10.28 (a)	6.63 (b)	4.28 (c)	6.35	6.28
Root length (cm)	2.93 (c)	5.58 (a)	4.27 (b)	2.80 (c)	3.83	3.96
No. of leaves	2.33 (b)	4.66 (a)	4.00 (a)	2.50 (b)	3.00	3.75
Leaf area (cm^2)	15.8	18 a	15.7 a	13.9 a	16.23 a	15.50 a
Bio chemical						
TSS (◦Brix)	6.43 (c)	10.31 (a)	8.15 (b)	6.13 (c)	7.74	7.75
Ascorbic acid (mg)	7.00 (c)	18.00 (a)	11.67 (b)	5.83 (c)	10.67	10.58
Phenols (mg /g f.w)	34.00 (b)	45.00 (a)	30.00 (b)	18.16(c)	31.83	32.33
LAA(μM trolox g^{-1}f.w.)	22.90 (b)	44.33 (a)	22.61 (b)	20.10 (b)	27.62	27.35
Amino acids (nmol/g)	24.23 (b)	33.33 (a)	21.50 (b)	16.66 (c)	23.55	24.30
Flavonoids (mg)	10.70 (c)	16.90 (a)	12.96 (b)	10.93 (c)	13.12	12.62
Carotenoids (μg $g^{-1)}$	4.21 (c)	5.67 (a)	5.22 (b)	4.11 (c)	4.77	4.83
Chlorophyll a (mg/g/F. wt)	0.35 (c)	1.20 (a)	0.63 (b)	0.24 (c)	0.64	0.56
Chlorophyll b (mg/g/F. wt)	0.28 (c)	0.70 (a)	0.44 (b)	0.20 (c)	0.43 (a)	0.38 (b)

The response of Ca application as foliar application ousted basal application method except in root length. Calcium applied as 200 ppm significantly supported vegetative growth and biochemical indices. Maximum plant fresh weight (8.10 g), dry weight (1.45 g), shoot and root length (7.43 cm and 4.70 cm), number of leaves per plant (4.66), and leaf area (25.4 cm²) were observed at Ca 200 ppm (Table 4).

Table 4. Effect of Ca supplementation on cilantro vegetative and biochemical analysis.

Parameters (Vegetative)	**Treatment Means**				**Application Methods Means**	
	(control)	T1(100ppm)	T2(150ppm)	T3(200ppm)	Foliar	Basal
Fresh weight (g)	3.96 (d)	5.23 (c)	6.38 (b)	8.10 (a)	7.24 (a)	4.60 (b)
Dry weight (g)	0.44 (d)	0.81(c)	1.04(b)	1.45 (a)	1.24 (a)	0.78 (b)
Shoot length (cm)	4.06 (c)	5.11 (b)	6.70 (a)	7.43 (a)	7.00 (a)	4.65 (b)
Root length (cm)	2.93 (c)	3.35 (bc)	4.11 (ab)	4.70 (a)	3.59	3.95
No. of leaves	2.33 (c)	2.66 (bc)	3.66 (ab)	4.66 (a)	3.75 (a)	2.91 (b)
Leaf area (cm^2)	15.8b	20.3 b	19 b	25.4 a	22.4 a	17.9 b
Bio chemical						
TSS (◦Brix)	6.43 (c)	7.51 (b)	9.50 (a)	6.35 (c)	8.00 (a)	6.89 (b)
Ascorbic acid (mg)	7.00 (c)	8.70 (b)	11.50 (a)	7.16 (c)	9.13 (a)	8.05 (b)
Phenols (mg /g f.w)	34.00 (b)	34.66 (b)	38.16 (b)	45.50 (a)	39.25	36.91
LAA (μM trolox g^{-1}f.w.)	22.90 (b)	20.33 (b)	24.33 (b)	31.66 (a)	26.64 (a)	22.97 b)
Amino acids (nmol/g)	24.23 (b)	25.45 (ab)	26.43 (ab)	28.66 (a)	26.83	25.55
Flavonoids (mg)	10.70 (b)	10.88 (b)	12.78 (b)	15.03 (a)	12.93	11.76

Carotenoids (µg g^{-1})	4.21 (c)	4.34 (c)	4.51 (b)	4.74 (a)	4.56 (a)	4.33 (b)
Chlorophyll a (mg/g/F. wt)	0.35 (c)	0.36 (c)	0.60 (b)	0.98 (a)	0.66 (a)	0.49 (b)
Chlorophyll b (mg/g/F. wt)	0.28 (b)	0.28 (b)	0.35 (b)	0.50 (b)	0.39 (a)	0.32 (b)

Biochemical Indices

The application of Iodine as 2.5 mg/L ousted all other concentrations by exhibiting highest TSS, ascorbic acid, phenolic contents, LAA, amino acids, carotenoids, chlorophyll a and chlorophyll b contents as 8.40 ◦Brix, 12.33 mg, 46 mg/100g FW, 25.68 µM trolox g^{-1}f.w, 31.91 mmol g^{-1}, 5.13 mg, 0.90 mg/g FW and 0.58 mg/g FW contents, respectively. Interaction effect regarding biochemical attributes was enlightened when coriander plants received I as @2.5mg concentration with foliar application method (Fig. 1)

Table 5. Concentration and Application method interaction in response to iodine supplementation on vegetative and biochemical analysis of cilantro.

Parameter	Foliar				Basal			
	T_0	T_1	T_2	T_3	T_0	T_1	T_2	T_3
Fresh weight (g)	3.96	6.56 a	3.66b	3.20b	3.93	6.16 a	3.46 b	3 b
Dry weight (g)	0.44	0.65	0.37	0.25	0.40	0.56	0.32	0.22
Shoot length (cm)	4.06	5.53	3.83	3	4.06	5.13	3.43	2.96
Root length (cm)	2.93	3.23	3	2.83	2.90	3.13	2.70	2.30
No. of leaves	2.33	4	3	2.33	2.33	3.66	2.66	2
Leaf area (cm^2)	15.8	18.7	16.2	12.5	15.2	16	14.3	12.3

In this study, Comparison of treatment regarding biochemical attributes identified Se dose (1 mg/L), superior to all other concentrations by depicting maximum TSS, ascorbic acid, phenolic contents, flavonoids, carotenoids, chlorophyll a and b as 10.31◦Brix, 18 mg, 45 mg/g FW, 44.33 µM trolox g^{-1}f.w., 16.90 mg/g FW, 5.67 mg, chlorophyll a 120 mg/g FW and chlorophyll b 0.70 mg/g FW contents, respectively (Table 2). Interaction effect related to biochemical indices was maximum in Se @1mg concentration with basal application method while chlorophyll a and chlorophyll were assessed in Se @1mg concentration with foliar application method (Fig. 1). Treatment and method interaction was non-significant for amino acids.

In the current work, treatment means showed that Ca applied at 200ppm concentration exhibited maximum values for biochemical attributes including phenolic contents, LAA, amino acids, flavonoids, carotenoids and chlorophyll a and b as 45.50 mg/g FW, 31.66 µM Trolox/g FW, 28.66 mmol g^{-1}FW, 15.03mg, 4.74 mg/g FW, 0.98mg/g FW and 0.50mg/g FW, respectively (Table 4). However maximum TSS (10.01◦Brix) and ascorbic acid (12 mg) were evaluated in Ca @150ppm. Furthermore, interaction effect is mentioned in Fig. 1. Foliar application proved to be the best way to supplement Ca as comparison to basal application as depicted by biochemical attributes.

Table 6. Concentration and Application method interaction in response to selenium supplementation on vegetative and biochemical analysis of cilantro.

Parameter	Foliar				Basal			
	T_0	T_1	T_2	T_3	T_0	T_1	T_2	T_3
Fresh weight (g)	3.96	11.03	6.93	4.26	3.93	11.83	7.20	3.76
Dry weight (g)	0.44c	2.26a	1.26b	0.60c	0.40c	2.50a	1.56 b	0.43 c
Shoot length (cm)	4.06	10.40	6.90	4.03	4.06	10.16	6.36	4.53
Root length (cm)	2.93	5.46	4.10	2.83	2.90	5.70	4.45	2.76
No. of leaves	2.33	4	3.66	2	2.33	5.33	4.33	3
Leaf area (cm^2)	15.8	19.6	16.8	12.6	15.2	16.3	14.6	15.2

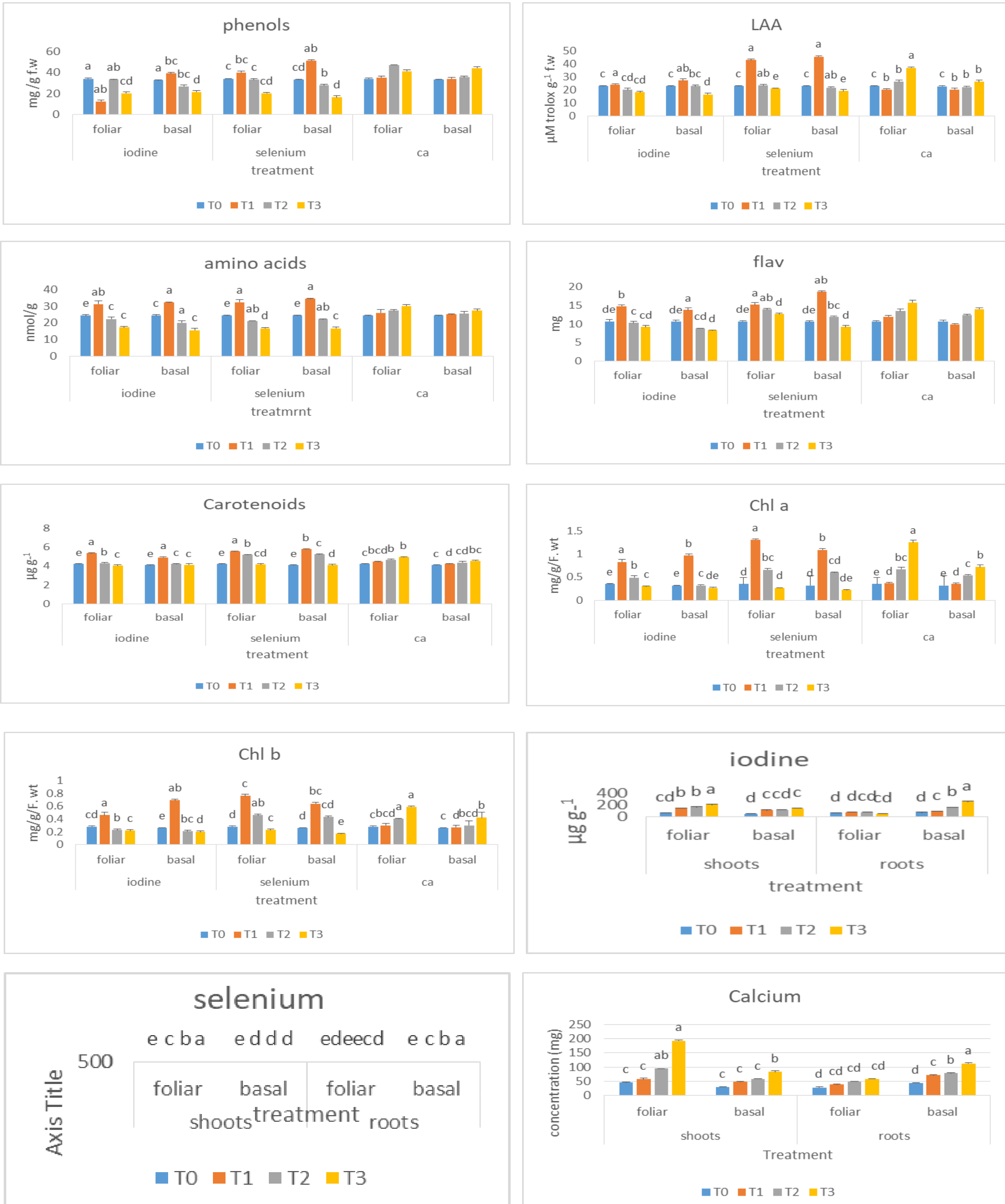

Figure 1. Interaction of applied nutrients (I, Se and Ca) and application methods on biochemical parameters and ionic concentrations in cilantro.

https://doi.org/10.55627/agribiol.003.02.1769

Nutrient Analysis

Our results demonstrated that maximum iodine concentration (205.76ug in foliar application of shoots and 254.43ug in roots in basal application) was measured in I @10mg/L concentration (Fig. 1). Furthermore, Se @ 2 mg/L concentration gave maximum Se contents (230ug in foliar application of shoots and 220mg in basal application in roots) in cilantro (Fig. 1) respectively. However, selenium and iodine applied at higher concentrations implemented chlorotic symptoms in leaves but lower doses reached the highest values regarding all the analysis. Furthermore, highest Calcium (192.8mg in foliar application and 112mg in basal application of shoots and roots) were quantified in Ca @200ppm concentration.

Table 7. Concentration and application methods interaction in response to Ca supplementation on vegetative and biochemical analysis of cilantro.

Parameter	Foliar				Basal			
	T_0	T1	T_2	T_3	T_0	T_1	T_2	T_3
Fresh weight (g)	3.96	6.46 c	8.26 b	10.26a	3.93	4 d	4.50 d	5.93 c
Dry weight (g)	0.44	1.09 c	1.44 b	1.98 a	0.40	0.53 ef	0.64 e	0.93d
Shoot length (cm)	4.06	6.53 b	8.23 a	9.16 a	4.06	3.70 d	5.16 bc	5.70 b
Root length (cm)	2.93	3.26	3.66	4.50	2.90	3.43	4.56	4.90
No. of leaves	2.33	3	4.33	5.33	2.33	2.33	3	4
Leaf area (cm^2)	15.8	24.06	21.5	28.2	15.2	16.6	16.4	22.7

DISCUSSION

In the current study, low dose of iodine (2.5mg/L) increased the vegetative growth of cilantro plants (plant fresh and plant dry weight, shoot and root length, leaf area and number of leaves) as well as improved the biochemical profiling includes; Total soluble solids, Vitamin c, acidity, carotenoids, chlorophyll contents, lipophilic antioxidant(LPA), starch contents, amino acids, carotenoids, flavonoids, phenolic contents. The results of the present study are consistent with Li et al, 2017 who successfully implemented the biofortification of iodine in pepper plants which accumulated iodine up to 1330 µg kg^{-1}. In his study it was also added that low dose of iodine slightly increased the ascorbic acid and total sugars. Additionally, iodine low dose also enhanced the antioxidant activity and photosynthetic activity in the leaves. In the present study it has also been observed that iodine low dose positively increased the ascorbic acid, lipophilic antioxidants and all other biochemical parameters of cilantro plants. However high doses of iodine represented different symptoms i.e reduction in growth, yellow spots and reduction in biomass and these results correlate with the finding of Duborska et al.,2020 that higher doses of iodine cause toxicity in plants. The present study also aligns with the results of Li et al., 2016 who evaluated that strawberries biofortified with KI cover easily the recommended intake 150ug per day.

Under the present study conditions among the tested selenium doses (1mg, 1.5mg, 2mg), 1mg/L Se depicted the maximum vegetative and biochemical results. These findings are in line with the findings of Ogunsuyi et al., (2025) who discussed that Se addition to soil enhanced the Se concentration in leaves as it is movable and increased the growth parameters (leaf area, plant height) and activity of vascular bundles. Ods, (2016) also evaluated that plant accumulate the Se in edible parts either it is applied as basal dose or foliar spray and this biofortified plant is a good source of Se for human diet. Medrano-Macías et al., (2016) also evaluated the similar results regarding Se and I positive effect in his research work. He suggested that biochemical and growth parameters of plants responded positively to lower doses of Se and I which increased the biomass and biochemical indices like antioxidants, amino acids proline contents and phenols as compared to high concentrations.

Furthermore, in the present investigation Ca@200ppm concentration significantly increased plant fresh weight and dry weight, shoot and root length number of leaves, leaf area and all the biochemical indices. All concentrations of Calcium responded positively on the cilantro plants and the present work is comparable to (M. D'Imperio et al., 2016) investigation that biofortification of Ca@200mgL-1 in baby leaf vegetables optimized the Calcium concentration and effected positively the biochemical and vegetative parameters of cilantro plants. Kathi et al. (2024) also founded that biofortification of microgreens with Ca nutrient increased Vitamin C which correlate with our results that recorded increased concentration of vitamin C in the cilantro plants by applying Calcium nutrient. Moreover, Current study shows that basal application of Ca effected root length positively and foliar application positively affected plant biomass, might be calcium is immobile nutrient. Current work relates to indications of white, 2012 that calcium enters the root apoplast from the rhizosphere and located in the middle lamella of cell walls and properties of rhizosphere and cell wall influence both directly and indirectly physical and chemical properties.

CONCLUSIONS

The applied doses (1mg, 1.5mg and 2mg) of selenium (foliar and basal) both affected the cilantro plants. Se @1mg/L uptake demonstrated highest results regarding morphological and analytical analysis. Basal dose of selenium increased plant biomass including plant fresh and dry weight, root length, number of leaves, TSS, phenolic contents, amino acids and carotenoids while shoot length, leaf area, lipophilic antioxidants, chlorophyll a and chlorophyll b contents responded positively to foliar application of Selenium. Successfully, low iodine dose (2.5mg/L) recorded excellent results in all vegetative and biochemical analysis of cilantro plants. Highest Iodine concentrations (5mg and 10mg) adversely affected the vegetative as well as biochemical profiling of cilantro plants. Vegetative parameters including plant fresh and dry weight, root length, shoot length, No. of leaves and leaf area response was best to foliar application while biochemical parameters including TSS, amino acids, flavonoids, carotenoids and chlorophyll a contents were positively subjected to foliar application method however, ascorbic acid, phenols, lipophilic antioxidants and chlorophyll b contents were evaluated in basal application method. Effectively, Ca @ 200ppm concentration performed very well in all the vegetative and biochemical analysis except TSS and ascorbic acid which were evaluated maximum in Ca @150ppm concentration. Foliar application method resulted in maximum improvements, except for root length.

ACKNOWLEDGEMENTS

Not applicable.

AUTHOR CONTRIBUTIONS

All the authors contributed equally to this research.

COMPETING OF INTEREST

No conflicts of interest have been disclosed by the authors.

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