

Original Research Article
**The Effect of Different Doses of Calcium Nitrate
Applications on some Phytonutrient Element
Contents of Leafy Parsley (*Petroselinum
crispum* (Mill.)) Plant**

ABSTRACT

Aims: Leafy parsley (*Petroselinum crispum* (Mill.)) plant is an important Ca source for human. This research was done to determine the different doses calcium nitrate application on some macro and micro phytonutrient element contents of leafy parsley plants.

Study design: Research was designed as 3 replications according to randomized block experimental design in unheated cold greenhouse conditions.

Place and Duration of Study: The experiment was carried out from November to January, 2014, Tekirdag city in Turkey.

Methodology: The seeds were sown as 1.5 gm⁻² for each parcel. Four calcium nitrate application doses (I. dose: 0 ppm, II. dose: 15 ppm, III. dose: 30 ppm and IV. dose: 45 ppm) were applied to parsley plants. The plants were harvested 65 day after sowing. Some macro and micro phytonutrient element (N, P, K, Ca, Mg, S, Fe, Cu, Zn and Mn) contents of plants were determined.

Results: According to the analyzing results, average total N contents of plants samples were determined 3.93 %, 3.96 %, 4.01 % and 4.07 %, respectively. Other macro elements P (0.32 %, 0.33 %, 0.35 % and 0.33 %), K (5.78 %, 5.92 %, 6.09 % and 6.46 %), Ca (0.67 %, 0.76 %, 0.78 % and 0.79 %), Mg (0.10 %, 0.11 %, 0.11 % and 0.12 %) and S (0.26 %, 0.34 %, 0.39 % and 0.52 %), were determined, respectively. Some micro element (Fe, Cu, Zn and Mn) contents of parsley plants, Fe (59.06, 62.16, 65.01 and 72.07 mg.kg⁻¹), Cu (27.62, 32.03, 38.90 and 39.80 mg.kg⁻¹), Mn (24.70, 27.50, 29.03 and 31.87 mg.kg⁻¹) and Zn (21.97, 23.30, 29.60 and 57.17 mg.kg⁻¹) were obtained, respectively.

Conclusion: These increases were found statistically significant for each phytonutrient element.

Keywords: Leafy parsley (*Petroselinum crispum* (Mill.)), Ca(NO₃)₂, macro phytonutrient elements, micro phytonutrient elements.

1. INTRODUCTION

Vegetables play an important role in human nutrition which is mostly consumed as uncooked, whereas the green ones are also used as aroma source in dishes, one of which is leafy parsley. It can be found in all seasons, and has a special significance because of its high vitamin C content and unique aroma.

Leafy parsley is widely used as a salad vegetable for which the mainland is the Mediterranean countries. Besides its richness in protein, vitamins C and E, and beta carotene, it has high amounts of minerals, such as Ca and K. There is 203 mg Ca and 104 mg potassium in 100 grams fresh parsley [1, 2, 3, 4, 5, and 6].

Calcium is used by plants in large quantities after N and K minerals [7]. The role of calcium in plant nutrition is often eclipsed by interest in macronutrients or specific micronutrients. Many times, calcium fertilization has been overlooked and is only considered when deficiency disorders influence the economic threshold of product quality and value. Calcium is a multifunctional nutrient in the physiology of crop plants and in the soluble form influencing availability and uptake. Cell wall strength and thickness are increased by calcium addition. Calcium is a critical part of the cell wall that produces strong structure. With rapid plant growth, the structural integrity of stems that hold flowers and fruit, as well as the quality of the fruit produced, is strongly coupled to calcium availability [7, 8, 9, 10, 11 and 12].

Comment [F1]: This objective is different from that in Introduction

Calcium has important effects on the quality and hardness of fruits and vegetables, shelf life, and resistance to disease agents [13]. It is important that the nutrients in the soil are in adequate proportions and at a sufficient level, that the plants are well fed. However, certain conditions may prevent the removal of nutrients even in soils containing sufficient nutrients [14]. There are many minerals in the soil as a source of calcium. The calcium content of the soil varies depending on the parent material, climatic conditions and physical and chemical properties of the soil. The calcium content of the coarse-grained soil is low. On the other hand, there is sufficient calcium in the arid and semi-arid soil of the region, which is composed of fine material and rich in calcium minerals. When the rate of transpiration drops, plants are not able to exploit this even if there is sufficient Ca in the soil. This results in the Ca deficiency as an indication [15]. One of the factors affecting yield and quality characteristics in leafy vegetables is the amount of nutrients that can be taken up by the plant from the soil. Not only the amount and the type of fertilizer to be given to the soil but also the form of fertilizer affect the amount of nutrients in the plant during the cultivation period.

In this research, the effects of different doses of calcium nitrate $\text{Ca}(\text{NO}_3)_2$ applications on parsley along with some macro and micro nutrient element contents are examined.

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2. MATERIAL AND METHOD

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The experiment was carried out from November to January, 2014, Tekirdag city in Turkey ($40^{\circ}97' \text{ N}$, $27^{\circ}51' \text{ E}$) using unheated high tunnel greenhouse covered by polyethilen (PE) with UV additive, which belongs to Namik Kemal University, Vocational School of Technical Sciences, Plant and Animal Production Department.

The large leaf parsley seeds (Vilmorin Firm) were used for the experiment. The general representation of the experiment is given in the Figure 1.

The experiment is designed according to the randomized block design with three replicates. Sowing is designed as 1.5 g.m^{-2} , and 4 doses of calcium nitrate fertilizer are applied (I. dose: 0 ppm, II. dose: 15 ppm, III. dose: 30 ppm and IV. dose: 45 ppm). 65 days after of seed sowing, leaves with stalk were cut 5 cm over the ground with a sharp knife. Single harvest was done in the experiment. Some chemical and physical characteristics of the research area soil are presented in the Table 1. The climate data measured inside the tunnel during the growing of the plants can be seen in Table 2. Irrigation was regularly carried out in the form of sprinkler irrigation during the growing season. Since there were no diseases and pests, pesticides were not used during the growing period.

Comment [F4]: Sentences should be in the form of past tenses.

Comment [F5]: How the fertilizer was applied should explain clearly

According to Table 1, the test soil was identified as having neutral reaction, no salt, medium lime, organic matter amount insufficiency, medium available phosphorus content, and potassium, Mg, Fe, Cu, Mn and Zn content were sufficiency.

The harvested plants were brought to the laboratory immediately, washed with distilled water two times and they were dried in 65°C drying-oven till their weights get stabilized for mineral content. They were ground and prepared for the analysis. Total N analysis was carried out with Kjeldahl method, and for their P, K, Ca, Mg, S, Fe, Cu, Zn and Mn analysis, ICP-OES device was used [16]. CPI INTERNATIONAL Advanced Analytical and Life Science Solutions peak performance certified reference materials were used for the elemental analyses. Detection limits for ICP-OES are given in Tables 3 and 4.

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Then experiment analysis results were evaluated SPSS 21 statistics software. ANOVA variance analysis was done and Duncan multiple comparison tests were conducted on the research results.

3. RESULTS AND DISCUSSION

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3.1. The Effects of the Calcium Nitrate Application on Parsley's Macro Phytonutrient Element (N, P, K, Ca, Mg, S) Contents

The effects of the increasing doses of calcium nitrate application on parsley's some macro nutrient elements are presented on the Table 5. When Table 5 is examined, significant increases can be observed (5 % degree) in N, P, K, Ca, Mg and S contents of parsley with calcium nitrate applications.

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It can be noticed that the increasing calcium nitrate doses form the plant's nitrogen nutrient elements. Nitrogen is also increased with soluble calcium sources such as calcium nitrate [8]. Effect of calcium nitrate foliar application was statistically significant for N, P, K, Ca, Mg contents of leaves. These effects were generally increased on N and Ca amount of leaves but decreased at 1.5% dose on P, K, Mg contents of leaves. As a result, the 1.0% dose of foliar application can be practically recommended [17]. Calcium nitrate applications increased the contents of Ca, K and P of leaves in potato plant [18]. In earlier researches, the amount of calcium fertilization that had been increased has been caused to increase potassium. In this research the amount of calcium fertilization that has been increased resulted in an increase in manganese and sulfur [19, 20]. In a study conducted at the head lettuce, increasing doses of calcium nitrate were observed to cause an increase in N, P, K, Ca, Mg elements in outer leaves of the plant [21].

Comment [F9]: Is it in soil or in plant?

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The effects of the increasing doses of calcium nitrate application on parsley's some macro nutrient elements are presented on the Figure 2, in which it can be observed that the increasing calcium nitrate doses have the plant's nutrient elements rise.

3.2. The Effects of Calcium Nitrate Application on Parsley's Some Micro Phytonutrient Element (Fe, Cu, Zn, Mn) Contents

The effects of the increasing doses calcium nitrate application on parsley's micro nutrient element contents are given on the Table 6. When Table 6 is examined, significant increases (5 % degree) in Fe, Cu, Mn and Zn contents of parsley plant with calcium nitrate applications can be observed.

Increasing amounts of calcium fertilizer application in tomatoes resulted in a decrease in leaf amounts of Fe, Zn, Cu and Mn depending on the variety [20]. For of the micro elements sufficiency limits the application levels of both calcium compounds respectively [22]. In a study conducted at the head lettuce, increasing doses of calcium nitrate were observed to cause an increase in Fe, Cu, Mn and Zn elements in the inner and outer leaves of the plant [21].

The effects of the increasing doses calcium nitrate application on parsley's micro nutrient element contents are given in the Figure 3. As it can be seen in the Figure 3, with the increasing calcium nitrate fertilization, the plant's micro nutrient elements increase.

4. CONCLUSIONS

In this research which aims to investigate the effects of the increasing doses of calcium nitrate application on parsley's some macro and micro nutrient element contents under unheated greenhouse conditions, significant increases in parsley's N, P, K, Ca, Mg, S, Fe, Cu, Mn and Zn nutrient elements have been identified compared to the control group. According to the results, the increasing doses of calcium nitrate application provide an increase in parsley's some macro and micro nutrient element contents.

On the other hand, the excessive and unconscious use of chemical fertilizers in agriculture has caused serious problems in the quality of agricultural products. For this reason, the amount, time and using method of chemical fertilizers that will be applied to soil and plant must be arranged according to soil and plant analyses.

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ETHICAL APPROVAL

As per international standard or university standard ethical approval has been collected and preserved by the authors.

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Figure 1.A general view from parsley plant experiment (Original).

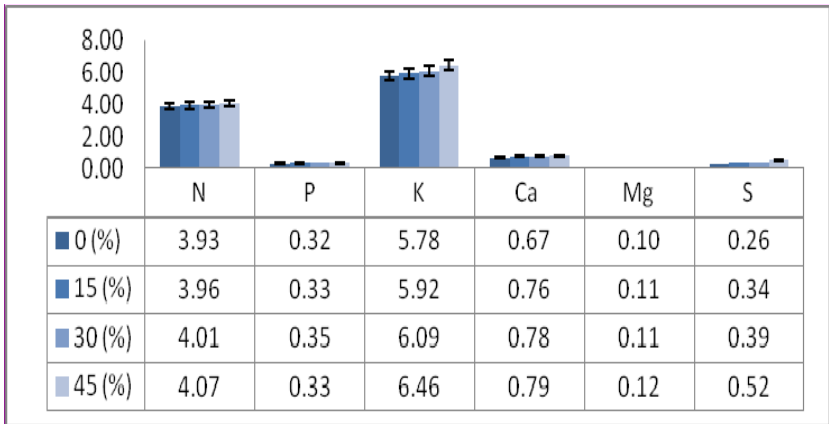
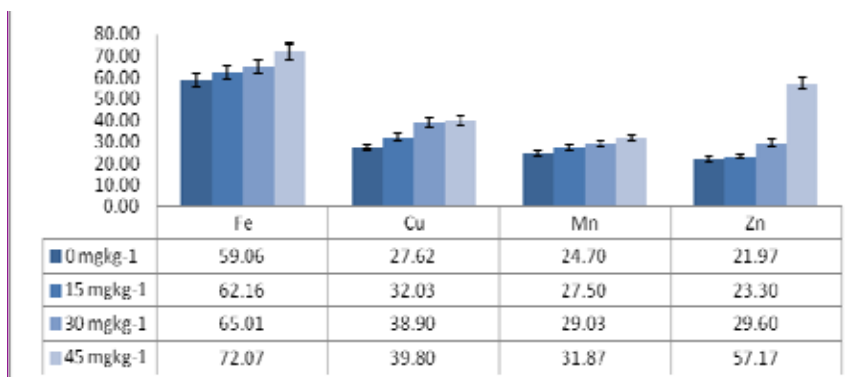


Figure 2.The effect of calcium nitrate application on some macro phytonutrient elements contents of parsley plant, (%).

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Figure 3.The effect of calcium nitrate application on some micro phytonutrient elements contents of parsley plant, (mgkg⁻¹).

Table 1.Some chemical and physical properties of experiment area soil.

Soil property	Analysis result
pH, 1: 2.5	6.75
EC x 10 ⁶	156
Lime (CaCO ₃), %	6.20
Organic matter, %	1.10
Ca, %	0.73
P ₂ O ₅ , kgda ⁻¹	12.10
K ₂ O, kgda ⁻¹	63.41
Mg, mgkg ⁻¹	320.60
Fe, mgkg ⁻¹	8.95
Cu, mgkg ⁻¹	1.43
Zn, mgkg ⁻¹	0.87
Mn, mgkg ⁻¹	10.72

Table 2.Average climate data in unheated greenhouse during the months of the experiment.

Month	Average Temperature (°C)	Maximum Temperature (°C)	Minimum Temperature (°C)	Average Humidity (%)
November	12.4	14.8	10.0	87
December	9.4	12.5	6.4	88
January	8.3	10.3	6.2	91

Table 3.Detection limits for ICP- OES

Element	LOD ($\mu\text{g kg}^{-1}$)	LOQ ($\mu\text{g kg}^{-1}$)
Cu	2.009	10
Fe	1.056	10
Mn	0.5189	10
Zn	1.566	10

Table 4.Detection limits for ICP- OES

Element	LOD (mg kg^{-1})	LOQ (mg kg^{-1})
Ca	2.98	5
Mg	0.166	5
K	2.40	5
P	10.66	10

Table 5.The effect of calcium nitrate application on some macro phytonutrient elements contents of parsley plant, %, *, **

Doses	N	P	K	Ca	Mg	S
I	3.93c	0.32b	5.78d	0.67b	0.10b	0.26c
II	3.96c	0.33b	5.92c	0.76a	0.11ab	0.34b
III	4.01b	0.35a	6.09b	0.78a	0.11ab	0.39b
VI	4.07a	0.33b	6.46a	0.79a	0.12a	0.52a

*: The values mean of three replications, **: each elements were evaluated individually and values in the same column with different letters are statistically significant at the level of 5 %.

Table 6.The effect of calcium nitrate application on some micro phytonutrient elements contents of parsley plant, mgkg^{-1} , *, **

Doses	Fe	Cu	Mn	Zn
I	59.06d	27.62c	24.70c	21.97c
II	62.16c	32.03b	27.50b	23.30c
III	65.01b	38.90ab	29.03b	29.60b
VI	72.07a	39.80a	31.87a	57.17a

*: The values mean of three replications, **: each elements were evaluated individually and values in the same column with different letters are statistically significant at the level of 5 %.

Comment [F14]: These table 5 and 6 are similar to figures 1 and 2