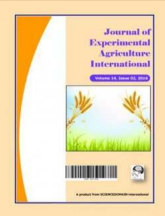

Journal of Experimental Agriculture International

19(5): 1-6, 2017; Article no.JEAI.37891
ISSN: 2457-0591
(Past name: American Journal of Experimental Agriculture, Past ISSN: 2231-0606)

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

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Authors' contributions

This work was carried out in collaboration between all authors. Author AA led other authors in supervising the designed study. Results, statistical analyses and discussion of the research findings were done by all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JEAI/2017/37891
Editor(s):
(1) Mohammad Reza Naroui Rad, Department of Seed and Plant İmprovement, Sistan Agricultural and Natural Resources Research Center, AREEO, Zabol, Iran.
(2) Rusu Teodor, Professor, Department of Technical and Soil Sciences, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Romania.
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(5) Uğur Şirin, Adnan Menderes University, Turkey.
Complete Peer review History: http://www.sciencedomain.org/review-history/22670

Original Research Article

Received 31st October 2017
Accepted 6th January 2018
Published 10th January 2018

ABSTRACT

Leafy parsley (*Petroselinum crispum* (Mill)) plant is an important source of Ca for human and 100 grams of leafy parsley plant provides 200-300 grams of Ca. This research was conducted to determine the different doses of calcium nitrate application on some macro and micro phytonutrient

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element contents of leafy parsley (*Petroselinum crispum* (Mill)) plant. For this purpose, the experiment followed randomized block experimental design with three replications in greenhouse conditions. 1.5 gm^{-2} plant seeds sowed 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. Parsley plants were harvested 75 days after of seed sowing. Some macro and micronutrient element (N, P, K, Ca, Mg, S, Fe, Cu, Zn and Mn) contents of plants were analyzed. According to the results, average total N contents of plant samples were determined as 3.93%, 3.96%, 4.01%, and 4.07%, respectively. Other macro elements were determined as follows: 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%), respectively. Nevertheless, for some microelements, the contents were obtained as; Fe (59.06, 62.16, 65.01 and 72.07 $mgkg^{-1}$) Cu (27.62, 32.03, 38.90 and 39.80 $mgkg^{-1}$) Mn (24.70, 27.50, 29.03 and 31.87 $mgkg^{-1}$), and Zn (21.97, 23.30, 29.60 and 57.17 $mgkg^{-1}$), respectively. The increasing doses of calcium nitrate application resulted in increasing outcomes, which are statistically significant, for each of the nutrient elements.

Keywords: Leafy parsley (Petroselinum crispum (Mill.)); $Ca(NO_3)_2$; macro phytonutrient elements; micro phytonutrient elements.

1. INTRODUCTION

Leafy parsley is among the vegetables that play important roles in the nutrition of people and that are mostly consumed raw and/or uncooked. 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 [1-6].

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 the 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 [7-12].

Calcium has important effects on the quality and hardness of fruits and vegetables, shelf life, and resistance to disease agents [10]. It is important that the nutrients in the soil are inadequate 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 [13].

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 [14].

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.

The aim of this research is to determine the effect of calcium nitrate applications on some phytonutrient content of parsley.

2. MATERIALS AND METHODS

The experiment was carried out from November to January, 2014, Tekirdag city in Turkey

(40°97' N, 27°51' E) using unheated high tunnel greenhouse covered by polyetilen (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 Figure 1.

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

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

The harvested plants were brought to the laboratory immediately, washed with distilled water two times and they were dried in 65 ^0C drying-oven till their weights get stabilized. 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 for which ICP-OES device was used [15]. All plant analysis was done with three replications. CPI INTERNATIONAL Advanced Analytical and Life Science Solutions peak performance certified reference materials were used for the elementary analyses. Detection limits for ICP-OES are given in Tables 3 and 4.

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_2O_5, $kgda^{-1}$	12.10
K_2O, $kgda^{-1}$	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

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

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

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

Month	Average temperature (℃)	Maximum temperature (℃)	Minimum temperature (℃)	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 (µg kg^{-1})	LOQ (µg 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

3. RESULTS AND DISCUSSION

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 macronutrient elements are presented in 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.

It can be noticed that the increased calcium nitrate doses form the plant's nitrogen nutrient elements. Nitrogen can increase 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% dose of a foliar application can be practically recommended [16].

Similar to this research results, calcium nitrate applications increased the contents of Ca, K and P of leaves in potato plant [17]. According to some earlier researchers, manganese and sulfur contents of some vegetables were increased with increasing calcium applications [18,19].

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 [20].

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 micronutrient element contents are given in 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 [19]. For of the microelements, sufficiency limits the application levels of both calcium compounds respectively [21]. In a study

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
IV	4.07a	0.33b	6.46a	0.79a	0.12a	0.52a

: The values mean of three replications, **: each element were evaluated individually and values in the same column with different letters are statistically significant at the level of 5 %, *: I: 0 ppm, II: 15 ppm, III: 30 ppm, IV: 45 ppm*

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
IV	72.07a	39.80a	31.87a	57.17a

: The values mean of three replications, **: each element were evaluated individually and values in the same column with different letters are statistically significant at the level of 5 %, *: I: 0 ppm, II: 15 ppm, III: 30 ppm, IV: 45 ppm*

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 [20].

4. CONCLUSIONS

In this research, increasing doses of calcium nitrate application to determine parsley's some macro and micronutrient (N, P, K, Ca, Mg, S, Fe, Cu, Mn and Zn) element contents under unheated greenhouse conditions. As a result, significant increases have been acknowledged concerning the control group. According to the results, the increasing doses of calcium nitrate application provide an increase in parsley's some macro and micronutrient element contents. Besides, calcium nitrate fertilizer should be applied to parsley plant according to the soil and plant analysis results in order to have the yield and the quality increased.

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.

ETHICAL APPROVAL

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

ACKNOWLEDGEMENTS

The abstract of this paper has been presented at the International Conference Turkey, Natural Nutrition and Healthy Living 2016.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Bakowski J, Michalik H. Usefulness of some vegetable species to produce dried. Biul. Warzywn. 1986;29:191–207.
2. Simon JE. Essential oils and culinary herbs. Advances in New Crops. Timber Press, Portland, OR. 1990;472–483.
3. Rumpel J, Kaniszewski S. Influence of nitrogen fertilization on yield and nitrate nitrogen content of turnip- rooted parsley. Acta Hort. 1994;371:413–416.
4. Kmiecik W, Lisiewska Z. Comparison of leaf yields and chemical composition of the Hamburg and leafy types of parsley, leaf yields and their structure. Folia Hort. 1999; 11(1):53-63.
5. Buchter-Weisbrodt H, Gemüse- genuss und gesundheit: Petersilie. Gemüse. 2005; 5:40.
6. Kolota E. Yield and quality of leafy parsley as affected by the nitrogen fertilization. Acta Sci. Pol., Hort Cult. 2011;10(3):145-154.
7. Brady NC, Weil R. The nature and properties of soils. Revised 14th ed. Pearson Prentice Hall. New Jersey; 2008.
8. Easterwood GW. Calcium's role in plant nutrition. Fluid J. 2002;36(10):16-19.
9. Kacar B. Basic plant nutrient. Nobel Publ. 2012;206. Ankara.
10. Kow N, Nabwami J. A review of effects of nutrient elements on crop quality. African J Food, Agric Nut and Dev. 2015;15(1): 9777-9793.
11. Yinanc A, Adiloglu S. Use of plants in water treatment: models and pilot study case in Kozan district. J of Agric Faculty. 2017;14:14-124. (In Turkish).
12. White PJ, Broadley MR. Calcium in plants. Ann of Bot. 2003;92(4):487-511.
13. Bouzo C, Cortez SB. Effect of calcium foliar application on the fruit quality of melon. Artic. 2012;38(3):4-9.

14. Kacar B, Katkat AV. Plant nutrition. Nobel Publ. 2006;849. Ankara.
15. Kacar B, Inal. Plant analysis. Nobel Publ. 2010;849. Ankara.
16. Yener H, Coban H, Cakici H. Effect of potassium (K) applications from foliar on the yield and N, P, K content of leaves in sultana (*Vitis vinifera* L.) grapes. Ege Univ J of Agric Faculty. 2008;45(1):21-25.
17. Clough GH. Potato tuber yield, mineral concentration, and quality after calcium fertilization. Journal of the American Soc for Hort Sci. 1994;119(2):175-179.
18. Tuna AL, Ozer O. Farkli kalsiyum bilesiklerinin karpuz (*Citrullus lanatus*) bitkisinde verim, beslenme ve bazi kalite ozellikleri uzerine etkisi. Ege Univ Ziraat Fak Derg. 2005;42(1):203-212. (In Turkish).
19. Budak Z, Erdal I. Yapraktan kalsiyum uygulamasinin farkli sera domates cesitlerinde verim, meyve kalitesi ve mineral beslenmesine etkisi. Top Bil ve Bit Bes Der. 2016;4(1):1-10. (In Turkish).
20. Kavak S, Bozokalfa MK, Ugur A, Yagmur B, and Esiyok D. Farkli azot kaynaklarinin bas salatada (*Lactuca sativa* var. *capitata*) verim, kalite ve mineral madde miktarı uzerine etkisi. Ege Univ Ziraat Fak Derg. 2003;40(3):33-40. (In Turkish).
21. Bergmann W. Nutritional disorders of plants-development, visual and analytical diagnosis. G. Fischer, NY Verlag, Jena. 1992;351.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/22670