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THE EFFECTS OF SOLID AND LIQUID EARTHWORM FERTILIZER DOSES ON THE NUTRIENT CONTENT OF *NARCISSUS* CV. "ROYAL CONNECTION" PLANT OF GROWN IN ECOLOGICAL CONDITIONS OF SIIRT PROVINCE, TURKEY

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ABSTRACT

Today, an important problem is the conversion of organic wastes into vermicompost and alternative organic fertilizer is obtained which is beneficial to sustain the productivity of the soil. Vermicompost is fertilizer material rich in symbiotic, asymbiotic microorganisms, mycorrhizal fungi and actinomycetes, as well as worm secretions, growth hormones, enzymes, vitamins and amino acids. Vermicompost increases the population of beneficial organism in the soil by using these beneficial properties in plant growth and suppresses diseases and harmful effects and provides positive changes in physical, chemical and biological parameters of soil and provides significant improvements in plant growth and yield and nutrient uptake.

This study was conducted in order to examine the effects of solid and liquid earthworm fertilizer dosages on nutrients uptaking of *Narcissus* cv. 'Royal Connection' plant in the Siirt University in 2016-2017 in the ecological conditions of Siirt province. The 25, 50 and 100 g (S1, S2 and S3) for solid fertilizer and; 0.5%; 1% and 2% (L1, L2 and L3) for liquid fertilizer was applied on each bulb. In the study, some nutrients in leaves and bulbs were analyzed. The mean values of N, P, K, Ca, Mg, Fe, Mn, Zn and Cu contents belong to *Narcissus* bulbs are varied between 1.633-2.013%, 2.787-4.195%, 0.631-0.795%, 0.366-0.866% ($p<0.01$), 0.096-0.162% ($p<0.05$), 179.265-399.063 mg kg^{-1} ($p<0.01$), 14.620-16.674 mg kg^{-1}; 155.697-461.033 mg kg^{-1} ($p<0.01$), and 30.333-45.799 mg kg^{-1}, respectively.

KEYWORDS:
Earthworm fertilizer, *Narcissus*, plant nutrient elements, vermicompost

INTRODUCTION

Narcissus genus belong to Amaryllidaceae family and it develops in soils which is rich in terms of organic matter content, moist, sandy, loamy and well drained loose structured soils. It doesn't like the soil which contains high clayey, with high groundwater and acidic. The content of organic matter should be above 3% and the pH value is between 6-7.5 [1]. As a result of many researches, vermicompost which called organic fertilizer has been searched for sustainability of soil fertility. Since it has effect of suppressing on plant diseases originating from soil [2-3], it causes the intensive use of these products in organic farming practices [4, 5, 6]. Vermicompost contains nitrate, phosphate, convertible calcium and soluble potassium, which are useful for macro or micronutrient for plants. It also contains hormones secreted by microorganisms and promoting plant growth [7]. Vermicompost not only ensures that plants are healthy, high quality and productive with the nutrients they bring up to the soil, but also it increases soil fertility and quality by regulates their development with humic acid and growth hormones, and more importantly increasing microbial activity and microbial biomass levels. [8] reported that vermicompost applications were more effective in yield and yield items than NPK application in the comparison of vermicompost and NPK fertilizer application in strawberry. Vermicompost and similar organic fertilizer applications affect soil structure, air permeability, water permeability, availability of nutrients, microbial activities [9-10]. Firstly, [11-12] observed that small doses of vermicompost added to the potting media of several ornamental species, produced a much larger increase in plant growth than the equivalent dose of nutrients [13]. [12] reported that vermicomposts increased ornamental seedling emergence compared with those in control commercial plant growth media, using a wide range of test plants such as pea, lettuce, wheat, cabbage, tomato and radish.

TABLE 1
Some properties of experimental soil.

Analysis	Unit	Result	Evaluation
Textur	%	72	Clay
pH	-	7.33	Notr
EC	ds m^{-1}	1.12	Saltless
Lime	%	14.8	Middle level
Organic matter	%	1.64	Low
Phosphorus (P_2O_5)	kg da^{-1}	3.70	Low
Potassium (K_2O)	kg da^{-1}	128.7	Enough

TABLE 2
Properties of solid and liquid earthworm fertilizer [27].

Properties	Solid earthworm fertilizer (%)	Liquid earthworm fertilizer (%)
pH	6.5-7.5	8.5-10.5
Total organic matter	20-25	7
Total nitrogen	0.8-1.2	1
Organic nitrogen	0.6-0.9	-
Total humic-fulvic	10-15	6
Humidity	20-25	-

Vermicompost has been positively affected by some of the various plants that can be used as ornamental plants. According to the literature survey, vermicompost-treated ornamental plants are determined as *Eleagnus pungens, Cotoneaster conspicua, Pyracantha, Viburnum bodnantense, Chaemaecyparis lawsonia, Cupressocyparis leylandii* and *Juniperus communis* [12], *Chrysanthemum* [14], poinsettia [15], marigold [16, 17, 18, 19], *Rosmarinus officinalis* [20], *Geranium* [21], *Petunia* [22], *Pinus pinaster* [23-24], *Hyacinthus orientalis* [25-26].

The *Narcissus* plant is a geophyte species requires less workforce and easy to grow when ecological requirements are met and a suitable growing condition is provided. In literature searches, although it is easy to grow and care, *Narcissus* growing has not been determined in Siirt province before. This study was carried out to determine the effects on the content of nutrient in leaves and bulbs of plant by applying different doses of solid and liquid earthworm fertilizers to the *Narcissus* cv. “Royal Connection” plant which the orchard planting is not commonly grown in the Siirt province.

MATERIALS AND METHODS

This study was carried out in the Research and Application Field of Faculty of Agriculture in Siirt University during 2016-2017 vegetation periods. As research material, *Narcissus* cv. 'Royal Connection' bulbs were used.

The experimental area of Faculty of Agricultural in Kezer Campus of Siirt University has a flat profile with a sloping, nearly inclined alluvial structure. According to soil analysis results taken from a sample at a depth of 0-30 cm before planting in the experimental area, it was determined that experimental area can be classified in the clay class in terms of texturization, the soil with mild alkaline character contains lime in the middle level and there is no salinity problem, insufficient with regard to receivable phosphorus and organic matter, and potassium level is sufficient (Table 1).

The study, based on the "Randomized Block Design", consisted of 3 replicate blocks and in each time, 12 bulbs are planted. Inter and intra rows are 25 cm and planting depth of 10 cm within the parcel were opened and solid and liquid earthworm fertilizer was applied to the pits. Control parcels were formed to compare with the applications. Earthworm fertilizer (S), a solid earthworm fertilizer; 25 g / bulb (S1), 50 g / bulb (S2), 100 g / bulb (S3), liquid (L) bulb which is a liquid earthworm fertilizers were used at 0.5% (L1), 1% (L2), and 2% (L3) doses. The used earthworm fertilizers are obtained from *Eisenia foetida* culture worms known as red California worm produced by a producer company (Table 2). Irrigation was realized naturally using autumn-winter-spring rains.

Nutrient analysis was performed in nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), iron (Fe), manganese (Mn), zinc (Zn) and copper (Cu) in the leave samples obtained during flowering and bulbs samples obtained after the aboveground part of plant was completely dried. Analysis of plant nutrients was done according to [28]. Nitrogen analysis by Kjeldahl method; other elements were prepared by microwave method and analyzed by ICP Q model ICP-MS of Thermo Scientific brand.

Data were planned using two-factor randomized block design by SAS 9.1 statistical package program. The LSD multiple comparison test was used to compare the averages. Tests were conducted at $\alpha = 0.05$ significance level [29].

RESULTS

Nitrogen (N) content (%). Increasing doses of both fertilizer forms positively affected N content (Table 3). Mean values of N in bulbs varied from 1.633 to 2.013% when N values varied in leaves from 3.033 to 3.470%. Increased dosing of both fertilizer forms led to a decrease in N content in bulbs (Figure 1).

Phosphorus (P) content (%). The highest P contents in the leaves were founded in control by 0.531%, and the lowest in L1 by 0.404% (Table 3). In the bulbs, the highest P content was founded in control (4.195%) while the lowest was in S1 (2.787%) (Figure 1).

Potassium (K) content (%). Accordingly, the highest K contents in the leaves were found in S2 by 5.047% and the lowest K content was found in L3 by 3.549% (Table 3). While the lowest K content (0.631%) was determined in control parcels, the highest K content in bulbs (0.795%) in S3 (Figure 1).

Calcium (Ca) content (%). The average values of Ca contents in leaves were highest in S2 by 0.922% and were lowest in L1 by 0.457%; as for mean values of Ca content in bulbs were highest in S2 applications by 0.866%, and the lowest in L2 applications by 0.366% (Table 3) (Figure 1).

Magnesium (Mg) content (%). The highest content of Mg in leaves was found in L2 by 0.232%, the lowest was found in L1 by 0.161%. According to these findings, the highest content of Mg in bulbs of *Narcissus* plant was in S2 by 0.162%, while the lowest Mg content was obtained in control parcels by 0.096% (Table 3) (Figure 1).

Iron (Fe) content (mg kg^{-1}). While the highest content of Fe in the leaves was found in S2 with 544.333 mg kg^{-1} and the lowest value was found in L3 with 307.570 mg kg^{-1}, the content of Fe in bulb was highest in L2 with 399.063 mg kg^{-1} and was the lowest in L1 application with 179.265 mg kg^{-1} (Table 4) (Figure 2).

Manganese (Mn) content (mg kg^{-1}). The highest Mn content in the leave was in L2 with 58.668 mg kg^{-1} and lowest in S3 with 37.005 mg kg^{-1}. The highest content of Mn in the bulb was in S1 with 16.674 mg kg^{-1} with and the lowest in the control parcels with 14.620 mg kg^{-1} (Table 4) (Figure 2).

Zinc (Zn) content (mg kg^{-1}). The highest Zn content (368.890 mg kg^{-1}) was obtained in L3 and the lowest Zn content (182 mg kg^{-1}) was in the control parcels in the leave. In the bulb of the *Narcissus* plant, Zn content was highest in S3 (461.033 mg kg^{-1}) and lowest in L3 (155.697 mg kg^{-1}) application (Table 4) (Figure 2).

Copper (Cu) content (mg kg^{-1}). The highest Cu content in the leave was obtained in L2 (34.056 mg kg^{-1}), lowest was in the control parcels (22.285 mg kg^{-1}). According to Table 4, Cu contents in bulbs was highest in S3 (45.799 mg kg^{-1}) and lowest (30.333 mg kg^{-1}) in control parcels (Figure 2).

TABLE 3
The effects of applications on the content of the macronutrient elements in the leaves and bulbs of the *Narcissus* plant.

Organs	Applications	N (%)	P (%)	K (%)	Ca (%)	Mg (%)
Leaves	Control	3.033	0.531 A*	4.713 A**	0.689 BC**	0.220 AB**
	S1	3.133	0.529 A	4.446 AB	0.692 BC	0.202 BCD
	S2	3.127	0.504 A	5.047 A	0.922 A	0.216 ABC
	S3	3.470	0.484 ABC	3.884 BC	0.495 D	0.183 DE
	L1	3.207	0.404 C	3.741 BC	0.457 D	0.161 E
	L2	3.337	0.492 AB	4.926 A	0.798 AB	0.232 A
	L3	3.420	0.414 BC	3.549 C	0.595 CD	0.198 CD
		no-significant	p<0.05	p<0.01	p<0.01	p<0.01
Bulbs	Control	1.753	4.195	0.631	0.391 DE**	0.096 C*
	S1	2.013	2.787	0.729	0.461 CD	0.122 BC
	S2	1.957	4.096	0.730	0.866 A	0.162 A
	S3	1.637	4.083	0.795	0.715 B	0.122 BC
	L1	1.793	4.08	0.646	0.537 C	0.115 BC
	L2	1.687	4.06	0.668	0.366 E	0.121 BC
	L3	1.633	4.07	0.677	0.770 B	0.130 B
		no-significant	no-significant	no-significant	p<0.01	p<0.05

S: Solid earthworm fertilizer; S1 (25 g / bulb), S2 (50 g / bulb), S3 (100 g / bulb)
L: Liquid earthworm fertilizer; L1 (0.5%), L2 (1%), L3 (2%)
*means followed by the same letter in the line indicate no statistical difference at %5 level
**means followed by the same letter in the line indicate no statistical difference at %1 level

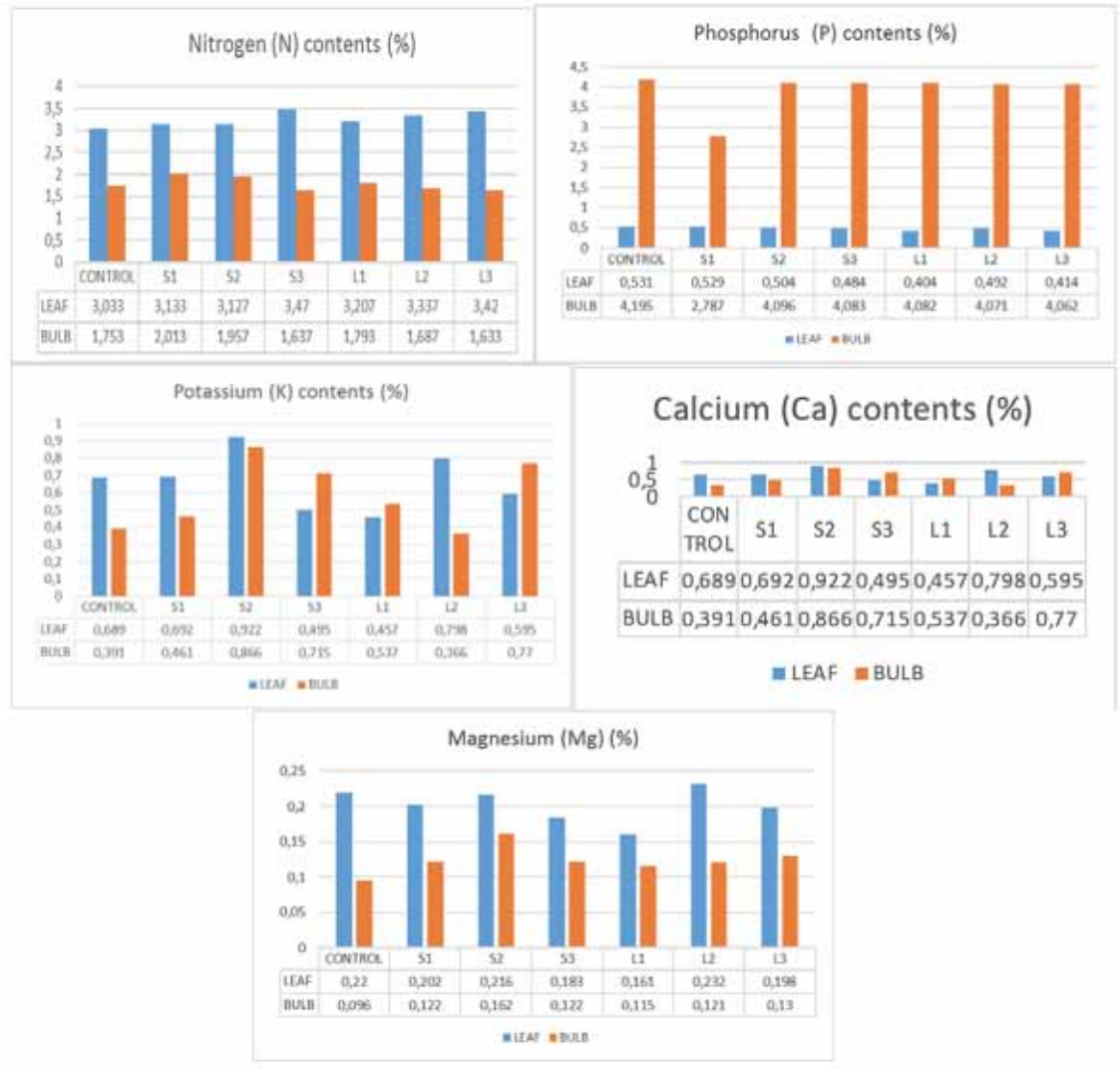

FIGURE 1
Effects of applications on leaf and bulb macro element contents
S: Solid earthworm fertilizer; S1 (25 g / bulb), S2 (50 g / bulb), S3 (100 g / bulb); L: Liquid earthworm fertilizer; L1 (0.5%), L2 (1%), L3 (2%)

TABLE 4
The effects of applications on the content of the micronutrient elements in the leaves and bulbs of the *Narcissus* plant.

Organs	Applications	Fe (mg kg^{-1})	Mn (mg kg^{-1})	Zn (mg kg^{-1})	Cu (mg kg^{-1})
Leaves	Control	404.706 BC**	47.208 AB**	182.000 C**	22.285 D*
	S1	351.198 CD	40.380 B	190.333 BC	25.133 BCD
	S2	544.333 A	57.763 A	291.497 A	24.857 CD
	S3	341.607 CD	37.005 B	279.161 AB	33.280 A
	L1	325.793 CD	40.151 B	195.181 BC	32.190 AB
	L2	476.653 AB	58.668 A	363.353 A	34.056 A
	L3	307.570 D	37.354 B	368.890 A	31.484 ABC
	Sign. value	p<0.01	p<0.01	p<0.01	p<0.05
Bulbs	Control	258.000 BC**	14.620	381.805 AB**	30.333
	S1	331.996 AB	16.674	423.766 A	41.547
	S2	364.685 AB	15.914	299.552 B	36.155
	S3	21.716 C	16.334	461.033 A	45.799
	L1	179.265 C	16.558	197.370 C	32.084
	L2	399.063 A	16.469	294.517 B	32.238
	L3	334.099 AB	15.929	155.697 C	35.995
	Sign. value	p<0.01	no-significant	p<0.01	no-significant

S: Solid earthworm fertilizer; S1 (25 g / bulb), S2 (50 g / bulb), S3 (100 g / bulb)
L: Liquid earthworm fertilizer; L1 (0.5%), L2 (1%), L3 (2%)
*means followed by the same letter in the line indicate no statistical difference at %5 level
**means followed by the same letter in the line indicate no statistical difference at %1 level

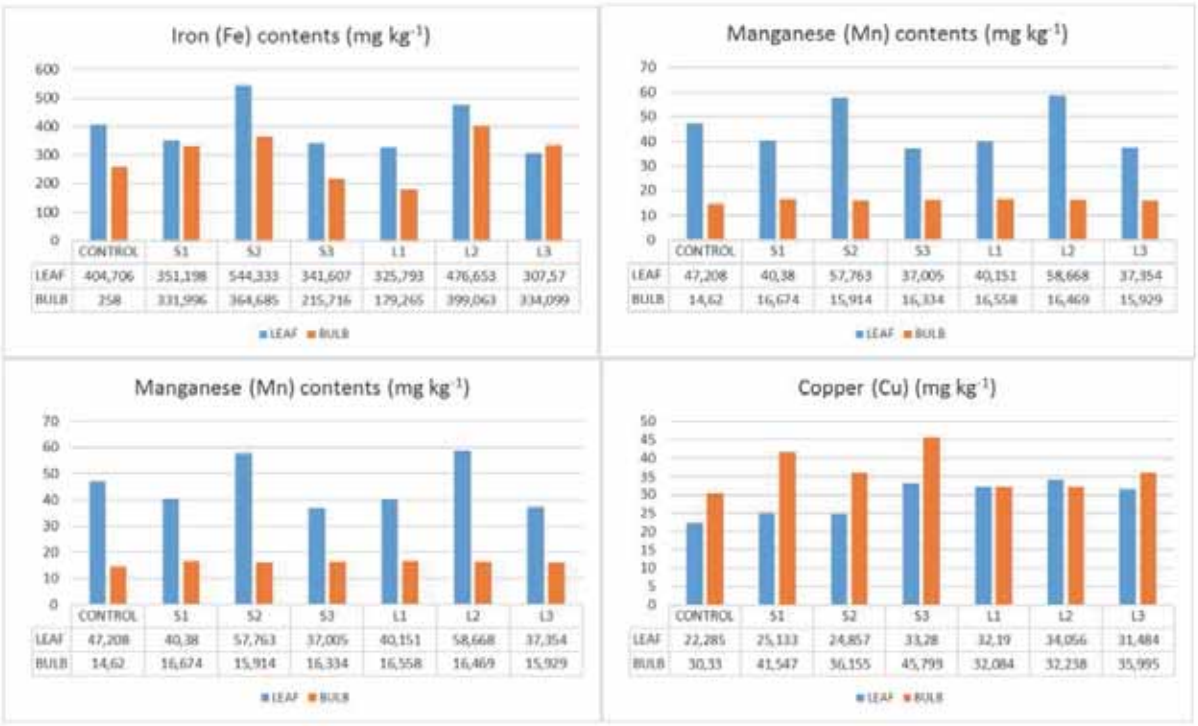

FIGURE 2
Effects of applications on leaf and bulb micro element contents
S: Solid earthworm fertilizer; S1 (25 g / bulb), S2 (50 g / bulb), S3 (100 g / bulb); L: Liquid earthworm fertilizer; L1 (0.5%), L2 (1%), L3 (2%)

DISCUSSIONS

In a field study with *Narcissus tazetta* subsp. *tazetta* plant, nitrogen, phosphorus, potassium content in the aboveground organs of the plant was determined as 2.47%, 0.068, 0.28, respectively [30]. In a field study conducted with *Romulea columnae* subsp. *columnae* plant, while N content in vegetative samples taken from the organs of the plant was 1.38%, this ratio in the samples taken in the generative period was found to be 0.95% [31]. In the study of [32], N content of the leaves and bulbs of the fertilizers in organic fertilization with Hybrid *Gladiolus* "Dolce Vita" plant chicken manure, farm manure, waste mushroom compost and peat were determined as 1.650-1.967% and 2.467-4.861%, respectively. [33] stated that in order to determine 0, 25, 50 and 75 kg^{-1} nickel (Ni) applications were effective against *Narcissus poeticus* L. cv. "Ice Folies" on the nutrient content of the plant, K, Ca, Mg, Fe, Mn, Zn, Cu content in the leaves and bulbs were found as 2.06-2.20% and 0.75-0.89%, 0.48-0.59% and 0.22-0.27%, 0.14-0.17% and 0.07-0.09%, 56.5-66.6 mg kg^{-1} and 14.7-27.4 mg kg^{-1}, 30.1-48.8 mg kg^{-1} and 8.7-10.3 mg kg^{-1}, 28.7-41.0 mg kg^{-1} and 18.9-21.0 mg kg^{-1}, 11.0-41.3 mg kg^{-1} and 5.4-7.6 mg kg^{-1}, respectively.

[34] determined the content of Zn and Cu in the leaves and bulbs of the hyacinth plant by applying lead to the hyacinth bulbs in greenhouse conditions was between 33.3-50.1 mg kg^{-1} and 21.7-32.3 mg kg^{-1}, 6.8-13.8 mg kg^{-1} and 2.1-3.4 mg kg^{-1}, respectively.

[26] studied on *Hyacinthus orientalis* 'Purple Star' in field conditions. The researches applied inorganic and earthworm fertilizers to bulbs. They obtained nutrient element contents in leaf and bulbs like N (2.403-4.450% and 1.063-1.713%), P (0.269-0.603% and 0.191-0.337%), K (3.112-6.758% and 0.817-1.183%), Ca (0.775-1.130%- 0.287-0.372%), Mg (0.230-0.346 mg kg^{-1} and 0.089-0.119 mg kg^{-1}), Fe (802.333-1520.657 mg kg^{-1} and 169.54-482.209 mg kg^{-1}), Mn (46.253-88.585 mg kg^{-1} and 12.410-23.374 mg kg^{-1}), Zn (15.148-33.560 mg kg^{-1} and 7.390-18.556 mg kg^{-1}) and Cu (8.582-18.616 mg kg^{-1} and 4.711-6.949 mg kg^{-1}).

When we compared the findings of our study with literature search presented, the content of K in leave is found two times higher. Since the high rate in control application as well as earthworm fertilizer proves that growing area of this study is appropriate. Variety differences also need to be considered. As it is seen in the previous studies, the content of K in the leaves differ a great change compared to the plant species grown. Plant species and variety have a great importance along with the cultivated area and conditions. In this study, K values obtained from leaves and bulbs were found close to each other. The result of the control application is also close to K values obtained from other applications indicates that earthworm fertilizers

have a positive effect on K content but little effect on some forms and doses.

Since there is a difference between plant species and varieties and environmental conditions in literature presented, changes in Mg contents in leaves are observed. However, when only varieties of *Narcissus* are considered, the mean values of Mg in leaves and bulbs in our study are higher than other studies. Earthworm fertilizers have a positive effect on Mg contents.

The mean values of Fe obtained in our study were much higher than other studies both on the leave and on bulb. It is thought that the suitability of the cultivation area and the effect of earthworm fertilizer have a positive effect on Fe content.

As understood in this study, the Mn content was inversely proportional with the leave and bulb of the *Narcissus*. In the leaves, medium doses of both fertilizer forms in particular have had a positive effect. By the way, no significant differences were observed in the content of Mn in the bulbs. Nevertheless, earthworm fertilizer for Mn content of the *Narcissus* has been positive contribution compared to previous studies. It can be seen in our study that; the earthworm fertilizer has a positive effect on the Zn content of the *Narcissus* plant. While solid earthworm fertilizer was effective on the Zn contents in the leaves, liquid earthworm fertilizer was effective on the content of bulbs. A relatively large increase is observed compared to the previous researches.

There are differences in the content of Cu of subject to plant species compared with the previous studies. However, when the *Narcissus* are investigated, approximate contents to average are observed. Nevertheless, it is clear that the earthworm fertilizer causes an increase in Cu content both on the leave and on the bulb.

CONCLUSIONS

As a result, the study has a primary characteristic in terms of *Narcissus* growing and wo earthworm rm fertiliser use in ornamental plants in Siirt province. As a result of literature review, it has not founded any study examining *Narcissus* growing and earthworm fertilizer applied to any ornamental plants in Siirt province. This research finding proves the applicablity of study which inorganic fertilizer and conventional manure has been widely used in agricultural activities in the region. The *Narcissus* plants, with its smell and appearance, is an aromatic plant with aesthetic bulb. Variety studied is a perfect cut flower with magnificent smell, yellow color and long flower stalk, and besides it is a beautiful landscape plant. Since the bulbs demand very few labor force after the sewing (due to no need for irrigation and requires only a few times weeding) in Siirt conditions, it cost little. As solid and liquid earthworm also affects plant growth positively permits the *Narcissus* plant to be grown commercially in the region. earthworm fertilizer is a nature-friendly fertilizer. It not only contributes positively to the plant nutrition and growth but also do not causes the salt accumulation which is unconsciously or continuously used in the soil such as inorganic fertilizer, but it provides the improvement of soil structure and enrichment of minerals.

The *Narcissus* planting should be encouraged in the region, in terms of low cost and maintenance costs which can be used several areas at once. Farmers should be informed and encouraged to use this fertilizer, do not cause pollution in terms of both smell and apperance, to prevent salt accumulation in the soil, and to improve the physical and chemical structure of the soil.

Besides, this study has important role in promoting narcissus farming in Siirt, it has applicability features to other plant groups and especially to ornamental plant species. Due to the earthworm fertilizer which has positive effects on the bulb development as well as the cut flower production, using earthworm fertilizer in *Narcissus* farming will have an important contribution to the ornamental plant sector and producers in region and extend the vision of flower production in Siirt province.

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