

EVOLUȚIA STĂRII DE NUTRIȚIE A CIREȘULUI ȘI MĂRULUI ÎN LOTUL EXPERIMENTAL DE LA ICDP PITEȘTI, SUB INFLUENȚA UNOR TEHNOLOGII NOI DE FERTIRIGARE

CHERRY AND APPLE NUTRITION STATUS AT RIFG PITEȘTI, ROMANIA EXPERIMENTAL FIELD INFLUENCED BY NEW FERTIGATION TECHNOLOGIES

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Abstract

Nutrition state of three apple varieties and GiSeIA sweet cherry variety grafted on four parent stocks has been studied for a three years period, 2019-2021, through foliar analysis, in the frame of a project that aimed at early multi sensor diagnosis of nutritional stress in order to optimize fertigation methods in fruit tree growing. Leaves were collected to this end from every experimental lot in all three consecutive years; the samples were brought to the laboratory, dried and ground, and mineral nutrition elements (nitrogen, phosphorus, potassium, calcium, magnesium, zinc, copper, iron, and manganese) were analyzed, using dedicated laboratory methodology. The analytical results highlighted a normal nutrition of the fruit tree varieties, with differences (assessed by statistic analysis) determined by variety/parent stock and applied treatments, all of them inside the normal contents ranges. The only exception consists of high manganese contents in cherry leaves which don't necessarily endanger mineral nutrition.

Cuvinte cheie: fertirigare, nutriție minerală, măr, cireș.

Key words: fertigation, mineral nutrition, apple, sweet cherry.

1. Introduction

Fruits are largely cultivated crops worldwide as they accounted for 10% of the world production of primary crops in 2021 and 17% in value. They are very important in human diet, largely consumed worldwide and an essential vegetal food, very important socially and economically. Fruit harvested area was 5% in 2021 of the World primary crops harvested area.

Fruit production amounted to 909,644 thousand tons worldwide in 2021 out of which 81,880 in Europe and Romania produced 3,004 thousand tones. The total crops value was 474,789 million USD worldwide, 55,030 in Europe, and 2,080 in Romania. Fruit crops harvested area was 66,482 thousand ha worldwide, 7,147 thousand ha in Europe and 315 thousand ha in Romania (Food and Agriculture Organization of the United Nations, 2023).

Apples are a rich source of phytochemicals, and epidemiological studies have linked the consumption of apples with reduced risk of some cancers, cardiovascular disease, asthma, and diabetes (Boyer and Liu, 2004). Consumption of apple juice could exert some benefits on a variety of markers associated with the risk of developing chronic diseases (Marcotte et al., 2022).

The production and consumption of cherries has increased recently due to consumer awareness of their health benefits, since they are rich in polyphenolics (namely anthocyanins and hydroxycinnamic acids). Global sweet cherry production increased over the last years from 1.9 to 2.32 million tons, with Turkey, USA, Iran as the main producers. Sweet cherries are appreciated for their organoleptic aspects, such as taste, texture and color. They exert beneficial health effects to counteract oxidative stress, reduce inflammation, modulate blood glucose, and enhance cognitive function (Blando and Oomah, 2019). Anthocyanin-rich cherries are known for preventing/decreasing risk factors associated with obesity (Noratto et al., 2018).

Much of fruit production is processed worldwide. In Poland for example more than half of produced apples is processed which generate wastes, such as pomace, which can be a potential source for health food preparations (Kruczek et al., 2017). Apple pomace is a rich source of health-benefitting nutrients, including minerals, dietary fiber, antioxidants, and ursolic acid, which suggest it has potential use as a dietary supplement, functional food, and/or food additive (Skinner et al., 2019).

Apple and cherry cultivation are very important in Romania too. Out of a total 1,484.1 thousand tons total fruit production in 2022 551.9 thousand tons were apples and 66.6 thousand tons cherries (National Statistics Institute, 2023).

Much attention is paid by the Pitești – Mărăcineni Research and Development Institute for Fruit Tree Growing to these species and to developing new efficient and environment friendly technologies for their growth and the Minister for Agriculture and Rural Development is also interested and finances such research. In such a recent project financed by the Minister new fertigation technologies were tested for cultivating apple and cherry. This paper presents the fruit trees nutritional status along the three experimental years.

2. Material and methods

The experimental schema implied three apple varieties 'Jonagold Boerekamp', 'Red Braeburn', and 'Jonagold Novajo' and the 'Regina' cherry variety grafted on four rootstocks: 'GiSelA 3', 'GiSelA 5', 'GiSelA 12' and 'Weigi 2'. Six fertilizing products were used in the cultivation process, in seven variants for apple and four variants for cherry, each including an unfertilized control (Table 1).

Leaves samples were collected in order to assess the fruit tree species nutritional state from the middle of the yearly shoots facing South, at three moments: fall 2019, before beginning the experimentation; July 2020; and July 2021. The samples were dried and finely grounded, and the analytical results were reported for the dry material.

Standardized analytical methods were used for foliar diagnosis that are currently used in ICPA laboratories and described in "Methodology of plant analysis in order to assess mineral nutrition status" (Răuță and Chiriac, 1980), namely:

- total nitrogen was determined by the Kjeldhal method;
- phosphorus determination was done by colorimetry, with ammonium metavanadate and ammonium molybdate;
- potassium and calcium were determined by flame photometry in a 0,5 *n* hydrochloric acid (HCl) solution;
- magnesium, zinc, copper, iron, and manganese were determined in the same solution through atomic absorption spectrometry.

Foliar analysis results were statistically computed using an SPSS program; homogeneity was tested for the analytical values series; statistical distributions of the analytical values were determined; analysis of variance was performed to establish differences between experimental variants, between varieties and applied treatments and their statistical significance was assessed.

3. Results and discussions

3.1. Fruit tree mineral nutrition status before the beginning of the experiment (2019)

Representative leaves samples were collected from the experimental lot in autumn 2019 to establish a reference as regards the mineral nutritional state of the studies species, varieties, and root stocks. The samples presented normal mineral elements contents (Table 2), so a good nutritional state.

3.2. Fruit tree mineral nutrition status in the first experimental year (2020)

Leaves samples were collected again in July 2020, for each specie, variety, and root stock, from each fertilization variant. The results are briefly presented in Tables 3-8.

Foliar diagnosis performed on the apple and cherry leaves collected from the experimental field for each apple variety, cherry root stock, and fertilization variant highlighted some statistically significant differences between mineral elements contents, induced either by the apple variety or cherry root stock, or by the applied treatment. All these differences were registered inside the normal contents' ranges mentioned by literature, which, corroborated with the soil samples fertility properties, highlight normal nutrition conditions for the analyzed fruit tree species, varieties, and root stocks.

3.3. Results registered in the last research phase

3.3.1. Mineral nutrition of the apple varieties

The distribution of the mineral elements contents in the apple leaves collected after two years experimentation (2021; Fig. 1) mainly range in the normal contents' domains for the studied fruit tree species (Table 2) and are alike those registered in the previous year. An important modification of the manganese values variation interval is only noticed, up to 227.0 mg/kg, as compared to the 128.1 mg/kg in the previous year and of its distribution, less homogenous, suggesting and anthropic input (namely with the pest-control products), relatively low though because the median (ME) and Module (Mo) values of 154.0 respectively 142.0 mg/kg are close to the normal contents' interval upper limit (140 mg/kg).

As in the previous research stage, the analysis of variance highlighted statistically significant differences between the studied apple varieties and between the applied treatments. These differences, within the normal contents' values ranges, are presented in Tables 9 and 10. It can be noticed that Red Braeburn variety accumulated significantly more nitrogen and manganese than the other two varieties and more phosphorus than 'Jonagold Novajo' but less than 'Jonagold Boerekamp' (Table 9). 'Jonagold Novajo' accumulated more zinc than the other two varieties. The differences between varieties diverge

from those registered in the previous research stage but, as the determined mineral elements contents values range in the normal contents domains this proves once more the nutritional equilibrium in the experimental fruit tree plantation.

Few statistically significant differences were registered between leaves mineral elements contents depending on fertilization treatments (Table 11). None whatsoever for calcium, magnesium, and iron, just like in the previous experimental year. As for nitrogen, which didn't register significant differences in the previous stage, the only significant variation is that of the M1 0.5% trade variant increase as compared to the F1 one. Phosphorus and potassium significantly varied between variants, as did the zinc one and less the copper one. So, the applied fertilizers induce various effects upon mineral elements absorption in apple leaves, all within the normal nutrition limits for this fruit tree species.

3.3.2. Mineral nutrition of 'Regina' sweet cherry

The mineral elements content values distribution in the cherry leaves sampled from the experimental lot (Fig. 2) are close to the normal one and framed within the normal contents' ranges for the studied fruit tree species.

Nitrogen, phosphorus, and copper contents analytical values exclusively vary inside the normal contents range (Table 12). A few values are registered for potassium and calcium a bit lower than the inferior limit of the normal contents' values, without consequences upon fruit trees nutritional status. Four of the iron contents values outrun the upper limit of the normal contents' interval by much, and half the manganese concentrations are above it.

Analysis of variance highlighted some statistically significant differences between root stocks and between the applied treatments. These differences, within normal contents ranges, are presented in Tables 13 and 14. Important differences are registered between root socks for nitrogen and phosphorus, especially favoring 'GiSela 5' and 'GiSela 3' rootstocks. Potassium nutrition seems not to vary between root stocks, while 'Regina' variety grafted on 'GiSela 3' seems to accumulate more calcium and magnesium. Zinc Copper, and manganese have higher concentrations for 'GiSela 3', and iron varies more between root stocks, favoring 'GiSela 12'.

Data in Table 14 suggest that Fertisol (2 kg/tree) and Polyfeed (1%) products have the best influence upon mineral nutrition as they improve nitrogen, potassium, calcium, zinc, and copper absorption in plants. On the other hand, it is noticed that all used products ensure maintaining a well-balanced cherry nutritional state as the variations between treatments keep the values inside the normal concentrations' domains.

4. Conclusions

Foliar diagnosis performed on apple and cherry leaves samples in the frame of experimenting new fertilization variants and various pest control products ascertains a normal mineral nutrition of the fruit tree species, with differences induced by the variety/root stock and by the applied treatments, all within normal contents ranges.

The only exception rests in some high manganese concentrations in cherry leaves which doesn't necessarily endanger the mineral nutrition.

Few differences between the mineral contents were statistically significant as influenced by fertilization or from a variety/root stock to the next.

Fruit trees mineral nutrition state should be permanently monitored in a plantation in order to early diagnose possible disequilibria occurred as a consequence of growing technologies or induced by natural factors, especially in such experimental fruit tree plantations where new fertilization and pest control products and new technologies are permanently used.

The many analytical data of the leaves mineral composition could be used to further study its variation between experimental years, depending on climatic conditions or between fruit tree species.

References

1. Jeanelle Boyer, Rui Hai Liu, 2004. Apple phytochemicals and their health benefits, *Nutrition Journal* 2004, 3: 5. (<http://www.nutritionj.com/content/3/1/5>, accessed 5.11.2024).
2. Marcotte Bastien Marcotte, Marie Verheyde, Sonia Pomerleau, Alain Doyen, Charles Couillard, 2022. Health Benefits of Apple Juice Consumption: A Review of Interventional Trials on Humans, *Nutrients* 2022, 14: 821. <https://doi.org/10.3390/nu14040821>.
3. Federica Blando, B. Dave Oomah, 2019. Sweet and sour cherries: Origin, distribution, nutritional composition and health benefits, *Trends in Food Science & Technology* 86: 517–529.
4. Marek Kruczek, Dorota Gumul, Miroslava Kacaniova, Eva Ivanishova, Jan Marecek, Halina Gambus, 2017. Industrial Apple Pomace By-Products as a Potential Source of Pro-Health Compounds in Functional Food, *Journal of Microbiology Biotechnology and Food Sciences*, Volume 7, Issue 1: 22-26. DOI: 10.15414/jmbfs.2017.7.1.22-26.

5. Giuliana D. Noratto, Nara N. Lage, Boon P. Chew, Susanne U. Mertens-Talcott, Stephen T. Talcott, Maria L. Pedrosa, 2018. Non-anthocyanin phenolics in cherry (*Prunus avium* L.) modulate IL-6, liver lipids and expression of PPAR δ and LXRs in obese diabetic (db/db) mice, *Food Chemistry* 266: 405–414.
6. Răuță C., Chiriac Aurelia, 1980. *Plant Analysis Methodology for Mineral Nutritional State assessment*, ICPA Bucharest (published in Romanian).
7. R. Chris Skinner, Joseph C. Gicliotti, Kang-Mo Ku, Janet C. Tou, 2018. A comprehensive analysis of the composition, health benefits, and safety of apple pomace, *Nutrition Reviews*, Volume 76, Issue 12: 893-909. DOI10.1093/nutrit/nuy033).
8. National Statistical Institute, 2023, *Romania Statistic Annual, 2023*. I.S.S.N.: 1220 – 3246, I.S.S.N.-L: 1220 – 3246.
9. *Statistical Year Book, World Food and Agriculture, 2023*. Food and Agriculture Organization of the United Nations, ISBN 978-92-5-138262-2.

Tables and figures

Table 1. The experimental schema

Species	Variety/Rootstock	Fertilization variants
Apple	Jonagold Boerekamp/M 9 Red Braeburn/M 9 Jonagold Novajo/M 9	V ₁ unfertilized control V ₂ PolyFeed V ₃ Fertisol V ₄ CropMax V ₅ product M1 V ₆ product M2 V ₇ product F
Sweet cherry	Regina/GiSeIA 3 Regina/GiSeIA 5 Regina/GiSeIA 12 Regina/Weigi 2	V ₁ unfertilized control V ₂ CropMax V ₃ Fertisol V ₄ PolyFeed

Table 2. Foliar diagnosis of the samples collected before the beginning of the experiment (2019) as compared to values cited in literature (Răuță and Chiriac, 1980)

Species	Nt %	P %	K %	Ca %	Mg %	Zn mg/kg	Cu mg/kg	Fe mg/kg	Mn mg/kg
Apple	1.24	0.15	2.2	0.79	0.24	13.1	5.1	150	17.6
	0.68	0.16	1.2	1.08	0.32	3.3	26.2	180	10.8
Sweet cherry	1.67	0.13	2.6	1.02	0.21	4.8	4.8	131	13.0
	2.18	0.17	2.3	0.49	0.21	28.8	6.9	117	15.9
normal contents ranges									
Apple	2.5-2.7	0.13-0.20	1.4-1.7	0.7-1.0	0.25-0.40	25-50	6-12	20-200	25-140
Sweet cherry	2.03-3.30	0.16-0.22	1.67-2.08	0.90-3.00	-	~ 29	5-57	30-70	~ 195

Table 3. Statistical parameters of the mineral elements content values in apple leaves collected in the first experimental year (2020) as compared to values cited in literature (Răuță and Chiriac, 1980)

Statistical parameters	N %	P %	K %	Ca %	Mg %	Zn mg/kg	Cu mg/kg	Mn mg/kg	Fe mg/kg
\bar{x}	2.41	0.19	1.60	1.21	0.29	10.0	7.0	56.8	110.6
Me	2.37	0.19	1.61	1.20	0.29	7.9	6.3	55.4	108.2
Mo	2.25	0.15	1.60	1.00	0.31	7.8	6.0	48.1	89.7
σ	0.20	0.04	0.27	0.24	0.05	5.9	1.9	17.2	26.9
X _{min}	2.00	0.13	1.06	0.73	0.20	0.4	4.7	30.5	76.7
X _{max}	2.84	0.27	2.25	1.84	0.41	26.5	14.3	106.4	213.6
normal contents ranges	2.5-2.7	0.13-0.20	1.4-1.7	0.70-1.00	0.25-0.40	25-50	6-12	25-140	50-400

Table 4. Differences registered between the leaves mineral elements contents depending on the apple variety

Variety	Nt %	P %	K %	Ca %	Mg %	Zn %	Cu %	Mn %	Fe %
Jonagold	2.25 a	0.16 a	1.39 a	1.14 a	0.25 a	6.3 a	6.6a	42.2 a	97.9 a
Boerekamp	2.45 b	0.20 b	1.63 b	1.05 a	0.33 c	8.5 a	7.2 a	58.4 b	116.8 b
Jonagold Novajo	2.53 b	0.21 b	1.80 b	1.45 b	0.29 b	15.3 b	7.2 a	69.8 c	117.1 b

Table 5. Differences registered between the leaves mineral elements content depending on the fertilization variant

Variety	Nt %	P %	K %	Ca %	Mg %	Zn %	Cu %	Mn %	Fe %
Unfertilized control	2.38 a	0.20 ab	1.56 abc	1.25 a	0.29 a	9.0 ab	5.7 a	49.3 a	110.9 a
M1 0.5%	2.41 a	0.19 ab	1.63 bc	1.12 a	0.29 a	11.8 b	10.0 b	57.6 ab	101.6 a
M2 0.5%	2.36 a	0.20 ab	1.82 d	1.25 a	0.24 a	11.1 b	9.2 b	65.9 b	109.5 a
Cropmax 0.2%	2.38 a	0.19 ab	1.56 abc	1.26 a	0.31 a	10.0 ab	5.9 a	56.8 ab	110.4 a
Fertisol 2 kg/pom	2.42 a	0.17 a	1.74 cd	1.24 a	0.28 a	9.3 ab	6.2 a	59.0 ab	113.7 a
F 1%	2.46 a	0.21 b	1.42 a	1.16 a	0.29 a	11.9 b	6.1 a	57.9 ab	115.5 a
Polyfeed 1%	2.47 a	0.19 ab	1.52 ab	1.24 a	0.28 a	7.2 a	6.0 a	51.4 a	112.6 a

Table 6. Statistical parameters of the mineral elements content values in cherry leaves collected in the first experimental year (2020) as compared to values cited in literature (Răuță and Chiriac, 1980)

Statistical parameters	N %	P %	K %	Ca %	Mg %	Zn mg/kg	Cu mg/kg	Mn mg/kg	Fe mg/kg
\bar{x}	2.95	0.28	2.13	1.31	0.29	21.6	11.6	128.1	82.2
Me	2.89	0.28	2.20	1.25	0.29	21.2	12.1	111.2	74.5
Mo	2.72	0.27	2.10	1.18	0.22	20.9	9.2	46.8	28.0
σ	0.30	0.03	0.42	0.32	0.06	7.4	1.8	61.8	32.6
X _{min}	2.20	0.26	1.01	0.59	0.16	9.2	8.4	46.8	28.0
X _{max}	3.76	0.35	2.88	2.24	0.43	47.3	15.1	426.1	192.6
normal contents ranges	2.03-3.30	0.16-0.22	1.67-2.08	0.90-3.00	-	~ 29	5-57	30-70	~ 195

Table 7. Differences registered between the leaves mineral elements content depending on the cherry rootstock

Rootstock	Nt %	P %	K %	Ca %	Mg %	Zn %	Cu %	Mn %	Fe %
GiSelA 3	2.92 ab	0.30 b	2.34 b	1.21 a	0.25 a	25.1 b	13.1 c	152.8 b	68.7 a
GiSelA 5	3.18 c	0.27 a	2.32 b	1.11 a	0.23 a	25.8 b	9.7 a	158.3 b	68.7 a
GiSelA 12	2.97 b	0.28 ab	1.73 a	1.65 b	0.32 b	21.6 b	12.8 c	123.2 b	113.2 b
Weigi 2	2.73 a	0.29 b	2.14 b	1.26 a	0.35 c	14.0 a	10.8 b	77.9 a	75.8 a

Table 8. Differences registered between the leaves mineral elements contents depending on the fertilization variant

Variety	Nt %	P %	K %	Ca %	Mg %	Zn %	Cu %	Mn %	Fe %
Unfertilized control	2.89 a	0.27 a	2.41 b	1.36 a	0.29 a	20.8 a	11.3 a	126.1 ab	78.8 ab
Cropmax 0.2%	2.87 a	0.29 a	1.96 a	1.18 a	0.28 a	18.8 a	11.2 a	108.1 a	95.8 b
Fertisol 2 kg/pom	3.14 b	0.30 a	2.07 a	1.33 a	0.30 a	25.2 b	12.3 b	157.6 b	86.0 ab
Polyfeed 1%	2.90 a	0.28 a	2.09 a	1.35 a	0.28 a	21.7 ab	11.5 ab	120.5 ab	68.2 a

Table 9. Statistical parameters of the mineral elements content values in the apple leaves collected from the experimental field as compared to the normal content values (full grown leaves) cited by literature (Răuță and Chiriac, 1980)

Statistical parameters	N %	P %	K %	Ca %	Mg %	Zn mg/kg	Cu mg/kg	Mn mg/kg	Fe mg/kg
\bar{x}	2.29	0.26	1.61	1.73	0.32	33.4	8.3	160.9	122.4
Me	2.21	0.25	1.61	1.62	0.32	32.8	7.4	154.0	109.0
Mo	2.18	0.23	1.13	1.21	0.32	31.6	7.1	142.0	90.0
σ	0.31	0.06	0.34	0.52	0.05	13.7	3.1	31.0	45.0
Xmin	1.54	0.16	0.99	0.71	0.17	10.6	4.5	98.0	73.0
Xmax	2.98	0.40	2.86	3.43	0.42	74.5	23.7	227.0	317.0
normal contents intervals	2.5-2.7	0.13-0.20	1.4-1.7	0.70-1.00	0.25-0.40	25-50	6-12	25-140	50-400

Table 10. Differences registered between leaves mineral content depending on the apple variety

Variety	Nt %	P %	K %	Ca %	Mg %	Zn mg/kg	Cu mg/kg	Mn mg/kg	Fe mg/kg
Jonagold Boerekamp	2.03 a	0.31 c	1.87 b	1.36 a	0.27 a	25.6 a	7.3 a	152.8 b	105.2 a
Red Braeburn	2.64 c	0.25 b	1.51 a	2.02 b	0.34 b	29.6 a	8.4 ab	191.8 c	129.8 b
Jonagold Novajo	2.19 b	0.22 a	1.45 a	1.80 b	0.35 b	44.93 b	9.3 b	138.0 a	134.8 b

Table 11. Differences registered between mineral elements content in apple leaves depending on fertilization variants

Variety	Nt %	P %	K %	Ca %	Mg %	Zn %	Cu %	Mn %	Fe %
Unfertilized control	2.28 bc	0.29 e	1.51 b	1.58 a	0.30 a	23.6 a	6.0 a	157.7 ab	123.8 a
M1 0.5%	2.20 a	0.25 cd	1.55 b	1.82 a	0.32 a	38.5 b	12.0 b	166.6 b	111.67 a
M2 0.5%	2.24 bc	0.27 cde	1.81 cd	1.86 a	0.33 a	38.1 b	11.8 b	159.4 ab	118.8 a
Cropmax 0.2%	2.22 bc	0.27 cde	1.54 a	1.81 a	0.31 a	36.1 b	7.1 a	165.7 ab	145.2 a
Fertisol 2 kg/pom	2.34 bc	0.22 a	1.86 d	1.73 a	0.31 a	35.3 b	7.4 a	176.2 b	118.0 a
F 1%	2.38 b	0.25 b	1.40 a	1.80 a	0.34 a	31.7 ab	7.1 a	157.4 ab	131.8 a
Polyfeed 1%	2.35 bc	0.28 de	1.60 bc	1.49 a	0.32 a	30.3 ab	6.8 a	143.0 a	107.2 a

Table 12. Statistical parameters of the mineral elements content values in cherry leaves collected from the experimental lot, as compared to normal contents values cited by literature (Răuță and Chiriac, 1980)

Statistical parameter	N %	P %	K %	Ca %	Mg %	Zn mg/kg	Cu mg/kg	Mn mg/kg	Fe mg/kg
\bar{x}	2.73	0.30	2.60	1.39	0.33	20.0	7.1	98.8	112.0
Me	2.71	0.30	2.58	1.39	0.32	14.8	7.0	97.5	91.5
Mo	2.44	0.29	2.12	1.20	0.30	8.3	6.7	89.0	64.0
σ	0.28	0.06	0.41	0.40	0.06	12.2	0.9	24.0	63.9
Xmin	2.27	0.19	1.59	0.45	0.20	5.6	5.7	41.0	43.0
Xmax	3.48	0.43	4.14	2.04	0.44	44.9	10.4	149.0	310.0
Normal contents intervals	2.03-3.30	0.16-0.22	1.67-2.08	0.90-3.00		~ 29	5-57	30-70	~ 195

Table 13. Differences registered between mineral elements content in Regina cherry leaves depending on rootstock

Rootstock	Nt %	P %	K %	Ca %	Mg %	Zn %	Cu %	Mn %	Fe %
GiSelA 3	2.81 c	0.37 c	2.50 a	1.60 b	0.41 c	32.8 b	8.1 b	119.4 b	157.4 c
GiSelA 5	3.03 d	0.30 b	2.44 a	1.26 a	0.29 a	14.1 a	6.9 a	86.3 a	94.0 bc
GiSelA 12	2.63 b	0.28 b	2.77 a	1.35 a	0.28 a	17.6 a	6.8 a	107.8 b	127.8 cd
Weigi 2	2.44 a	0.23 a	2.69 a	1.33 a	0.34 b	15.3 a	6.5 a	81.6 a	68.7 a

Table 14. Differences registered between the mineral elements content in Regina cherry leaves depending on fertilization variants

Variant	Nt %	P %	K %	Ca %	Mg %	Zn %	Cu %	Mn %	Fe %
Unfertilized control	2.66 a	0.31 a	2.63 ab	1.18 a	0.32 a	19.9 ab	6.9 a	97.ab	107.0 a
Cropmax 0.2%	2.63 a	0.29 a	2.34 a	1.19 a	0.32 a	13.7 a	6.8 a	111.1 b	86.6 a
Fertisol 2 kg/pom	2.89 b	0.28 a	2.79 b	1.65 b	0.33 a	23.6 b	7.4 b	90.5 a	129.1 a
Polyfeed 1%	2.73 a	0.30 a	2.64 ab	1.52 b	0.34 a	22.7 b	7.3 ab	96.5 ab	125.2 a

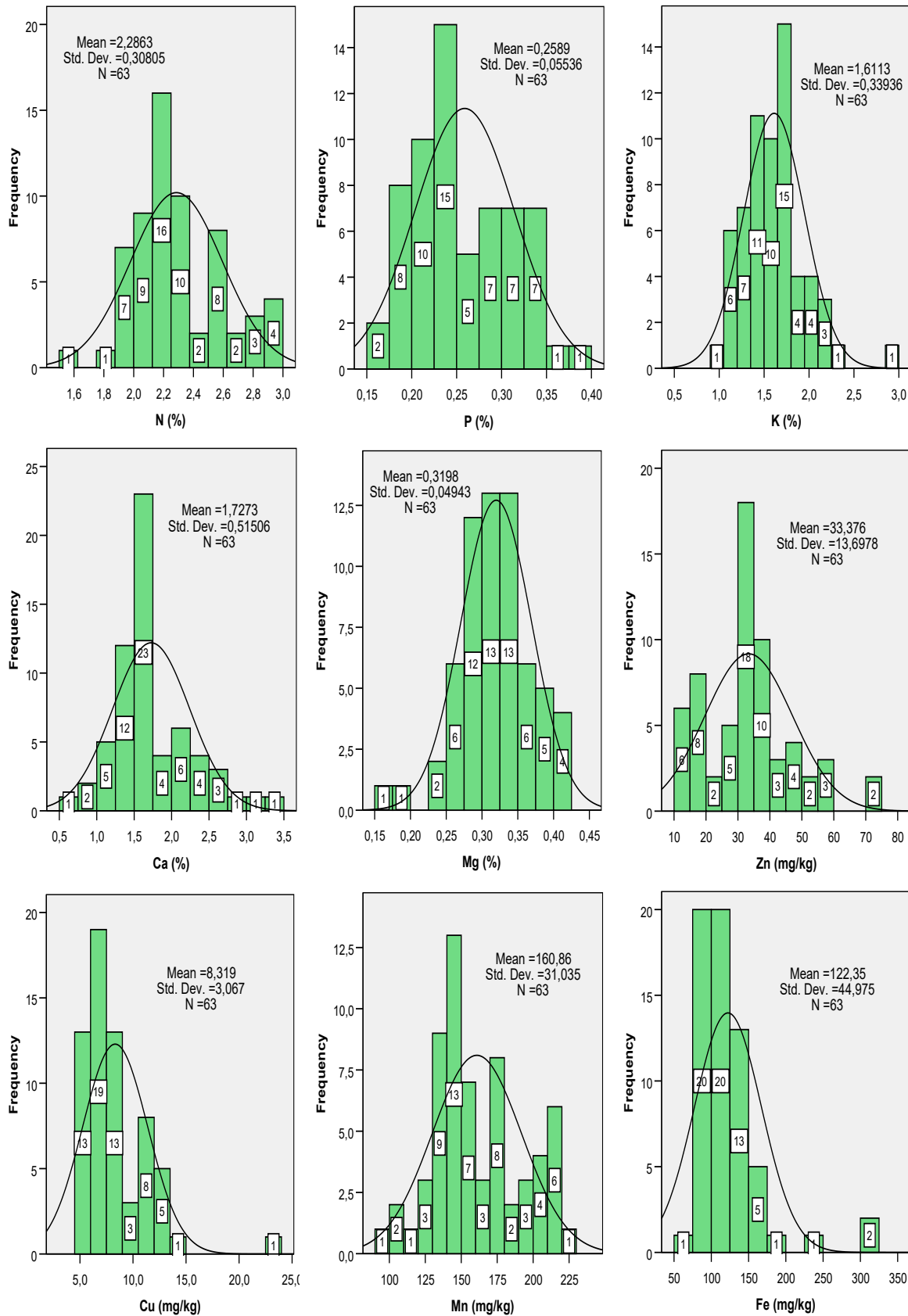


Fig. 1. Distribution histograms of mineral elements content values from apple leaves (2021)

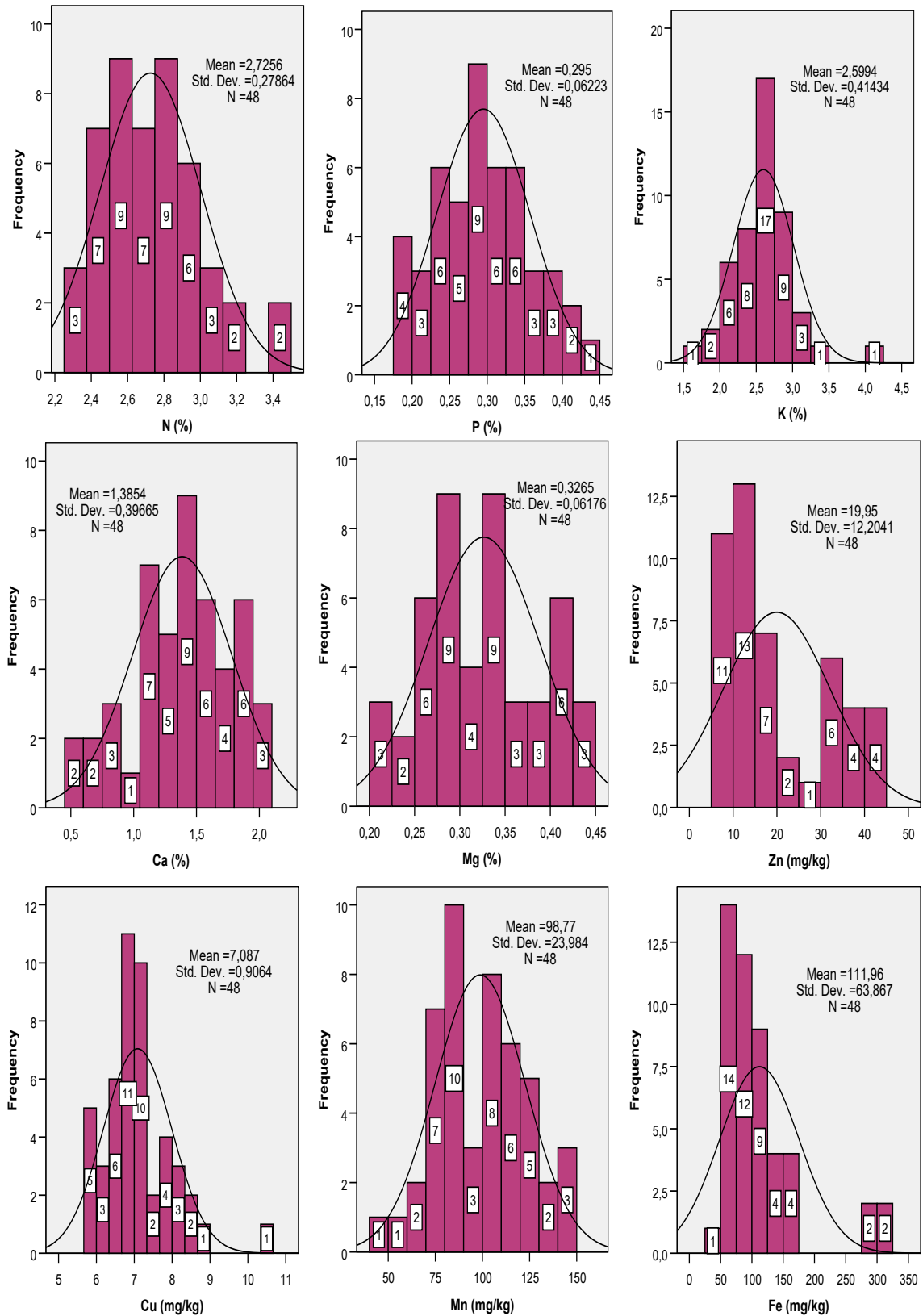


Fig. 2. Distribution histograms of mineral elements content values from cherry leaves (2021)