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The effect of nitrogen on the growth and development of grafted cuttings from the nursery

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ABSTRACT

The complex of agrotechnical measures that ensure a high yield of standard planting material and a favorable impact on the growth and development of woody plants is represented by both the grafting technique and the nutritional elements applied in the nursery. This paper studies the effect of nitrogen on the growth and development of grafted cuttings of four table grapes cultivars 'Argessis', 'Norocel', 'Memory', and 'Ştefăneşti', grafted on SO4-4 rootstock, planted in the nursery located on a specific soil of Stefanesti Arges viticultural center. After forcing, the grafted cuttings were paraffined with silver paraffin planted in a protected (solar) space, and subjected to 2 fertilization treatments with increased doses of nitrogen: 100 of the Optimal Dose and 75% of the D.O. Increased amounts of nitrogen positively influenced vegetative growth but inhibited root development, regardless of the cultivar. The length of the main shoots oscillated between 43.36 cm when applying 100% DO fertilization to the 'Argessis 'cultivar and 17.88 cm for 75% D.O. fertilization, to the 'Memory' cultivar. On the other hand, the total 100% D.O. fertilization led to a decrease in the diameter of the roots, for the first 3 main roots measured.

Keywords: nursery, vine, grafting, rootstock SO4-4, local cultivars

INTRODUCTION

Fertilizers are used to supplement certain soil nutrients when native nutrient levels and soil processes are not sufficient to supply those nutrients for optimum plant growth. N, P, and K are the three major elements used in plant growth. Their utilization is described below. Nitrogen (N) – Of all the essential elements, nitrogen is often the one most limiting for optimum plant growth. Adequate nitrogen produces vigorous growth and a green color. Most of the nitrogen in soils is present as part of the organic matter and becomes available for use by plants as organic matter is decomposed by soil microorganisms. The amount of nitrogen provided by these natural soil processes is generally not enough to maintain the vigorous growth of most plants, therefore, supplemental nitrogen from fertilizer is usually required. One of the main conditions for obtaining high-quality planting material, along with ensuring moisture, is a sufficient amount of nutrients in the soil. Verzilin *et al*. (2020), recommend for soils with a low supply of nutrients the application of 75-95 t/ha of organic fertilizers which must be applied at the same time with plowing in the plantation, 750-950 kg of potassium and 650-850 kg of phosphorus fertilizers.
Grigoreva *et.al.* (2018), along with the main fertilizers, recommend foliar feeding with manganese, boric acid, zinc sulfate, and ammonium sulfate. Recent studies (Romanenko, 2020; Volkova *et. al.,* 2020; Duong and Pushkareva, 2020; Venkitasamy *et. al.,* 2019)

recommend a 0.005% sodium humate solution for both root and foliar application, noting not only an improvement in product quality but also an increase in soil fertility. In a study on obtaining a high yield of vigorous grafted vines with a well-developed root system and mature shoots, Grighel and Dadu (2014) recommend the application of organic fertilizers (20–60 t/ha) before planting and minerals N_{140}: P_{100}: K_{80} applied after planting the grafted cuttings throughout the growth and development period, depending on the type of soil. In addition, they recommend additional nutrition for irrigation - manure juice (1:10) or chicken manure (1:3-5), plus nitrogen fertilizers, in the first half of the growing season - fertilizers with phosphorus and potassium (10 - 30 kg/ha s.a.). Our study evaluates the effect of nitrogen fertilization on the yield and quality of grapevine cuttings in nurseries.

MATERIALS AND METHODS

The experiment was carried out at INCDBH Stefanesti, in the Laboratory of Ecology and Multiplication of Horticultural Species aiming to improve the production technologies of viticultural propagation material, in the current context of climate change. Four local cultivars were chosen for table grapes ('Argessis', 'Norocel', 'Memory', and 'Ștefănești'), grafted on the SO4-4 rootstock. The grafting was done at the table, towards the end of February. To be used for grafting, the grafted eyes were moistened for 24 hours at a temperature of 30°C, for 30 hours at a temperature of 30°C, and in the grafting process, paraffin with stimulators was used. After fortification, were analyzed the following parameters: the starting in vegetation, the length and diameter of the main roots and the callus formation.

Before planting in the nursery, for better protection, a paraffin treatment was applied, using silver color paraffin. Paraffin before forcing, which was performed immediately after grafting, aimed to prevent the negative effect of some environmental factors in the process of callus and attachment to grafting. Paraffin the grafted vines before planting in the school of vines was aimed at avoiding dehydration and protecting the young shoots from solar radiation, to increase the yield of grafted vines and raise work productivity. The rooted cuttings were planted in raised earth mounds covered with polyethylene film, the planting system in double rows (with a width of 20 cm), resulting in 3900, in a protected space of 300 m^2. During the plant development period, two fertilizations options, using N:P:K (30:10:10), were applied weekly for 8 weeks, by fertigation: V1 100% of the recommended optimal dose (D.O.) and V2- 75% of the D.O. The amounts of fertilizers calculated for the 3900 vine cuttings were 200 kg N:P:K (30:10:10) in case of V1 and 150 kg. N:P:K (30:10:10) in V2, respectively 60 Kg N, 20 Kg P_2O_5 and 20 kg K_2O, applied in V1 (optimal recommended dose) and 45 kg N, 15 kg P_2O_5 and 15 Kg K_2O, applied in V2.

During the entire growth period of the grafted cuttings, drip irrigation was applied. In October, the following indicators were monitored: shoot length (cm), shoot diameter (mm), number of roots, length of the 3 main roots, and diameter of the 3 main roots.

To highlight the differences between the effect of nitrogen on the indicators analyzed during the study was applied the Duncan test (test with multiple intervals) for a statistical assurance of 5% as well as simple descriptive statistics that show the minimum and maximum values recorded for each indicator depending on the applied fertilization dose.

REZULTS AND DISCUSSIONS

The management of temperature and air humidity during the forcing period

In the experiment, from the beginning of the forcing process, the temperature was 30°C during the first three days, after which it decreased, remaining constant until the end of the forcing period, namely the 11^{th} - 18^{th} day (Table 1).

Table 1. Evolution of temperature and air humidity during the forcing cycle

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Temperature ºC	30					29	29	28	28	28	27	27	27	27	26	26	25	25
Air humidity %	85-95										85	85	85	80	80	75	75	75

A good percentage regarding the start in vegetation was registered in case of 'Argessis' *cv.* (100%), having 10% higher start in vegetation compared to the 'Stefăneşti' *cv.* The 'Norocel' and 'Memory' *cvs*. (table 2) also stood out with good results regarding the start of vegetation, under the conditions of keeping the environmental factors presented in Table 1. After forcing, the 'Argessis' cultivar showed the highest shoot growth (12.7 cm), compared to only 6.24 cm, 6.02 cm, respectively 4.28 cm as recorded in the other cultivars (table 2). Regarding the diameter of the roots, it was higher in case of 'Memory' cultivar (1.4 mm), followed by the 'Argessis cultivar (1.1 mm).

Table 2. The influence of physical processes on the grafting process

Cultivar	Callus width (cm)	Callus percentage (%)	Percent start in vegetation (%)	Shoot length (cm)	Root diameter (mm)
Argessis	1,26	82	100	12.7±1.11	1.1±0.19
Norocel	1.14	60	95	6.24±0.48	0.87±0.12
Memory	1.08	87	96	6.02±0.22	1.4±0.24
Ştefăneşti	0.96	40	90	4.28±0.21	0.6±0.33

The effect of fertilization on the growth of grafted cuttings from the nursery

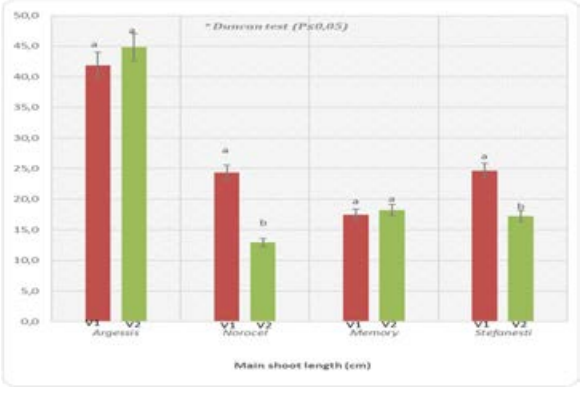

Figure 1. The influence of fertilization on shoot length (cm), depending on the cultivar

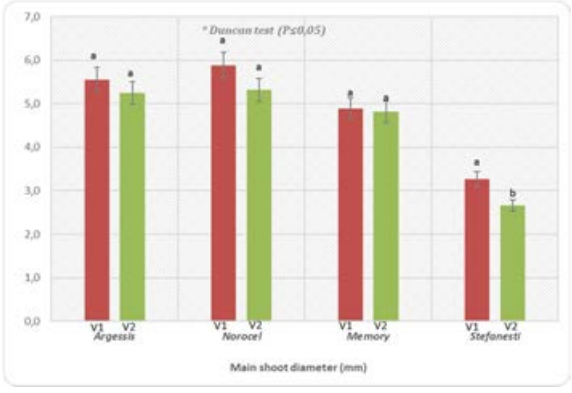

Figure 2. The influence of fertilization on the diameter of the shoots (mm), depending on the cultivar

**Letters in the graph that are not common represent statistical differences according to the Duncan test*

From Figure 1 it can be seen that fertilization influenced the growth of the shoots in the nurseries, regardless of the cultivar. Thus, the greatest growth of shoots was recorded in V1, the differences being significant. Except for 'Argessis' *cv*., where the highest increases were evident in V2 (75% D.O) with 44.84 cm, compared to 41.88 cm, as recorded in V1 (100% D.O nitrogen), in all other cultivars the largest increases were evident in the case of applying the optimal fertilization with nitrate (V1). Regarding the diameter of the shoots, it was higher in V1 (100% D.O nitrogen), even if the differences are not significant (Figure 2). The highest values were evident in the 'Norocel' *cv.* (5.8 mm) in V1. The same significant differences are also observed regarding the number of roots. It was higher in the case of V1, regardless of the cultivar, the differences being significant (figure 3)

For the 4 cultivars of table grapes grafted on the SO4-4 rootstock and planted in the nursery in the protected space, the average values of the length of the vegetative growths (shoots) were 25.23 cm and the maximum values for the whole experiment were 66.20 cm. Also, for the diameter of shoot growth and the total number of roots, the minimum values were 2.52 and 5.0, and the maximum values were 2.67 mm and 30 roots (Table 3). It can be seen that by applying fertilization, the histogram regarding these indicators is much different, the sample is no longer homogeneous due to the effect of the experimental variants (Figure 4). The highest shoots growth was recorded in 'Argessis' *cv.*, while 'Ştefăneşti' *cv.* recorded the highest number of roots (figure 5), in response to the application of D.O. with nitrogen (V1), figure 4.

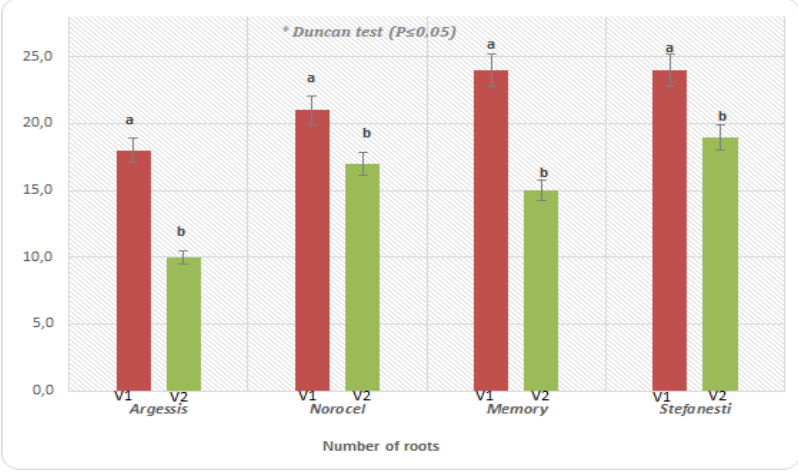

Figure 3. The influence of fertilization on the number of roots depending on the cultivar
**Letters in the graph that are not common represent statistical differences according to the Duncan test*

Table 3. Statistical indicators of growth vigor indicators: shoot length (cm), shoot diameter (mm), number of roots in the analyzed cultivars, from the nursery in the protected area, 2024 at INCDBH Stefanesti

Statistic indicator		Shoot length (cm)	Shoot diameter (mm)	Number of roots
N	Valid	40	40	40
Mean		25.2275	4.7190	18.3750
Median		20.5000	4.9050	19.0000
Mode		14.80(a)	2.52(a)	18.00
Std. Deviation		12.95410	1.34116	6.12974
Skewness		1.500	.086	-.325
Std. Error of Skewness		.374	.374	.374
Kurtosis		1.903	-.298	-.230
Std. Error of Kurtosis		.733	.733	.733
Range		54.90	5.15	25.00
Minimum		11.30	2.52	5.00
Maximum		66.20	7.67	53.00

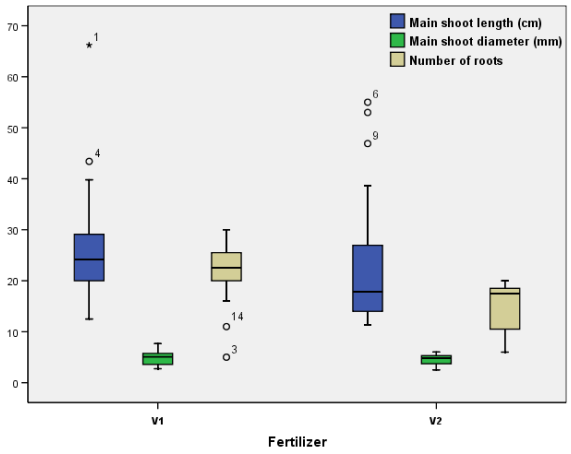

Figure 4. Box-plot, with the distribution of the values recorded on vegetative growth (minimum, maximum and average) and the influence of the fertilization regime

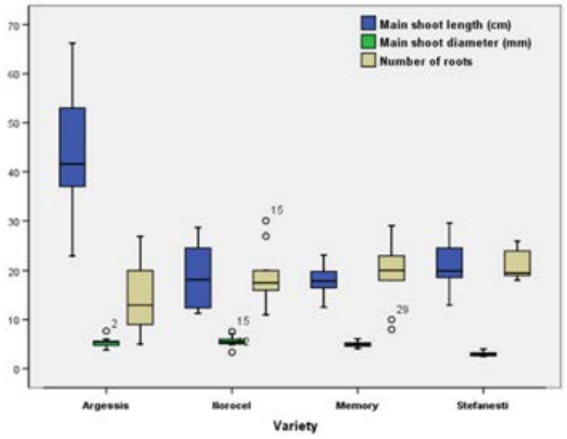

Figure 5. Box-plot, with the distribution of the values recorded on vegetative growth (minimum, maximum, and average) and the influence of the cultivar

The optimal dose of nitrogen application (V1) inhibited the growth of the main roots, leading to significant differences in the length of the 3 main roots in the 'Argessis' and 'Memory' *cvs.* (figures 6, 7 and 8). In the 'Argessis' *cv.* the greatest growth of the main root was recorded in V2 (75% D.O. nitrogen) with 22.14 cm, compared to V1 where only 15.02 cm were recorded. Significant differences regarding the growth of the main root were also evident in the 'Memory' *cv*., which recorded 22.7 cm in V2, compared to 8.9 cm as was evident in V1, a sign that the optimal dose (100% D.O. nitrogen) negatively influenced the root development, in case of this cultivar. It should be noted that the 'Stefăneşti' *cv.* responded positively to the application of the optimal dose of nitrogen (100% D.O nitrogen), recording the largest root growths of 26.18 cm in V1 compared to 11.38 cm recorded in V2. However, the secondary roots induced the greatest increases in V2, a sign that the optimal recommended dose (100% D.O. nitrogen) inhibited the growth of the secondary roots. (figure 7), except for the 'Norocel' and 'Memory' *cvs.*

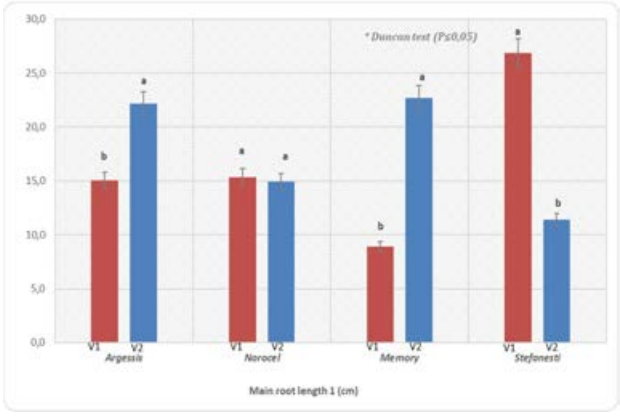

Figure 6. The influence of fertilization on the main root length (cm) , depending on the cultivar

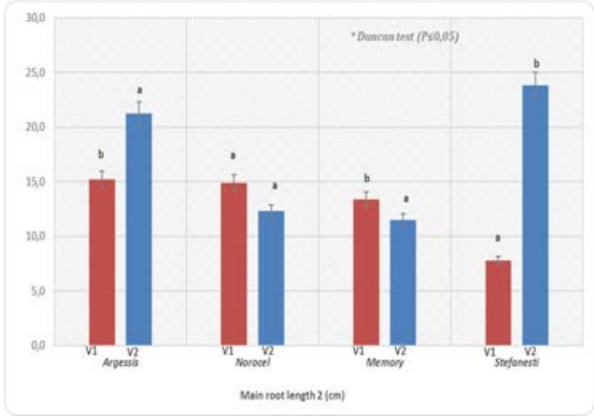

Figure 7. The influence of fertilization on the secondary root length (cm), depending on the cultivar

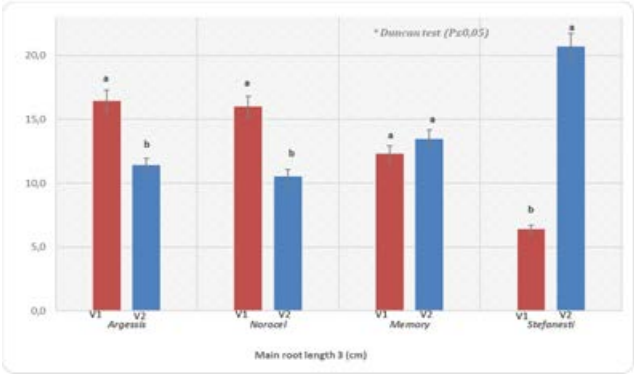

Figure 8. The influence of fertilization on the 3rd root length (cm), depending on the cultivar
**Letters in the graph that are not common represent statistical differences according to the Duncan test*

For all the 3 analyzed roots, the largest diameter was recorded in V2 (75% D.O nitrogen), a sign that high amounts of nitrogen led to the inhibition of growth in diameter, regardless of the cultivar, the differences between the two fertilization options being significant (Figures 9,10 and 11). The largest increases in diameter for the main root were recorded in the 'Norocel' *cv.* with 3.24 mm, in V2, compared to 2.13 mm as recorded in V1. The smallest increases were recorded in the 'Ştefăneşti' *cv*., between 1.86 mm (in V1) and 1.67 mm in V2, the differences being insignificant. (Figure 9). The same differences recorded in V2 were also highlighted in the case of the diameter of the secondary roots, respectively, of the third analyzed root (fig, 10 and 11), regardless of the cultivar.

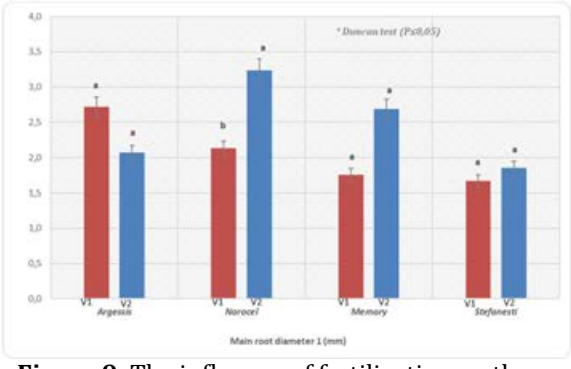

Figure 9. The influence of fertilization on the diameter of the main root (mm), depending on the cultivar

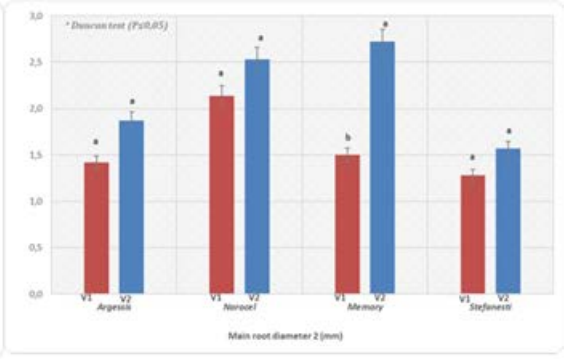

Figure 10. The influence of fertilization on the diameter of the secondary root (mm), depending on the cultivar

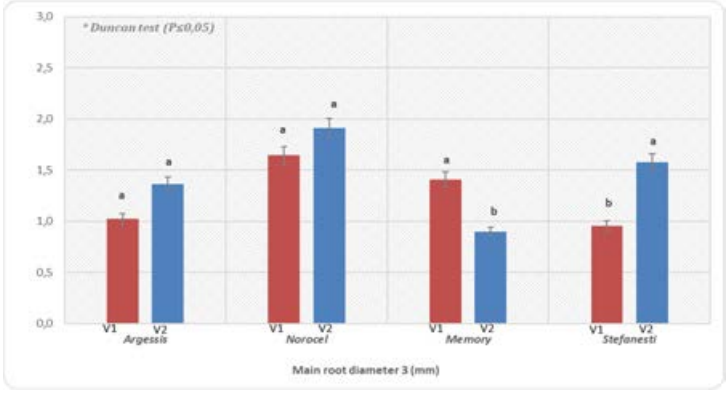

Figure 11. The influence of fertilization on the diameter of the third root (mm), depending on the cultivar

Table 4 shows the maximum and minimum values recorded on the growth of the main roots as well as their diameter. In the figures corresponding to the analyzed values, on the average of the cultivars it can be observed that V2 induced the greatest growth of the main roots, as well as their largest diameter (figures 12,13, 14, 15).

Table 4. Statistical indicators of growth vigor indicators: length of the main root (cm), diameter of the main root (mm), number of roots in the analyzed cultivars, from the nursery in the protected area, 2024 at INCDBH Stefanesti

		Main root length 1 (cm)	Main root length 2 (cm)	Main root length 3 (cm)	Main root diameter 1 (mm)	Main root diameter 2 (mm)	Main root diameter 31 (mm)
N	Valid	40	40	40	40	40	40
	Missing	0	0	0	0	0	0
Mean		17.1575	15.0225	13.3600	2.1530	1.8793	1.3485
Median		15.6500	13.6500	12.2500	2.0100	1.7300	1.4150
Mode		10.30(a)	13.20(a)	9.30(a)	2.12(a)	1.74(a)	0.90(a)
Std. Deviation		6.96205	6.06340	5.44637	0.62526	0.77777	0.51227
Skewness		0.652	0.648	0.945	0.420	1.353	0.183
Std. Error of Skewness		0.374	0.374	0.374	0.374	0.374	0.374
Kurtosis		-0.222	-0.100	1.600	-0.431	3.730	-0.193
Std. Error of Kurtosis		0.733	0.733	0.733	0.733	0.733	0.733
Range		27.50	25.50	27.00	2.68	4.28	2.26
Minimum		8.00	4.80	4.00	0.82	0.51	0.37
Maximum		35.50	30.30	31.00	3.50	4.79	2.63

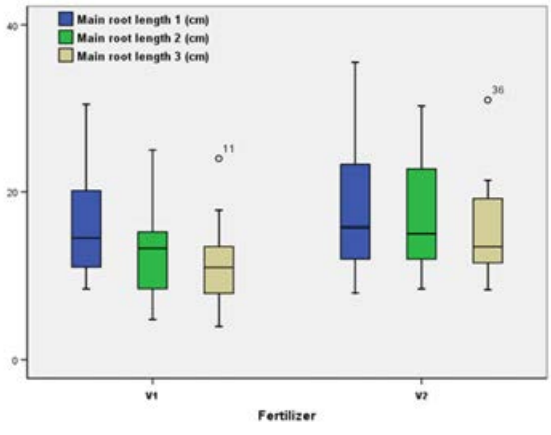

Figure 12. Box-plot, with the distribution of the values recorded on the growth of the main roots (minimum, maximum and average) and the influence of the fertilization regim

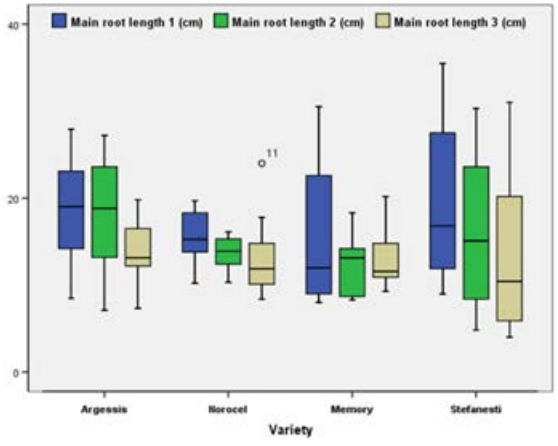

Figure 13. Box-plot, with the distribution of the values recorded on the growth of the main roots (minimum, maximum and average) and the influence of the cultivar

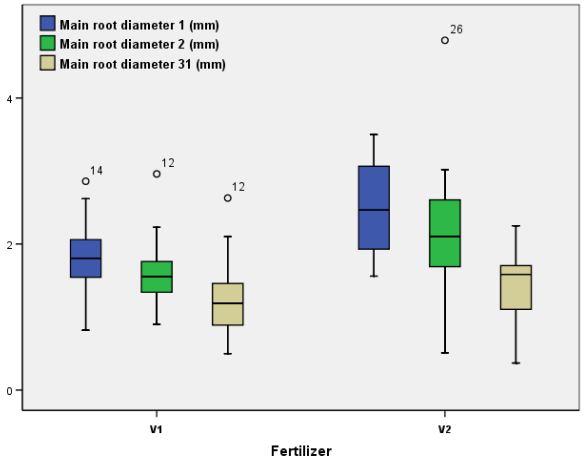

Figure 14. Box-plot, with the distribution of the values recorded on the diameter of the 3 main analyzed roots (minimum, maximum, and average) and the influence of the fertilization regime

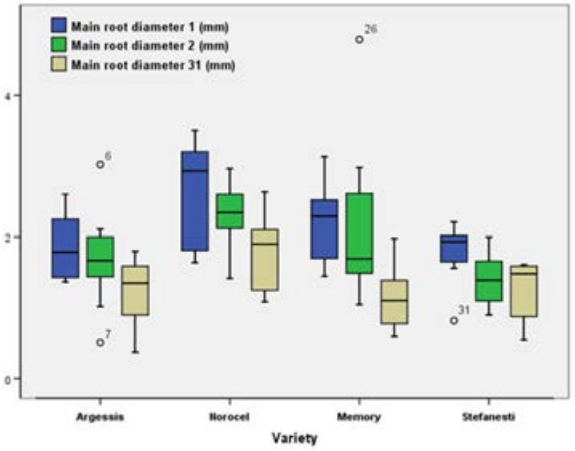

Figure 15. Box-plot, with the distribution of the values recorded on the diameter of the 3 main analyzed roots (minimum, maximum, and average) and the influence of the cultivar

CONCLUSIONS

Research on the influence of the recommended optimal dose (V1- 100% D.O. of nitrogen) on vegetative growth led to improved results in terms of shoot growth and diameter, as well as the number of roots formed. The length of the main shoots oscillated between 43.36 cm when applying 100% DO fertilization to the 'Argessis' cultivar and 17.88 cm for 75% D.O. fertilization, to the 'Memory' cultivar. At the same time, a dose low to the optimal level of nitrogen (75% D.O. nitrogen) improved both root length and diameter. Since there are no studies on the influence of nitrogen on shoot quality in the nurcery, further studies are needed over several years, because nitrate is not tightly held by soil particles and is soluble in soil water, and because of the mobility of nitrogen, soil tests for nitrogen are valid for shorter periods than most other elements.

REFERENCES

1. Grighel Gh, and Dadu C., (2014). Fertilizarea plantaţiilor mamă altoi, portaltoi şi a şcolii de viţe. Pomicultura, Viticultura şi Vinificaţia nr. 3 [51]
2. Grigoreva L. V., (2018). Biological growth peculiarities of the cuttings of various rootstocks in a horizontal nursery, International Journal of Pharmaceutical Research, **10(4)**, 632-640
3. Romanenko E. S., (2011). Biologically active preparations with growth-stimulating activity in viticulture. Winemaking and viticulture, **3**, 44 https://elibrary.ru/item.asp?id=16549657
4. Venkitasamy C., Zhao L., Zhang R.,and Pan Z., (2019). Grapes Integrated Processing Technologies for Food and Agricultural By-Products, 133-163 E3S Web of Conferences **210**, 05003 (2020) *ITSE-2020* https://doi.org/10.1051/e3sconf/202021005003 6.
5. Verzilin Al, Fedulova Y.,and PimkinM ,(2020). New biologically pure fertilizers in grape nurseries. E3S Web of Conferences 210, 05003 https://doi.org/10.1051/e3sconf/202021005003
6. Volkova M., Matveikina E., Volkov J .and Stranisheshevskaya E.,(2020). Organic viticulture as an important aspect of conserving biodiversity in Crimean agrocenoses. E3S Web of Conferences, **175**, 09004 DOI**:** 10.1051/e3sconf/202017509004