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EVALUATION OF THE FUNCTIONAL STATE OF PEACH VARIETIES (*PRUNUS PERSICA* Mill.) WHEN EXPOSED HYDROTHERMAL STRESS TO PLANTS

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ABSTRACT
The article presents data on the change in the ratio of pigments and fluorescence of chlorophyll in peach leaves in the optimal period of vegetation and under hydrothermal stress. When determining the resistance of a peach to unfavorable environmental factors, methods based on laboratory, fixed changes in the physiological and biochemical processes occurring in plants are used. In the period of inadequate water availability, the water deficit in peach leaves increased to an average of 15%, while less stable – an increase in the parameter to 18% was observed. It is shown that the xeromorphic character of the leaf apparatus is associated with a slight change in the anatomical characteristics of the leaf (the thickness of the leaf blade before and after the drought), which determines the permanence of the turgor. In this case, in the leaves of resistant varieties, the loss of turgor is insignificant (LSD ($p \leq 0.05$) = 7.24); the thickness of the leaf fluctuates within 0.20 mm. On the background of stress impact, a clear varietal difference was shown, which allowed us to develop a scale for a comparative assessment of the resistance of peach varieties and clones. During the active growth of the assimilation surface, an increase in the amount of green pigments in the leaves of experimental plants was noted. Perspective varieties of peach contain significantly higher amounts of chlorophylls compared to other varieties (LSD ($p \leq 0.05$) = 0.30). Under unfavorable conditions, in these varieties the ratio of the sum of chlorophylls to carotenoids is higher, which is confirmed by their more developed adaptive potential. Reorganization of the pigmentary apparatus during the period of hydrothermal stress is accompanied by an increase in the coefficient of photosynthetic activity (Kf_n) and a decrease in the fluorescence level (F_T) of chlorophyll. Thus, the water deficit, pigment composition and fluorescence of chlorophyll make it possible to identify the resistance of peach varieties and clones to the action of hydrothermal stressors. Based on the results of the studies, the most resistant varieties and clones of peaches have been identified for the humid subtropics of Russia (Larisa, Early bloy, Medin red, Slavutich, Donetskij zheltij, Vanity and Form 1).

Keywords: peach; humid subtropics; hydrothermal stress; pigments; fluorescence; water deficit; viability; sustainability

INTRODUCTION
Peach (*Prunus persica* Mill.) – is a perennial deciduous plant from East Asia, belonging to the family of rosaceous (*Rosaceae* Juss). The height of the tree is up to 5 – 8 m, the diameter of the trunk is up to 30 cm. Crown, depending on the variety, is broad-spread or back-pyramidal. Peach distinguishes leaf and flower buds, which are located in the axils of the leaves. Leaves are alternate, narrow-lanceolate with jagged edges. Flowering is abundant, lasts from 5 to 20 days, flowers – pink or campanulate **(Shaitan et al., 1989)**. In conditions of humid subtropics of Russia, a productive period with a fairly stable crop can last from 15 to 20 years. The silvicultural care of forest plantations for culture includes the use of systems for the formation of crowns, taking into account the age and variety, the use of fertilizers and phyto-processing, which contributes to the fruitfulness of the peach (in the amount of more than 25 $c.ha^{-1}$) from the third year of life **(Eremin, 2006; DeJong et al., 2004; Tworkoski and Takeda, 2007; Zec et al., 2013; Ryndin et al., 2016)**. Fruit ripening depending on the variety occurs from July to September, which makes it possible to provide the population with fresh fruits for a long period of time (**Eremin, 2006; Insausti and Gorjon, 2016**).

Peach is one of the leading drupaceous fruit crops, which, because of its high rate of fertility, is the most economically viable **(Cociu et al., 1985; Vietoris et al., 2014; Divis et al., 2017; Fikselova et al., 2018)**. The popularity of peach is great all over the world, it is grown in almost all European countries (Austria, France, Germany, Italy, Croatia, etc.), Asian countries (Afghanistan, Pakistan, Nepal, India, etc.), America (Argentine, Brazil, Bolivia, Peru, Venezuela, etc.), in the United States and Canada, in African countries (Kenya, Zimbabwe, Ethiopia, Egypt, etc.) and in the post-Soviet space (Armenia, Azerbaijan, Kazakhstan, Moldova, Tajikistan etc.). **(FAOSTAT, 2018; DeJong et al., 2004; Eremin and Eremina, 2014; Ryndin et al., 2016)**. In Russia it is grown (in Transcaucasia, Krasnodar Krai, Crimea and other regions), not only for domestic use, but also exported (on average 253 tons) to such countries as Mongolia, Belarus, Ukraine, etc. Demand for fruits peach is always quite high, so, only in 2017, in addition to its products, 185 thousand tons of fruits were imported to Russia, mainly from China and Serbia (on average, 28 – 29% of imports) **(Export and import of Russia by goods and countries, 2018)**.

Crops are high in vitamins, sugars, pectins and organic acids, a fairly large list of chemical elements (potassium, magnesium, calcium, zinc, manganese, etc.). The market annually offers new, more advanced varieties for resistance to abiotic and biotic stressors. It is no exception that complex studies conducted at the All-Russian Scientific Research Institute of Floriculture and Subtropical Crops (Sochi) aimed at identifying the most adaptive plants to biotic and abiotic factors with the output for obtaining stable-yielding, high-quality varieties (**Abilfazova, 2014; Abilfazova, 2016; Abilfazova, 2018; Ryndin et al., 2011; Smagin, 2014; Besedina et al., 2017)**. At this given moment, the collection of the Institute includes 58 varieties.

In humid subtropics of Russia, soil and climatic conditions are the limiting factors for this culture: the spring is cold and rainy, in summer there is air and soil drought against the background of high solar activity, air temperature up to 30 °C and above, relative humidity over 80% **(Abilfazova, 2014)**. These adverse conditions contribute to the weakening of the adaptive potential of the crop, which leads to a decrease in yield, a deterioration in the quality of products, and often also to plant death.

Scientific hypothesis

The most resistant varieties have a loss of turgor insignificant; higher amounts of chlorophylls; the ratio of the sum of chlorophylls to carotenoids is higher increase; and higher the coefficient of photosynthetic activity (Kf_n). The water deficit, pigment composition and fluorescence of chlorophyll make it possible to identify the resistance of peach varieties and clones to the action of hydrothermal stressors.

MATERIAL AND METHODOLOGY

Experimental varieties and clones were selected: Red Heaven, Larisa, Early red, Earley blow, Slavutich, Donetskij zheltij, Donetskij belij, Medinas red, Pamjat Grishko, Vanity, Osennij sjurpriz, Form 1 and Form 2. Plant was planting 2004 – 2008. Under the scheme of 5 x 2 m grown on the plantation of the experimental and technological department of the sector of fruit crops Institute. The stock of the AP – 1 ("Kuban" – 86).

The site soil – brown forest, residual-carbonate, depth 78 – 100 cm, humus content 1.39 – 2.95%, pH = 6.49 – 7.86. Agrotechnics common for cultivation of peach culture in conditions of humid subtropics of Russia provides V-shaped pruning with short annual pruning for fruiting **(Eremin, 2006)** and introduction of a fertilizer complex N120P90K90.

The selection of leaves for laboratory tests was carried out from june to september. As an indicator organ used physiologically mature leaves, which were the 7^{th} or 9^{th} leaf from the base of the sprout. To diagnose the varietal stability of the peach against unfavorable environmental conditions, the index of water deficiency, the content of photosynthetic pigments and an estimation of the functional state of plants by the parameters of slow induction of fluorescence of chlorophyll were used using the following methods:

- Water deficiency by comparing the water content in plant tissue with the amount of it in the same tissue in a state of complete turgor **(Gol`d et al., 2008)**;
- The content of chlorophyll a, b and carotenoids in leaves by spectrophotometric method (spectrophotometer PE-5400 VI, Russia) in acetone extracts (absorption 662, 644 and 440.5 nm, respectively) **(Rogozhin, 2013)**;
- Slow induction of fluorescence of chlorophyll – on LPT-3CF / RT-Df (Russia) instrument with subsequent processing of information in the computer program "SIA Interface", developers Budagovskaya ON, Budagovsky AV and Budagovsky IA **(Budagovsky et al., 2010)**.

STATISTICAL ANALYSIS

Statistical processing of the experimental data was carried out using the ANOVA package in STATGRAPHICS Centurion XV, version 15.1.02 and MS Excel 2007.

Statistical analysis included univariate analysis of variance (method of comparing averages using variance analysis, t-test) and variance analysis (ANOVA). The significance of the difference between the means of the least significant difference (LSD) with p-values ≤0.05 was also assessed. For establish the dependence of parameters on abiotic factors, correlation analysis with calculation of pair correlation coefficient was used.

RESULTS AND DISCUSSION

During the year, the average air temperature in the humid subtropical of Russia is 15.2 °C. The coldest month is January with an average temperature of 6.3 °C, and the warmest in August (an average of about 26.1 °C). However, during periods of active plant vegetation, meteorological conditions are often critical. A significant factor contributing to crop losses and deterioration in the quality of peach fruits is the increased instability and stress of weather conditions, as a result of which plants are exposed to a complex of unfavorable factors of nutrient and abiogenic nature **(Smagin, 2014; Tsipouridis et al., 2005)**. For more complete diagnosis of the functional state of plants in modern studies, one or two analyzes are not enough, complex ecological and physiological studies are needed to identify promising varieties and forms that are resistant to changing environmental conditions **(Ryndin et al., 2014)**. Lack of moisture is one of the often occurring adverse environmental factors affecting plants. The greatest harm it inflicts in the spring and summer, when the formation of generative organs of plants. In conditions of humid subtropics of Russia, repeated long droughts in combination with high temperature and solar insolation lead to the inhibition of plants, considerable shedding of generative formations and loss of yield. Violation of the water regime of plants is reflected in all physiological functions, and the resulting wilting of plants is accompanied by the appearance of water deficiency.

That is why the analysis of the functional state of plants under conditions of drought is carried out not only on indicators with an assessment of the state of the photosynthetic apparatus, but also with the analysis of water deficiency in leaves.

Analysis of the weather in the years of observation showed that in 2016 **(Weather data of Sochi, 2016-2017)** from May to August 575 mm of precipitation, which is almost equal to the average multi-year (566 mm). At the same time, in June and August a dry period was observed - only 50% of the norm fell out. The year 2017 was also characterized by a dry period during the active vegetation period: if in May the rainfall norm was closed – 184 mm (110 mm norm), in June 82% fell, in July – 53% of the average annual rate, in August it was only 26%. The years of observation were characterized by lower temperatures; the deviation from long-term values in 2016 was -7.3 °C, in 2017: -5.4°C. This led to a delay in vegetation on average by two weeks. However, during the growing season (June-September), the maximum air temperature exceeded the long-term norm and rose to 31.6 – 34.1 °C, which caused the early decay of growth processes on the background of the drought, affected the quality and quantity of the crop harvest. Determination of the level of water deficiency in peach leaves showed that in a favorable period this figure did not exceed 12%. In the period of inadequate water availability (July-August), in all varieties the water deficit rose to an average of 15%, in less stable - an increase in the parameter was observed to 18% (Figure 1), which correlated with high air temperature ($r = +0.77$). The most resistant was the grade Earley blow in which the water deficit in the leaves was significantly lower than the control Red Heaven in both optimal and stressful periods (LSD ($p \leq 0.05$) = 5.46).

Varieties Vanity and Osenniy surpis are later ripening, during the active fruiting period (July-August) they get into unfavorable conditions when the air temperature reaches +35 °C and higher against the background of a long absence of precipitation. However, low resistance to stressors of humid subtropics of Russia does not entreat the value of these varieties for use as quality indicators donors.

The increase in the indicator "water deficiency" was accompanied by a decrease in the leaf turgor and a change in its anatomical characteristics. Measurement of the thickness of leaf blades before and after a drought showed that in leaves of resistant peach varieties the loss of turgor was insignificant (LSD ($p \leq 0.05$) = 7.24), the thickness of the leaf fluctuated within 0.20 mm.

Against the backdrop of stress, a clear varietal difference was shown, which allowed us to develop a scale for a comparative assessment of the resistance of peach varieties and clones (Table 1).

During the impact of stressors in the most resistant to drought varieties and clones, the water deficit rises to 15%, the largest loss of turgor is observed because of the reduction in the thickness of the leaf blade to 0.14 mm. For medium-resistant varieties and clones, the water deficit is 18%, the thickness of the leaf blade is 0.12 mm. In low-resistant varieties, the water deficit is more than 18%, the thickness of the leaf is less than 0.10 mm. When studying the water regime of a peach, it was found that drought-resistant varieties are distinguished by an increase in water-holding capacity during a period of stress of hydrothermal conditions and a decrease in leaf turgor in comparison with unstable plants. Judging by the loss of water by the leaves of the plants (within 24 hours), Red Heaven, Medin red and Larisa varieties (65 – 72%) were distinguished by a high water-holding capacity, which is one of the signs of their better adaptation to unfavorable external conditions.

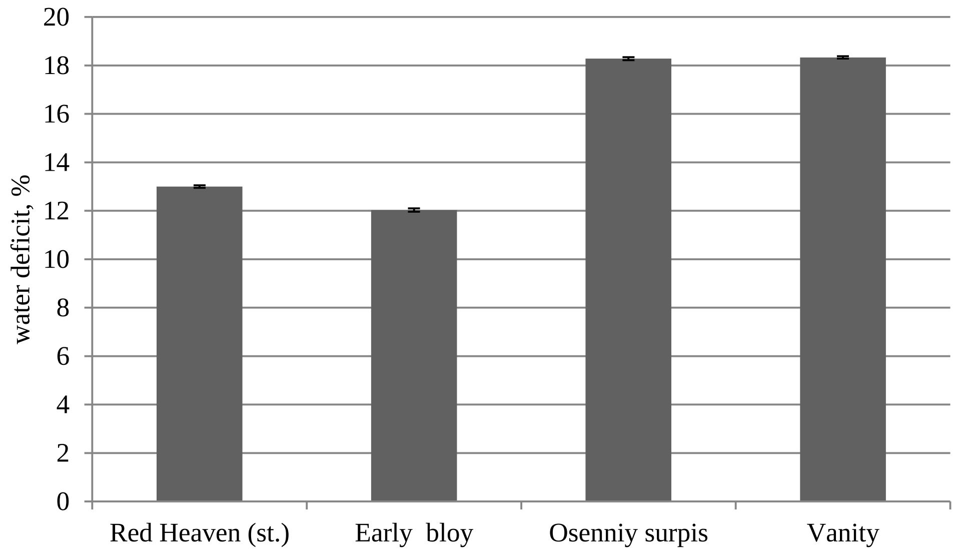

Figure 1 Water deficiency of leaves of resistant and unstable peach varieties, (LSD ($p \leq 0.05$) = 5.46.

Table 1 The scale of changes in the parameters of the water regime of leaves for a comparative assessment of the drought resistance of peach varieties and clones.

Terms of assessment	Parameter	Degrees of resistance of varieties		
		high	mid	low
Optimal conditions	Water deficit, %	10 – 12	12 – 15	>15
	Leaf thickness, mm	0.17 – 0.22	0.15 – 0.17	<0.15
Drought period	Water deficit, %	10 – 15	15 – 18	>18
	Leaf thickness, mm	0.13 – 0.15	0.10 – 0.13	<0.10

Table 2 The content of photosynthetic pigments in the leaves of experimental varieties and peach clones (mg.100 g^{-1} wet weight).

Cultivars/clones	Chlorophyll			
	a	b	a+b	a/b
Red Heaven (st.)	2.03 ±0.03	1.31 ±0.01	3.34 ±0.05	1.56 ±0.01
Larisa	2.27 ±0.01	1.60 ±0.01	3.87 ±0.03	1.41 ±0.01
Early red	2.08 ±0.01	1.26 ±0.02	3.34 ±0.03	1.65 ±0.02
Early bloy	1.92 ±0.02	1.10 ±0.02	3.06 ±0.04	1.83 ±0.01
Slavutich	2.28 ±0.03	1.67 ±0.01	3.95 ±0.02	1.38 ±0.01
Donetskij zheltij	2.22 ±0.03	1.58 ±0.01	3.80 ±0.06	1.41 ±0.03
Donetskij belij	2.19 ±0.04	1.29 ±0.01	3.48 ±0.01	1.79 ±0.01
Medin red	1.99 ±0.01	1.24 ±0.03	3.23 ±0.01	1.62 ±0.03
Pamjat Grishko	1.79 ±0.01	1.07 ±0.01	2.86 ±0.02	1.69 ±0.03
Vanity	2.26 ±0.02	1.56 ±0.04	3.82 ±0.04	1.45 ±0.02
Osenniy surpis	2.17 ±0.01	1.35 ±0.01	3.52 ±0.03	1.64 ±0.01
Form 1	1.92 ±0.01	1.09 ±0.01	3.01 ±0.02	1.77 ±0.01
Form 2	1.81 ±0.01	0.99 ±0.01	2.80 ±0.02	1.82 ±0.02

As one of the main criteria for assessing the functional state of plants under adverse conditions is the state of the photosynthetic apparatus, which is very sensitive to external influences. High air temperatures (above +30 °C) and insufficient water supply lead to a disruption of the synthesis of green pigments with an increase in the amount of carotenoids.

During the research in the optimal period of vegetation during the active growth of the assimilation surface, we noted an increase in the amount of green pigments in the leaves of experimental plants (Table 2). Peach varieties such as Larisa, Donetskij zheltij, Slavutich and Vanity contain significantly higher amounts of chlorophylls than other varieties (LSD ($p \leq 0.05$) = 0.30). In the same varieties, a low Ca/Cb ratio is also noted, which is an indicator of plant resistance to stressful conditions.

As the hydrothermal stress intensifies, the ratio of the sum of chlorophylls to carotenoids in all varieties and peach clones increases, which indicates the inclusion of adaptation mechanisms (Figure 2). At the same time, in the varieties Larisa, Donetskij zheltij, Slavutich and Vanity, this indicator is higher, which confirms their more developed adaptive potential.

For the diagnosis of the physiological state of plants, in particular, the study of the influence of abiotic factors on the photosynthetic productivity of plants, the fluorescence method **(Budagovskaya et al., 2010; Budagovskaya, 2013)**, which fixes the slow induction of chlorophyll fluorescence (SICF or Kautsky effect) is increasingly used. This method allows evaluating the efficiency of photosynthetic transformation of the energy absorbed by the leaf. Devices developed for this purpose A. V. Budagovskiy, O. N. Budagovskoy and I. A. Budagovskii, automatically register the SICF curve and calculate its main parameters **(Budagovsky et al., 2010)**. Determined by the effect of Kautsky (the change in the fluorescence intensity of chlorophyll, which occurs under the action of sufficiently bright light, reflects the work of the photosynthetic apparatus of the cell), the kinetics of IFC shows the state of the photosynthetic apparatus of the cell and serves as an important diagnostic indicator **(Budagovskaya, 2013)**.

As a result of the conducted studies it was found that high temperatures, affecting the functional state of plants, in particular, on the pigment composition of the leaf, led to a decrease in the viability level (F_m/F_T) of a number of varieties (Table 3).

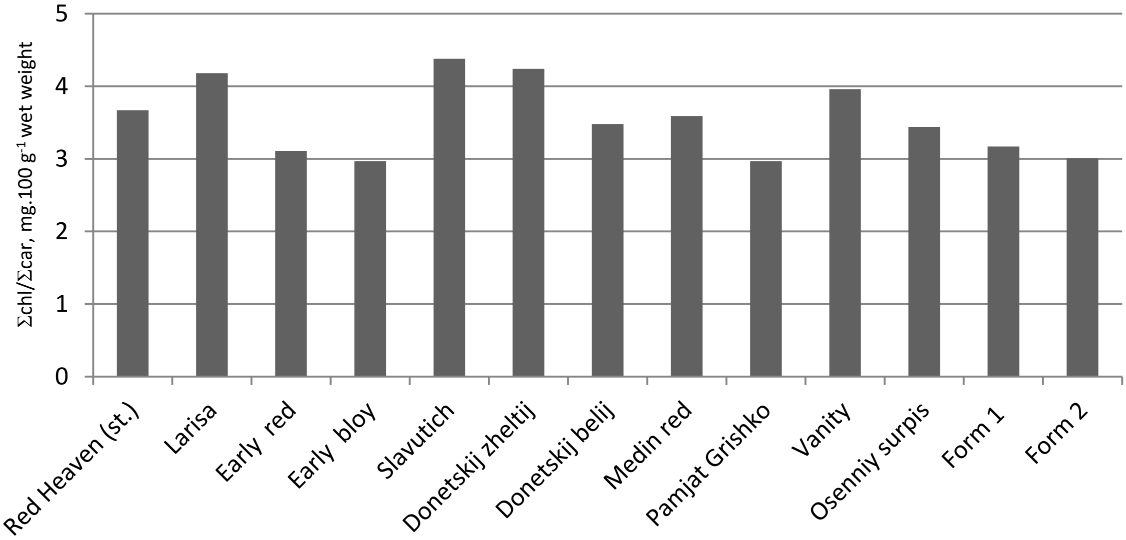

Figure 2 The ratio of the amount of chlorophylls to carotenoids in the critical period of vegetation LSD ($p \leq 0.05$) = 1.05.

Table 3 Influence of hydrothermal stressors on the fluorescence of peach leaf chlorophyll

Cultivars/clones	Fm*	F_T*	Kf_n*	Fm/F_T*
Red Heaven (st.)	124.11	37.13	0.46	3.52
Early red	130.96	40.54	0.46	3.24
Early bloy	115.16	18.90	0.58	6.18
Donetskij zheltij	125.45	29.43	0.52	4.43
Donetskij belij	131.66	35.11	0.49	3.83
Medin red	122.02	30.12	0.52	4.45
Pamjat Grishko	126.80	31.66	0.49	4.16
Osenniy surpis	135.07	46.80	0.45	3.11
Form 1	123.13	30.42	0.51	4.50
Form 2	128.28	36.76	0.46	3.52

Note: * Fm is the fluorescence maximum; F_T – stationary level of fluorescence; Kf_n is the coefficient of photosynthetic activity; F_m/F_T - viability index.

In stable varieties (Early bloy, Medin red, Donetskij zheltij, and Form 1), this process was characterized by an increase in the coefficient of photosynthetic activity (Kf_n) and a decrease in the fluorescence level (F_T) of chlorophyll.

CONCLUSION

Thus, when determining the resistance of peach plants to unfavorable environmental factors, methods based on laboratory, fixing changes in physiological and biochemical processes occurring in plants are used. Such indicators as water deficit, pigment composition and fluorescence of chlorophyll allow revealing the resistance of varieties and clones of peach to the action of hydrothermal stressors. Thus, it was found that the water deficit in the peach leaves during unfavorable for water availability did not exceed 15%, which is due to the xeromorphic nature of the leaf device. Simultaneously, an increase in the viability index and the coefficient of photosynthetic activity was observed in a number of varieties (Early bloy, Medin red, Donetskij belij, Form 1). According to the results of the research, the varieties and clones of peach that are the most resistant to the stressful conditions of the humid subtropics of Russia are noted (Larisa, Early bloy, Medin red, Slavutich, Donetskij zheltij, Vanity and Form 1).

REFERENCES

Abilfazova, Yu. S. 2014. Physiological and biochemical indicators of peach stability in relation to weather conditions in Sochi. *Horticulture and viticulture,* vol. 2004. no. 4, p. 42-44.

Abilfazova, Yu. S. 2016. Persistence of peach to stress factors of humid subtropics of Russia. *Vestnik of the Russian agricultural science,* [S.l.], no 6, p. 40-42. Available at: http://www.vestnik-rsn.ru/vrsn/article/view/336.

Abilfazova, Yu. S. 2018. Correlation dependence of indicators of the water status of *Persica vulgaris* (Mill.) On hydrothermal stressors of humid subtropics of Russia. *New technologies*, vol. 2018, no 1, p. 100-105.

Besedina, T. D., Smagin, N. E., Dobezhina, S. V. 2017. Adaptive potential of varieties of peach cultivated in humid subtropics of Russia. *APK Stavropol Newsletter*, vol. 1, no. 25, p. 123-129.

Budagovskaya, O. N. 2013. *Laser-optical methods and technical means of multiparameter diagnostics of plants and fruits*: Thesis of doctor of Technical Sciences. Moscow, Russia. 39. p. Available at: https://dlib.rsl.ru/viewer/01005532090

Budagovskaya, O. N., Budagovskii, A. V., Budagovskii, I. A. 2010. *Laser diagnostics of plants*. *Methodical. recommendations*. Michurinsk : Publishing House "Michurinsk". 54 p. ISBN 978-5-98429-064-7.

Budagovsky, A. V., Budagovskaya, O. N., Budagovskiy, I. A. 2010. Paradoxes of the optical properties of green cells and their practical application. *Photonics*, vol. 6, p. 22-28.

Cociu, V., Hough, L. F., Ionescu, P. R., Topor, E. 1985. Results on breeding new very early and early ripening peach and nectarine varieties. *Acta Horticulture*, vol. 173, p. 25-30. https://doi.org/10.17660/ActaHortic.1985.173.3

DeJong, T. M., Johnson, R. S., Doyle, J. F., Weibel, A., Solari, L., Marsal, J., Basile, B., Ramming, D., Bryła, D. 2004. Growth, yield and physiological behaviour of size-controlling peach rootstocks developed in California. Acta Horticulture, vol. 658, p. 449-455. https://doi.org/10.17660/ActaHortic.2004.658.66

Diviš, P., Šťávová, E., Pořízka, J., Drábiková, J. 2017. Determination of tin, chromium, cadmium and lead in canned fruits from the czech market. *Potravinarstvo Slovak Journal of Food Sciences*, vol. 11, no. 1, p. 564-570. https://doi.org/10.5219/749

Eremin, V. G. 2006. New technologies of peach cultivation in the Krasnodar region. Horticulture and viticulture, no. 6, p. 7-8.

Eremin, V. G., Eremina, O. V. 2014. Peach assortment for Krasnodar region. Contemporary horticulture, vol. 2, p. 6-12. Available at: http://journal.vniispk.ru

Export and import of Russia by goods and countries. 2018. [online] s.a. [cit.2018-08-07] Available at: http://ru-stat.com/date.

FAOSTAT. 2018. [online] s.a. [cit.2018-08-14] Available at: http://www.fao.org/faostat.

Fikselová, M., Czako, P., Gažo, J., Mendelová, A., Mellen, M. 2018. Sauvignon wine quality as affected by its processing and storage. *Potravinarstvo Slovak Journal of Food Sciences*, vol. 12, no. 1, p. 299-303. https://doi.org/10.5219/885

Gol`d, V. M., Gaevsky, N. A., Golovanova, T. I., Belonog, N. P., Gorbaneva, T. B. 2008. *Plant physiology : method. instructions on the lab. works*. Krasnoyarsk, Russia : IPK SFU, 61 p. ISBN 978-5-7638-1275-6.

Insausti, P., Gorjon, S. 2016. Floods affect physiological and growth variables of peach trees (*Prunus persica* (L.) Batsch), as well as the postharvest behavior of fruits. *Scientia Horticulturae*, vol. 152, p. 56-60. https://doi.org/10.1016/j.scienta.2013.01.005

Rogozhin, V. V. 2013. *Training manual on plants physiology and biochemistry*. Saint-Petersburg, Russia: GIORD. 350 p. ISBN: 978-5-98879-151-5.

Ryndin, A. V., Belous, O. G., Malyarovskaya, V. I., Pritula, Z. V., Abilfazova, Yu. S., Kozhevnikova, A. M. 2014. The use of physiological and biochemical methods for identifying the mechanisms of adaptation of subtropical, southern fruit and ornamental crops in the subtropical environment of Russia. *Agricultural Biology*, no 3, p. 40-48. https://doi.org/10.15389/agrobiology.2014.3.40rus

Ryndin, A. V., Lyakh, V. M., Smagin, N. E. 2016. Peach culture in different countries of the world. *Subtropical and decorative horticulture*, vol. 57, p. 9-24.

Ryndin, A. V., Smagin, N. E., Abilfazova, Yu. S. 2011. Perspective varieties of peach for humid subtropics of Russia (Sochi). *Subtropical and decorative horticulture*, vol. 44, p. 119-123. ISSN: 2225-3068.

Shaitan, I. M., Chuprina, L. M., Anpilogova, V. A. 1989. Biological features and cultivation of peach, apricot and cherry plum. Kyiv, Ukraine : Naukova Dumka. 154 p. ISBN 5-12-00082.

Smagin, N. E. 2014. The impact of extreme weather conditions on the productivity of peach in subtropical regions of Russia. Material conference. Sochi, p. 335-340. Available at: https://elibrary.ru/item.asp?id=35014590.

Tsipouridis, C., Thomidis, T., Michailides, Z., 2005. Influence of some external factors on the rooting of GF677, peach and nectarine shoot hardwood cuttings. *Aust. J. Exp. Agric.*, vol. 45, p. 107-113. https://doi.org/10.1071/EA03120

Tworkoski, T., Takeda, F. 2007. Rooting response of shoot cuttings from three peach growth habits. *Scientia Horticulturae*, vol. 115, p. 98-100. https://doi.org/10.1016/j.scienta.2007.08.004

Vietoris, V., Czako, P., Mendelová, A., Remeňová, Z., Závracký, M. 2014. Relations between must clarification and organoleptic attributes of wine varieties. *Potravinarstvo*, vol. 8, no. 1, p. 155-160. https://doi.org/10.5219/359

Weather data of Sochi. Hydrometeorological center. 2016-2017. [online] s.a. [cit.2018-09-03] Available at: http://www.pogodasochi.ru/inf.

Zec, G., Fotirić Akšić, M., Čolić, S., Vulić, T., Nikolić, D., Oparnica, Č., Janković, Z. 2013. Influence of vineyard peach selections on vigour and initial yield in peach and nectarine. *Genetika*, vol. 45, no.1, p. 11-20. https://doi.org/10.2298/GENSR1301011Z

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