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ADAPTABILITY OF CULTIVARS AND HYBRIDS OF TANGERINE IN A SUBTROPICAL ZONE OF RUSSIA

Julia Abilphazova, Oksana Belous

ABSTRACT

Results of researches of various cultivars and hybrids of tangerine growing in the conditions of the humid subtropics of Russia and possessing valuable physiological and biochemical markers are presented in article. The stress factors limiting cultivation of tangerine culture in Krasnodar region are defined. The assessment of the water saving and enzymes activity in tangerine leaves is given. Changes of physiological parameters at influence of a stressful factor are shown. The analysis of water deficiency is revealed existence of essential distinctions between cultivars and hybrids. Change of thickness of a leaf blade of tangerine is the important diagnostic characteristic testifying the ability of leaf tissues to accumulate and keep water. Researches are showing that difference between catalase action of cultivars and hybrids are insignificant. Strengthening of enzyme activity can testify to bigger violation of a functional state of plant cultivars in comparison with the hybrides. Water deficiency and drought resistance coefficient can be used for diagnostics of stability of tangerine to hydrothermal factors. Correlation coefficients between the studied markers were calculated and regression models of their interrelation were given. So, there was a high correlation between thickness of a leaf blade and water deficiency index; close correlation between water deficiency and thickness of a leaf blade, as well as dependence of average degree on water deficiency and catalase activity were noted. There were revealed tangerine cultivars and hybrids which are stable in in the changing environmental conditions and have high biochemical value of fruits.

Keywords: tangerine; water deficit; turgor; catalase; resistance

INTRODUCTION

Humid subtropics of Krasnodar region – the only place in Russia where citrus plants, and first of all, tangerines can be grown up in field conditions. However, in recent years field cultivation of a citrus in this zone was reduced to a minimum, first of all, unprofitability of their cultivation due to high costs of watering during a drought and acquisition modern and reliable materials for frost protection. The abnormal phenomena existing in subtropics of Russia (severe droughts, frosts, etc.) have an adverse effect on course of physiology-biochemical processes that is expressed in change not only exchange processes in cages, but also growth, development, duration of fructification of plants. So, one of the major stressful factors in a subtropical zone of Krasnodar region is irregularity of rainfall distribution; the necessary quantity during all vegetative period are 500 – 600 mm, but in some years was no more than 150 – 200 mm, and often they have storm character. Besides, the summer period in subtropics of Russia is characterized by high air temperature, with not sufficient available soil moisture. It creates here on the coast conditions for annually repeating droughty periods in which the inhibition of plants growth, their wilting and even drying are observed. The stressor's influence leads to considerable cropping losses of citrus which have a strengthened ovary abscission. In response to instability of abiotic factors a citrus becomes more susceptible to various diseases that conduct to decrease in efficiency and deterioration of fruits. Regarding to this there is a need for studying of adaptive potential of citrus plants using the methods of express diagnostics for an assessment of their physiological state and development of new cultivars and hybrids with adoptability to this region.

In a number of scientific institutions of the country were developed various methods of diagnostics of plants stability recommended for practical using containing various receptions of an assessment of resistance to extreme factors **(Udovenko, 1995; Goncharova, 2007; Reutsky and Radionov, 1992; Technique of researches, 1985)**. The offered methods differ on labor input, level of differentiation of the estimated objects on stability and except of their practical application. Besides, methods of diagnostics are depending on the studied species and specifics of stressful factors. However at the heart of plants including tangerine stability diagnostics are the general principles of their assessment which are based on mechanisms of adaptation of plants to stresses **(Udovenko, 1973; Goncharova, 2007; Radchenko, 2005)**.

The purpose of these long-term researches was to study of citrus plants biological features, their reactions to adverse factors of the environment for establishment of diagnostic criteria of stability, selection of assortment of tangerines which are steady to humid subtropics of Russia.

MATERIAL AND METHODOLOGY

The present researches were conducted using followed tangerine genotypes: Sentyabrsky; Kodorsky; Unshiu; hybrid 16939 (Miagava-Vase x Natsu); hybrid 16954 (Miagava-Vase x Yuka). Plants were grown up in a field conditions in the Institute collection in 3-fold frequency since 1986, the total area of a site makes 400 m^2, the schema are 4 x 2 m. Soils are brown forest and low unsaturated. Physiologically uniform leaves of tangerine which finished their growth were selected for analyses. Selection of tangerine leaves was made from June to August depending on a cultivar, terms of leaves increase and approach of stressful conditions (a drought, high or low air temperatures, etc.). The agriculture is standard for tangerine planting.

Researches were conducted in field and laboratory conditions on the basis of Russian Research Institute of Floriculture and Subtropical Crops with use of classical methods: determination of water deficiency by Pochinok **(Pochinok, 1976)**; activity of enzyme of a catalase – by method of gasometry **(Gunar, 1972)**; thickness of a leaf was determined by a field turgor meter, coefficient of heat resistance – by express method of diagnosing **(Kushnirenko et al., 1986)**.

The program STATGRAPHICS Centurion XV and the mathematical software package of MS Excel 7.0 were applied an assessment of experiment results.

RESULTS AND DISCUSSION

On the Black Sea coast of Krasnodar region the limiting factor in summertime is the drought which can proceed two and more months. And, the most critical and droughty months for tangerine was June – August when average temperature rose above +25.0 °C at high relative humidity of air (to 80%).

Use of physiological methods in periods of low humidity of the soil, air and high temperatures allowed to establish influence of a drought on a condition of plants and to reveal features of formation of drought resistance by them **(Abilfazova, 2002; Belous, 2009)**. At diagnostics of stability of tangerine cutivars we used an assessment in a complex of parameters of the water mode and enzyme's activity **(Goncharova, 2007; Radchenko, 2005; Romanova, 2008)**. These parameters are characterized by variability and high response on many abiotic factors therefore it was necessary to observe special care in selection of plant material for the analysis and taking note of stressful factors on plants.Water deficiency during the spring period leads to delay of a shoots gain, to blooming of buds and budding, later blossoming of tangerine (in average for 2 weeks later, than usually) was established in our research. During this period the content of water in leaves is an important diagnostic indicator of a physiological condition of citrus plants for which is necessary optimal moisture, especially in the spring and at the beginning of summer, when active growth of vegetative and generative organs is going on.

At the beginning of the stressful period was revealed that water deficiency of tangerine is ranging from 9.5% (grade Yubilejny) to 16.3% (grade Slava Vaviliv). At this time the high values of parameter at plants (more than 11%) are connected with lack of necessary watering. We were showing that further a strengthening of water deficiency on average for 1 – 5% (Figure 1).

Variability of an indicator on cultivars was from 26% (cultivar Miagava-Vase) to 31.8% (cultivar Yubilejny). High values of variability coefficient at a cultivar Yubilejny testify to its plasticity that is important at cultivation of the cultivar in unstable climatic conditions. The analysis of an indicator «water deficiency» revealed existence of essential distinctions between cultivars and hybrids (least significant difference at 95% level = 4.4). In general, cultivars Yubilejny and Kodorsky which water deficiency is significantly lower both in optimum and during the stressful period are the steadiest. At the same time, the cultivar Slava Vaviliv has a higher water deficiency throughout the entire period of supervision.

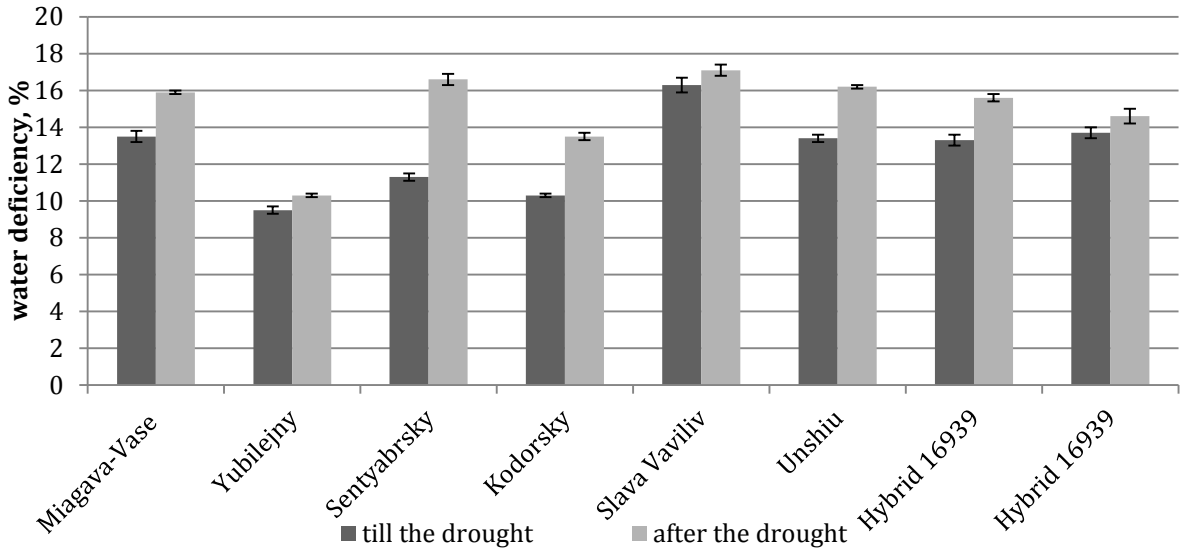

Figure 1 Water deficiency of tangerine.

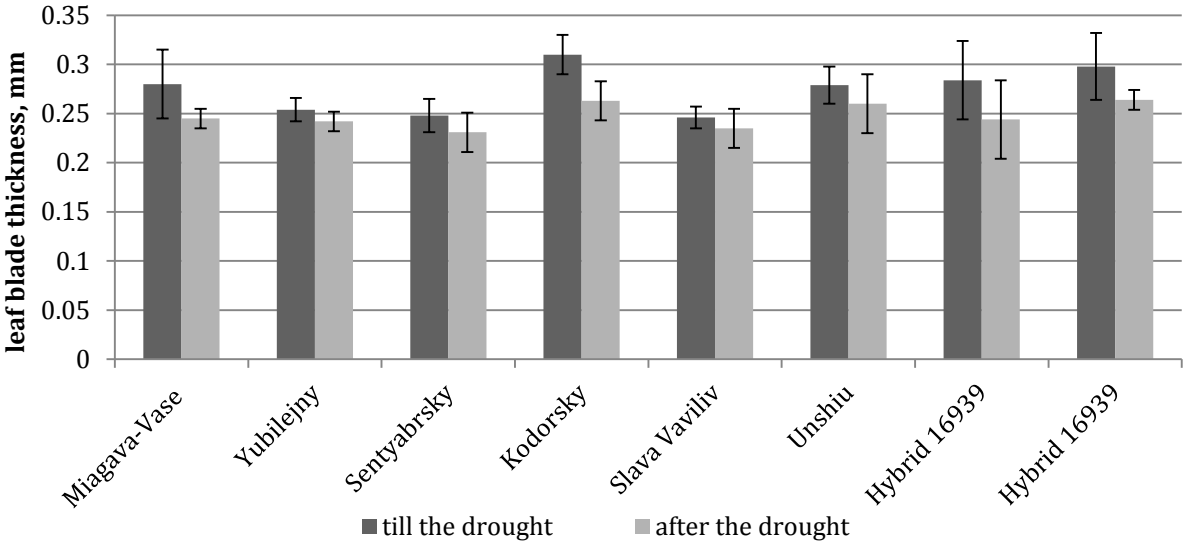

Figure 2 Change of tangerine leaf blade thickness.

There is a considerable loss of plant cells turgor during the drought that is a consequence of water deficiency. Change of thickness of a tangerine's leaf blade is the important diagnostic characteristic testifying the ability of leaf tissues to accumulate and keep water. As was showen in our researches, there is a close correlation (r = 0.72) between thickness of a leaf blade and the value of water deficiency. The analysis of biometric parameters of leaf blade of tangerine at till the drought period showed that the greatest thickness of a leaf characterizes a cultivar Kodorsky, by the smallest – a cultivar Slava Vaviliv, distinctions between cultivars are essential: least significant difference at 95% level = 0.020 (Figure 2). Increase of water deficiency leads to decrease in leaf turgor that is connected with deterioration of hydrothermal factors; changing the relation of T1/T2 which is stability coefficient changes (the coefficient equal 1.0 testifies to high resistance of plants to a drought). Stability of this indicator during action of stressful factors is a sign of plants stability. In the cultivar Yubilejny high resistance to action stress factor was observed as it was shown in our researches.

The mechanisms which function at the level of enzymes systems and provide the adaptation of plants to adverse conditions of environment are significant for a plant. These mechanisms were shown in the form of change of concentration of enzymes and/or activity of their multiple molecular forms **(Romanova, 2008)**. Enzymatic processes characterize features of a metabolism at different plants. Various physiological properties, including biological stability are connected with their action. One of the main oxidation-reduction enzymes of plants is the catalase. Change of enzymatic activity testifies to change of adaptability of plants to an adverse effect of environment;

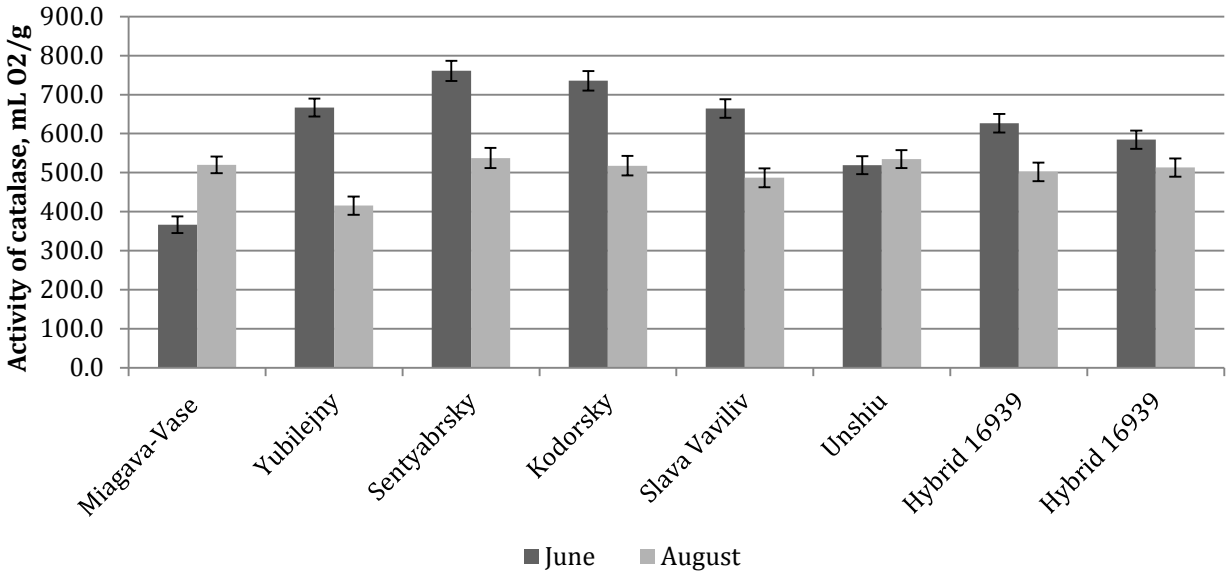

Figure 3 Enzymatic activate of tangerine.

Table 1 Characterize of physiology parameters of cultivars and hybrids of tangerine.

Cultivars	Water deficit %	V %	Enzymatic activity, mL O2/g	V %	Leaf blade mm	V %
Miagava-Vase St.	14.7 ±1.7	26	443.4 ±21.1	21	0.263 ±0.025	20
Yubilejny	9.0 ±0.6	32	541.2 ±23.3	23	0.248 ±0.008	20
Sentyabrsky	14.0 ±3.7	27	649.2 ±25.5	25	0.240 ±0.012	20
Kodorsky	11.9 ±2.3	29	626.7 ±25.0	25	0.287 ±0.033	19
Slava Vaviliv	16.7 ±0.6	24	575.7 ±24.0	24	0.241 ±0.008	20
Unshiu	14.8 ±2.0	26	526.9 ±23.0	23	0.270 ±0.013	19
Hybrid 16939	14.5 ±1.6	26	564.4 ±23.8	24	0.264 ±0.028	19
Hybrid 16954	14.2 ±0.6	27	548.8 ±23.4	23	0.281 ±0.024	19
Least significant difference (95% confidence level)	4.4	-	283.5	-	0.020	-

therefore the task to study dynamics of enzymatic activity of various grades and hybrids of tangerine was set.

In June activity of a catalase in tangerine leaves was ranging from 366.7 mL O2/g (grade Miagava-Vase) to 760.8 mL O2/g (grade Yubilejny) by us was established. Strengthening of stressful influence led to minor change of enzymatic activity (V = 3.9 – 4.7) that points to stability of the parameter (Figure 3).

The cultivar Miagava-Vase had a strengthening of activity of a catalase against its falling at other cultivars, however, distinctions between cultivars and hybrids are insignificant (least significant difference at 95% level = 283.5). Strengthening of enzyme activity can testify to bigger violation of a functional state at plants of this cultivar in comparison with the others that characterizes this cultivar as unstable (Table 1).

CONCLUSION

Adaptability of the most perspective cultivars and hybrids of citrus cultures that revealed difficult mechanisms of interaction between the studied indicators was analyzed. Close correlation between water deficiency and leaf blade thickness, dependence of average degree between water deficiency and activity of a catalase are noted. We was defined that on two diagnosed indicators (size of water deficiency and coefficient of drought resistance) the cultivar Yubilejny is steadier than other cultivars. These characteristics can be used for diagnostics of stability of tangerine to hydrothermal factors. And also, can be used for a fast assessment of the cultivars and hybrids introduced and created developed at institute.

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Contact address:

Belous Oksana, Dr. Sci. Biol., associate professor, leading researcher of laboratory of biotechnology, biochemistry and physiology of plants of All-Union Scientific research institute of floriculture and subtropical cultures, Fabritius St., 2/28, Sochi, Russia, 354207; Head department of Sochi institute of Design, Business and

Law, Parkovaja st.17, Sochi, Russia; E-mail: oksana191962@mail.ru

Abilphazova Julia, Candidate of Biology, researcher of the laboratory of biotechnology, biochemistry and physiology of plants of All-Union Scientific research institute of floriculture and subtropical cultures, Fabritius St., 2/28, Sochi, Russia, 354207, E-mail: citrus_sochi@mail.ru