

INFLUENCE OF GRAPEVINE GENETIC AND PHYSIOLOGICAL FEATURES ON THE AGROCLIMATIC RESOURCES RELATED YIELD

Lyashenko Galina *, <https://orcid.org/0000-0003-2069-8971>

Muliukina Nina, <https://orcid.org/0000-0003-3176-9827>

Buzovska Maryna, <https://orcid.org/0000-0003-1334-4171>

Melnik Ella, <https://orcid.org/0000-0002-9272-4625>

Popova Hanna, <https://orcid.org/0000-0002-2714-5264>

Mandych Olesia, <https://orcid.org/0000-0002-8983-2246>

National Scientific Centre "Tairov Institute of Viticulture and Winemaking",

Odessa region, Ukraine

** e-mail lgv53@ukr.net*

Summary. The solution of food security actual problem for all countries is associated with the scientific substantiation of crop yields formation, first of all, the issues of plant photosynthetic activity under the influence of many environmental factors, among which agroclimatic and soil conditions have the greatest contribution. The aim of this article is to present the results of the 'Muscat Odessa' and 'Odessa Black' grapevine varieties yield study in the central regions of Ukraine Steppe zone. The research was carried out using agroclimatic information and the method of modeling the climatically possible yields formation. The peculiarities of various coefficients of PAR (photosynthetically active radiation) use influence, the calorific value of grapes and the coefficients characterizing the economic value of the crop (for grapes – the ratio of berry raw weight to the total vine plant weight) under the average values of photosynthetically active radiation (PAR) and moisture conditions during the growing season of grape varieties were revealed.

Keywords: grapes, potential and climatically possible yield, Steppe zone.

Introduction

The influence of weather conditions on the crop yields formation is beyond doubt, and the nature of this influence has been studied by scientists in the agricultural sector for a long time on the basis of the relationship between the main hydrometeorological indicators (temperature, precipitation) analysis and the size of the yield. Since the 70s, research in this direction has been carried out using mathematical modeling methods of yield formation. A number of models for various crop yield formation have been developed, which are based on the analysis of the photosynthesis and respiration processes as the main physiological processes and are aimed at assessing the photosynthetic activity of the vegetation cover (VP), the principles of which were laid down in the fundamental works of Nychyporovych O.O. and others. [1].

In the development of this area of research, Tooming H.G. formulated the concept of *скінз* maximum productivity, in which the main provisions are based on the desire of plants to form maximum productivity, and the limiting factors are environmental conditions, primarily weather and climatic [2]. It is proposed to consider potential and really possible yields, which can be obtained in a given territory for a certain agricultural crop. This direction was further developed by Polevoi A.M., Vitchenko O.M. and others [3, 4], and in the researches of Lyashenko G.V. this approach was modified in relation to the agroclimatic assessment of crop yield formation and implemented on the Ukraine territory example for six crops within the framework of the multi-scale agroclimatic zoning [5].

The first mathematical models based on vineyard photosynthetic activity theory were developed by A.G. Amirjanov and others [6-8] and has continued for the past 40 years. In the last 20 years, the NSC "Tairov Institute of Viticulture and Wine-Making" has developed a mathematical

dynamic model for the grape yields formation, which is implemented on the example of the 'Rubin Tairovsky' and 'Zagrey' varieties for the territory of the Forest-Steppe and Steppe zones of Ukraine [9]. At the same time, research is being carried out to improve the model of agroclimatic assessment of the yields formation of different groups of varieties, which differ in the requirements of grapevines for light, heat and moisture resources.

This paper presents the results of potential and climatically determined yield formation modeling for early and late ripeness grapevine varieties.

Materials and methods

As the main principle of the study, a systematic approach is considered, the essence of which lies in the consistency, complexity and detail of agroclimatic resources and agroclimatic assessments of the crop productivity formation. The determination of the maximum possible or potential yield is carried out taking into account the amount of photosynthetically active radiation that enters the vegetation cover and the genetic possibilities for its use, as well as the morphological characteristics of plants, which include the calorific value of the crop and the ratio between the mass of economically valuable and the total part of the crop. The real climatically possible yield is determined taking into account the moisture supply indicator.

In the course of the research, the average ten-day long-term values of the sunshine duration, the sum of photosynthetically active radiation, the average air temperatures in the warm period, the amount of precipitation and the reserves of productive moisture in the soil meter layer were used. The methods of agroclimatic calculations and generalizations and the method of potential and climatically possible yields determining were used.

To determine the potential and real climatically possible yield, the following formulas are proposed:

$$PY = 10^3 \cdot \eta \cdot K'_m \cdot \frac{\Sigma Q_f}{q}, \quad (1)$$

$$CRY = 10^3 \cdot \eta \cdot K'_m \cdot \frac{\Sigma Q_f}{q} \cdot \frac{Wm}{W_1}, \quad (2)$$

PY , CRY , η , K'_m , ΣQ_f , q , Wm , W_1 – accordingly, the potential and climatically possible grape yields in t/ha, the coefficient of the photosynthetically active radiation use in % or fractions of a unit, the coefficient of the economically valuable part of the crop, the sum of photosynthetically active radiation during the growing season, the calorific value of the crop unit, the average reserves of productive moisture in the meter layer of soil during the growing season and the value of the smallest moisture capacity of this soil for the meter layer

Thus, the proposed model is aimed at a comprehensive and most detailed consideration of the bioecological characteristics of grapes and agro-climatic resources during the growing season of 'Muscat Odessa' and 'Odessa Black' varieties with early and late ripening.

Results and discussion

Calculations of the photosynthetically active radiation amounts during the growing season of 'Muscat Odessa' and 'Odessa Black' varieties were carried out, which respectively amounted to 1390 and 1770 MJ per m², and the ratio of average moisture reserves in a meter layer of soil for this period to the value of the lowest moisture capacity ranges from 0.45 to 0.50. Calculations of potential and climatically possible radiation were carried out under the condition that grapes used 0.75, 1.0, 1.5 and 2.0% of photosynthetically active radiation (relative values 0.0075, 0.01, 0.015 and 0.02). The coefficient characterizing the ratio of the economically valuable part of the crop mass (grapes) to the total weight of the plant with a water content in grapes of 20% is taken to be

equal to 2.25 and 3.0 and the value of the calorific value per unit weight of grapes varies from 16000 to 17000 KJ/kg.

The obtained results of modeling the formation of potential, as the maximum possible, yield of grapes, indicate their significant variability under the influence of all indicators that characterize both climatic conditions and genetic and physiological properties of varieties. It can be clearly seen (Fig. 1) that with the same values of the coefficient indicators of photosynthetically active radiation use, the coefficient of the economically valuable part of the crop and the calorific value, the grape yield of the 'Odessa Black' variety is 5-25 t/he higher than that of the 'Muscat Odessa' variety. This is due to the longer duration of the growing season and more by almost 400 MJ/m², amount of photosynthetically active radiation. Among the indicators characterizing the genetic and physiological properties of grapes, the coefficient of photosynthetically active radiation use has the greatest impact on the potential yield variability. The difference in potential yield at coefficients of 0.75 and 2.0% for 'Muscat Odessa' and 'Odessa Black' varieties is 15-30 t/he. Where is the smaller variability of potential yield fixes under the other indicators changes – 5 – 10 t/he.

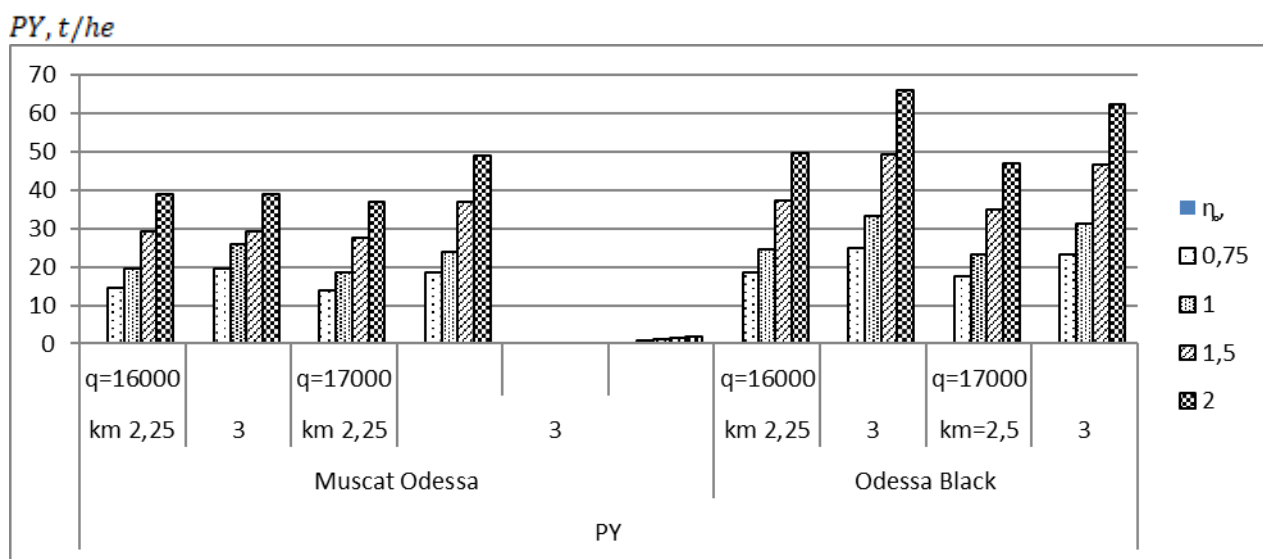


Figure 1. Variability of potential yield of 'Muscat Odessa' and 'Odessa Black' grapes in the central regions of the Ukraine Steppe zone

The difference in the impact of all indicators on climatically possible yields is very different. Their greatest difference is noted depending on moisture, which leads to a twofold decrease in the climatically possible yield compared to the potential one (Figs. 2 and 3). The greatest influence of the coefficient of photosynthetically active radiation use is noted. However, there is a decrease in the difference in climatically possible yield under the influence of different indicators in the varieties 'Muscat Odessa' and 'Odessa Black'.

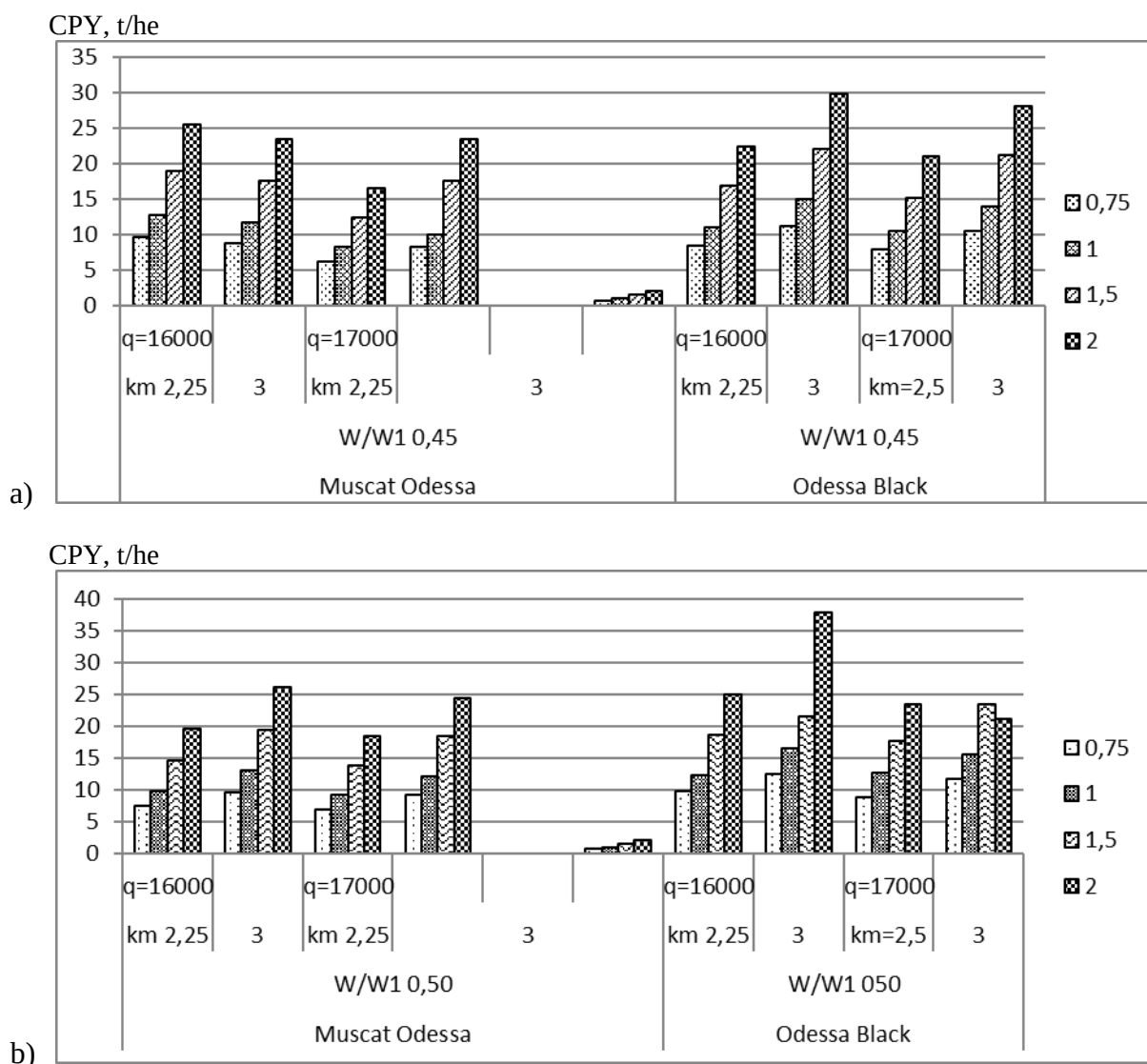


Figure. 2. Variability of climatically possible yield of 'Muscat Odessa' and 'Odessa Black' grapes in the central regions of the Ukraine Steppe zone

It should be noted that, according to numerous studies, the coefficient of photosynthetically active radiation use for most grape varieties ranges from 0.75 and 1.0% and sometimes reaches 1.5%.

Conclusions

The results obtained indicate the need for similar studies for other grape varieties and territories, which will optimize the location of the viticultural industry within the regions and the country. It makes sense to model yield formation for lands with different terrain and soils. It should be noted the possibility, as promising, of research aimed at obtaining high yields of grapes with directed breeding work on the development of new varieties with other genetic and physiological properties, first of all, with a higher coefficient of use of photosynthetically active radiation.

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