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Evaluation of Radiation – Thermal Resources during A Grapes Growing Period

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Abstract: *The radiation-thermal resources indexes that determine the formation of a grapes quality – a sugar content in grapes and a juice titrated acidity are substantiated in the article. A sunshine duration SS, the amount of average twenty-four hours (ΣTsv>10°C), average day (ΣTdn>10°C) and night (ΣTn>10°C) air temperatures, and the difference between the daytime and nighttime temperatures (ΣTdn-ΣTn)>10°C as the most appropriate index of the daily temperatures rhythm during a growing season are proposed to use as these indexes. The results of calculating the radiation-thermal resources for the period from 1986 to 2010, according to two agro-meteorological stations ("Odessa" and "Bolgrad"), which may well characterize the central and southern regions of the North-Western Black Sea region with the most advanced viticulture are presented. The analysis of the dynamics of these indexes was carried out and their trends were defined, as well as their statistical characteristics were calculated and the total probabilities or availability of each of the indexes were determined.*

Keywords: *plant physiology, a daily rhythm, vital processes, grapes, a crop, quality, radiation-thermal resources, indexes, sunshine duration, daytime and nighttime temperatures.*

I. INTRODUCTION

Grapes is a warm climate plant, so its commercial cultivation is concentrated mainly in the southern region of Ukraine. Among other fruit crops grapes occupies a special position because of its potential undemanding to soils, its drought resistance, which leads to a possibility of its growing on the little available lands and obtaining high yields, subject to necessary farming practices.

However, it is determined that light and thermal resources are defined as the conditions for grapes growing in general, a crop value formation and a grapes products quality. Therefore the studies dedicated the evaluation of light and thermal resources are notably relevant.

II. LITERATURE REVIEV

Since ancient times, the dependence of a quantity and a quality of viticulture and wine-production from weather-climatic conditions is found out. Since the middle of last century

agrometeorologists have been conducting researches aimed at determining the agro-climatic indexes that adequately reflect the relationship between a light, heat and moisture regime and product quality indexes, especially a sugar content in grapes and a titrated acidity.

Such indexes as a sunshine duration, the amount of active air temperatures for a warm period (with average air temperatures above 10°C), precipitation, Selyaninov hydrothermal coefficient [1] were extracted according to the results of numerous studies. Further, according to the results of more detailed studies during a growing season the given light, thermal and moisture resources indexes were examined in the context of the specific interphase periods, especially during the periods of grapes generative organs formation [2, 3, 4].

More recent researches conducted Z.A.MischenkoH.V.Lyashenko found out that a formation of a grape crop quality is defined in terms of light and thermal resources separately for day and night hours [5, 6]. Therefore, the research that includes a spatial and temporal variability of radiation-thermal resources on the indexes that reflect their daily rhythm is actual.

The calculation of the daily temperatures was made for the maximum temperature and the calculation of the night temperatures - for the lowest [5, 6]

R=0,91 (1)

R=0,93 (2)

where A1, A2, B1 and B2 - parameters of the equation, T_{day} and T_N –average day and night temperatures, Tmax

and Tmin - minimum and maximum daily temperatures

The method of accumulation determined the total sunshine duration, the amount of average daytime and night-time temperatures, and the difference between the amounts of day and night temperatures during the warm season. [7]
The calculation of the amount of the temperatures for the period is made with the formulas:

$$\Sigma T\partial н \geq 10°C = \Sigma\left(T_{ДН} \cdot N_{IV} + T_{ДН} N_V + \ldots + T_{ДН} \cdot N_X\right) \quad (3)$$

$$\Sigma T_H \geq 10°C = \Sigma\left(T_H \cdot N_{IV} + T_H N_V + \ldots + T_H \cdot N_X\right) \quad (4)$$

where T_{day} and T_N - theaveragemonthlyvalueofdaytimeandnighttimeair-temperatures; N with 1V, V, ...index, X - anumberofdaysandnightsinApril, MayandOctoberwith T_{day} and $T_N$from 10 ºC above.

Agro-climaticandclimatologicalinformationforthe meteorologicalvariablesis presented through thebasicstatisticalcharacteristics: theiraverage, extreme (the largest, the smallest) valuesspecifyingtheyearofobservation, a measureofvariability (a standarddeviation, a coefficientofvariation),forthe certaincharacteristics – a frequency (recurrence) ora probability.
Themaincharacteristicof the valuesis anaverage (long-term) value, whichiscalculatedbytheformula

$$x = \frac{\sum_{i=1}^{n} x_i}{n}, \quad (5)$$

where x - a memberoftherow (individualvalues), n - anumberofthe membersoftherow (an observationperiod).

A standarddeviationanda coefficientofvariationare determinedbythe formulas

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n}}, \quad (6)$$

$$C_v = \frac{\sigma}{\bar{x}} \quad (7)$$

Itisimportanttoidentifytheerrorofaverage valuesthatdependsonmanyfactors, primarilyonthevariabilityofthemeteorologicalvaluesandthe period of averaging. Theaveragesquareerrorof the arithmeticvalueisgivenby the formula

$$\sigma_{\bar{x}} = \frac{\sigma}{n}. \quad (8)$$

Withthesedatawecanestimateanaccuracyofaveragevaluesfor a givennumberofyearsanda standarddeviation, andidentifya period of observation (years) requiredtoobtaintheaveragevalueswith acorrespondingerror.
Lateronthetotalprobability or availabilityofeachoftheseparametersis determined by Oleksievgraphic-analytical method [8, 9] anda graph of availability is made.

III. MAIN RESULTS

Theaimofthepresentedpaperistoevaluate radio-thermalresourcesduringagrapesgrowingseasoninthe centralandsouthernOdessaregion.
A sunshineduration (SS), theamountofaverage twenty-four hours (ΣTs> 10 ° C), averagedaily (ΣTdn> 10 ° C) andaverage night (ΣTn> 10 ° C) air-temperatures, andthedifferencebetweenthedayandnighttemperatures (ΣTdn - ΣTn> 10 ° C), asthemosteffectiveindexofatemperaturesdailyrhythmduringthegrowingseasonareconsidered as thekeyindicatorsof radiation-thermal resources.
The calculationof theindexes is made on the base of theannual data from the agrometeorologicalstations(“Odessa” and

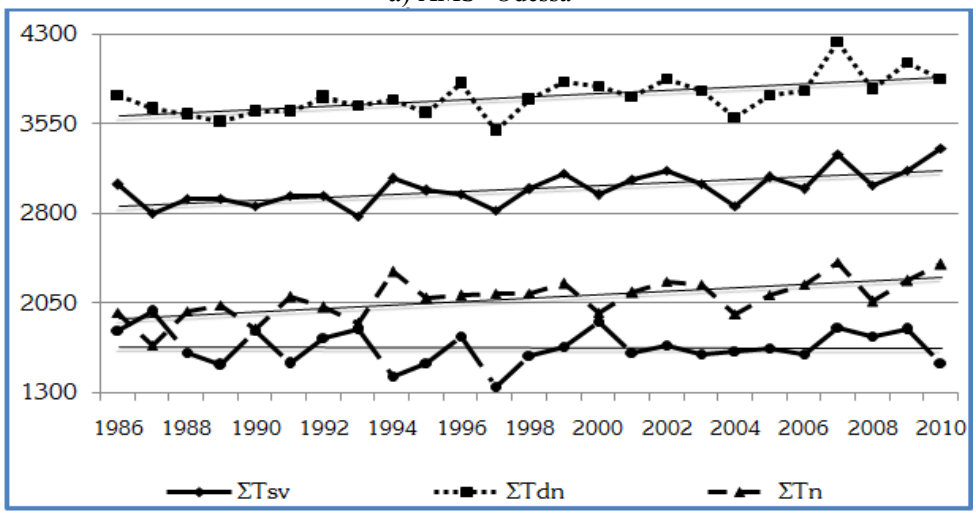
"Bolgrad") fortheperiodfrom 1986 to 2010.
Theanalyseisofthedynamicsof theseindexeswas carried out andtheirtrendsandstatisticalanalyse iswere identifiedandthetotalprobability or availabilityofeachoftheseparameterswere determined.
Forthe averageperennial amountsoft-average twenty-four hourstemperature 3014 and 3053°C forthe AMS"Odessa"and"Bolgrad" the amountsof averagedailyandaverage nighttemperaturesrespectivelyare 3784 and 3896, 2098 and 2083°C. The differencebetweenthe amountsof averagedailyandaverage nighttemperatures were1686 and 1807°C. MaximumvalueforΣTdn> 10 ° C for the AMS"Odessa"and"Bolgrad" was 4238 and 4256respectivelyin 2007; andminimumΣTnwasin 1987 and 2000 andit decreasedto 1700 and 1848°C (Table 1).
Moresignificantinterannualvariabilityofthermalresourceindexes, whichisestimatedonthecharacteristicsofa standarddeviation б anda coefficientofvariationCv is at the AMS"Odessa". Forexample, б of theamountsofaveragedailyandaverage nighttemperaturesat"Odessa"is 159 and 160°C, andatthe AMS "Bolgrad"is - 145°C and 158Cif б of the amountsofdailytemperaturesis 140 and 117°C. A sufficientlyhighvariabilityis also observe-din thedifferencebetweentheamountsofaveragedailyand average nighttemperatures - 144 and 124°C. Thecoefficientofvariationforallthe amountsof thetemperaturesdoesnotexceed 10%, whileitismoreasthe AMS "Odessa".

Theanalysisofthedynamicsofallthermal resourcesindexes was carried outandtheirtrend was determined.Itisclearlyseen (Figure 1) that the increasein the amounts ofaverage twenty-four hours, averagedailyandaverage nightairtemperatures (ΣTsv> 10 ° C, ΣTdn> 10 ° C, ΣTn> 10 ° C) from 1986 to 2010isthesameforthe AMS"Odessa"and"Bolgrad". Thetrendlinehasa formof increasing directlineswhichare practically parallel. Thedifferenceofaveragedailytemperaturesandaveragenighttemperatures (ΣTdn - ΣTn> 10°C) tendstodecrease.

Table 1 - Statisticalcharacteristicof agroclimatic indexesof thermalresourcesat the stations "Odessa"and"Bolgrad"

	X_{av}	X_{max}	X_{min}	σ	Cv, %
a) Odessa					
ΣTsv> 10 ° C	3014	3350	2774	140	4,6
ΣTdn> 10 ° C	3784	4238	3490	159	4,2
ΣTn> 10 ° C	2098	2390	1700	160	7,6
ΣTdn-ΣTn> 10°C	1686	1978	1355	144	8,6
b) Bolgrad					
ΣTsv> 10 ° C	3053	3374	2860	117	3,8
ΣTdn> 10 ° C	3896	4256	3571	145	3,7
ΣTn> 10 ° C	2089	2345	1848	158	5,9
ΣTdn-ΣTn> 10°C	1807	2245	1377	124	8,8

a) AMS "Odessa"



b) AMS "Bolgrad"

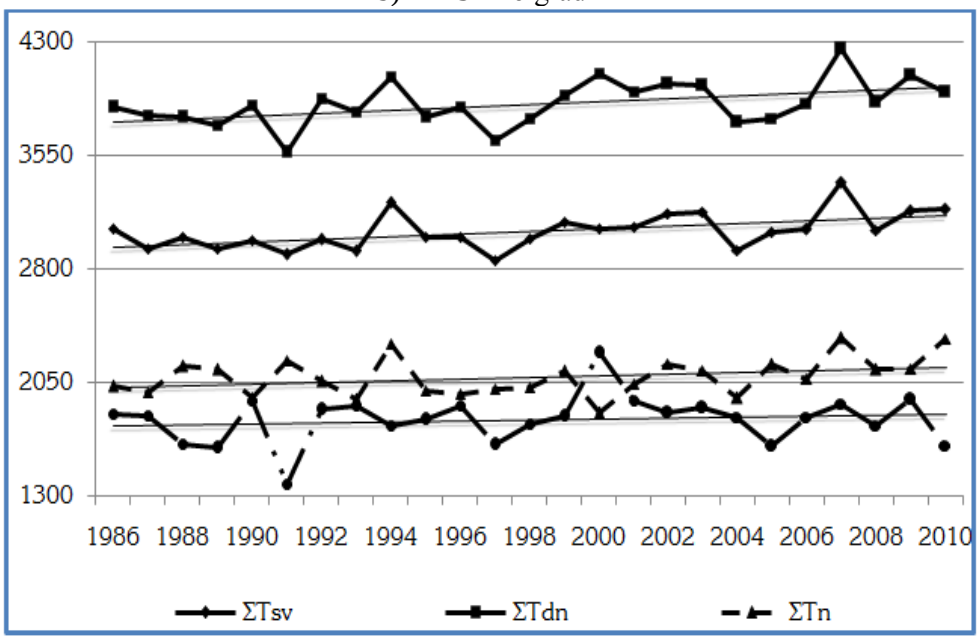


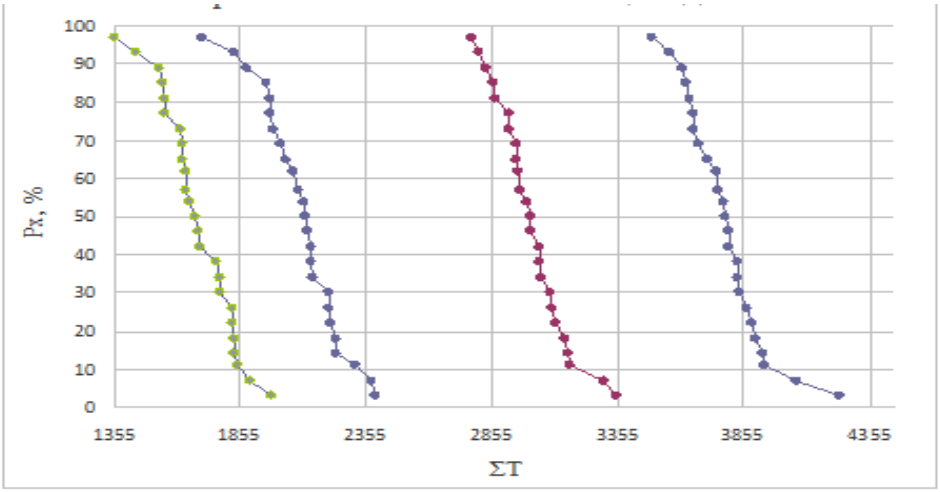
Figure 1 - The dynamics and a trend of thermal resources indexes at the agro-meteorological stations (AMS) "Odessa" (a) and "Bolgrad" (b), 1- the difference of the amounts of averagedailyandaverage nighttemperatures, 2- the amounts of average nighttemperatures, 3 - the amounts of average twenty-four hours temperatures, 4 - the amounts of daily temperatures.

Theanalysisofthedynamicsofallthermal resourcesindexes was carried outandtheirtrend was determined.Itisclearlyseen (Figure 1) that the increasein the amounts ofaverage twenty-four hours, averagedailyandaverage nightairtemperatures (ΣTsv> 10 ° C, ΣTdn> 10 ° C, ΣTn> 10 ° C) from 1986 to 2010isthesameforthe AMS"Odessa"and"Bolgrad". Thetrendlinehasa formof increasing directlineswhichare practically parallel. Thedifferenceofaveragedailytemperaturesandaveragenighttemperatures (ΣTdn - ΣTn> 10°C) tendstodecrease.

The calculations of a total probability of the amounts of the temperatures that allow to judge about their temporal variability were made (Figure 2). Built graphs of cumulative probability curves indicate practically the same density of the frequency of values distribution for all indexes and are parallel. They are nearly vertical in the limits of 20-80%. An elongation of the curves in the range of 0-20% and 80-100 indicates at a greater variability of the extreme values of the indexes.

The calculations of a sunshine duration for the period of grapes generative organs formation and the ripening period of different kinds of grapes SS 5-9 and SS 7-9) were made. In the studied area these periods last respectively from May and July to September.

a) AMS "Odessa



A sunshine duration at the agro-meteorological stations "Odessa" and "Bolgrad" for the period of a grapes generative organs formation (SS 5-9) changes from 1225 to 1650 and from 1247 to 1659 hours. The maximum duration was observed at these AMS in 2007. The minimum duration was observed in 1995 at the AMS "Odessa" and in 1990 - at the AMS "Bolgrad". The differences over the studied years are

b) AMS "Bolgrad"

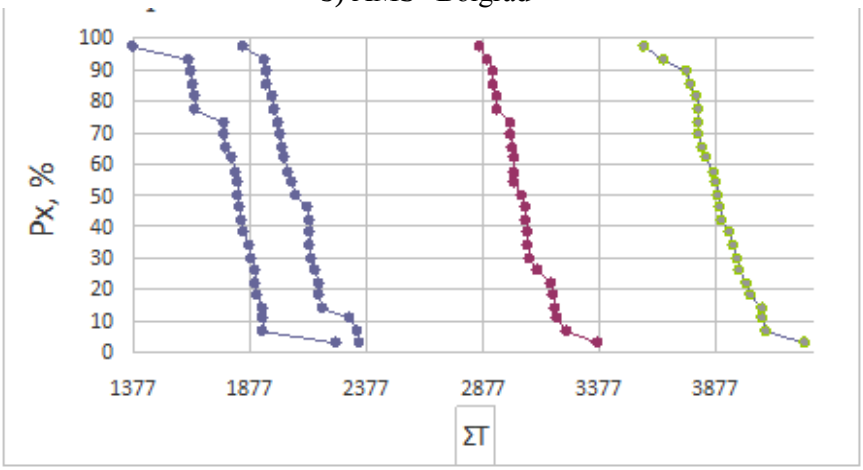


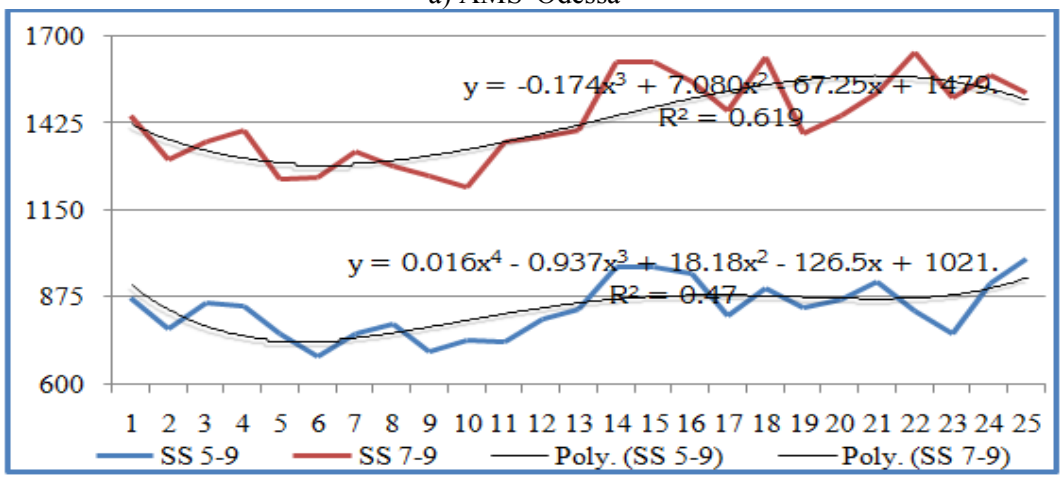
Figure 2 - Cumulative probability curves of the thermal resources at the agro-meteorological stations (AMS) 'Odessa' (a) and "Bolgrad" (b).
1- the difference of the amounts of averagedailyandaverage nighttemperatures, 2- the amounts of average nighttemperatures, 3 - the amounts of average twenty-four hours temperatures, 4 - the amounts of daily temperatures.

Respectively 425 and 412 hours.

The maximum sunshine duration for a grapes ripening period (SS 7-9) at the AMS "Odessa" and "Bolgrad" was 997 and 959 hours and was recorded in 2010 and 2003. The minimum value of this index decreased at the AMS "Odessa" and "Bolgrad" to 688 and 718 hours in 1991. Differences in a sunshine duration from July to September at these stations were 309 and 241 hours respectively.

Analysis of the dynamics and a trend of a sunshine duration according to the data from the AMS "Odessa" and "Bolgrad" shows a tendency of their increase from 1986 to 2010 (Figure 3). Moreover, in contrast to the amounts of the temperatures, a graph of the trend is represented by a curve that is approximated by a polynom of the 3rd and 4th degree. The curves of all the indexes have the same form for different absolute values. These obtained equations describe an interannual variability of the indexes.

a) AMS"Odessa"



b) AMS"Bolgrad"

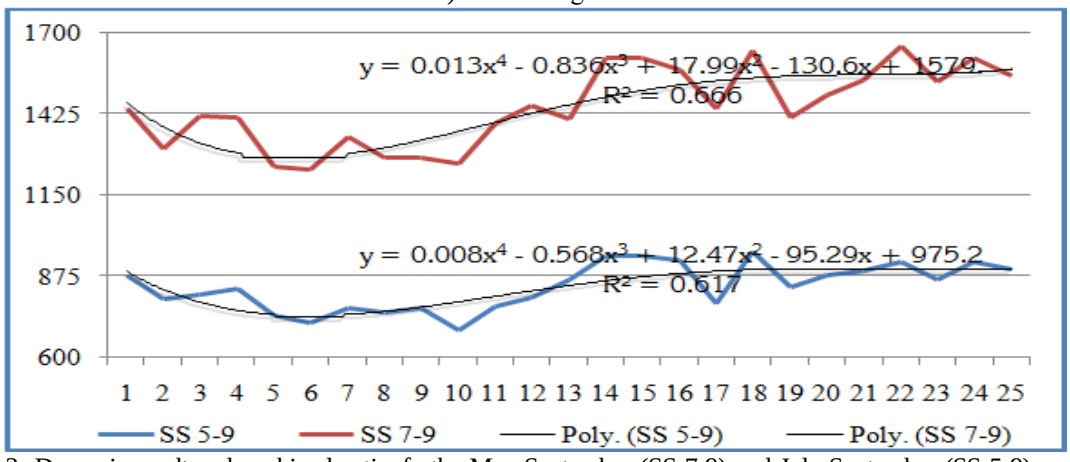


Figure 3- Dynamics andtrendsunshinedurationforthe May-September (SS 7-9) and July-September (SS 5-9) on AMC OdessaandBolgrad.

IV. CONCLUSIONS

Given studies have shown a significant variability of the light and thermal resource indexes for the period from 1986 to 2010 in the central and southern Odessa region. The limits of the absolute values of the amounts ofaverage twenty-four hours, averagedailyandaverage nightairtemperatures, the differences between the amounts of average daily andaverage nightair temperature as an index of a daily rhythm of the air temperature and a sunshine duration for May-September and July-September, as an index of the thermal resources are determined. The features of the variability were detected and a steady trend of increasing values of the indexes for the given years was found.

REFERENCES

[1]. Selyanynov G.T.Principlesof agroclimatic zoning of the USSR // Questionsof agroclimaticzoning of the USSR. – M.: the USSR MSH, 1958. - p. 7-14
[2]. Davytaya F.F.Studyofgrapes climatesinthe USSR andgrounding of their practicalapplication. Moscow– L.: Hydrometeoizdat, 1952. 304 p.
[3]. Turmanidze T.I.Climateanda grapecrop. - L.: Hydrometeoizdat, 1981. - 223 p.
[4]. Fursa D.I.Weather, irrigationand grapes productivity. - L .: Hydrometeoizdat, 1986. - 200 p.
[5]. Amyrdzhanov A.G.Sunradiationandgrapes productivity. - L.: Hydrometeoizdat, 1980. - 208 p.
[6]. Mishchenko Z.A. Dayandnightbioclimate. L.: Hydrometeoizdat, 1984. - 280 p.
[7]. Lyashenko G.V. Agroclimaticevaluationofcropproductivity. - Odessa. - 248 p.
[8]. Myschenko Z,A.Lyashenko A.V.Microclimatemappingof radiation-thermal resourcesbasedonmorphometric //Meteorology,climatologyandhydrology. - Odessa, 1995. - Vol. 30. - p.97-104.
[9]. LyashenkoG.V.Agroclimatic workshop.A schoolbook. - Odessa: TES. - 2014 - p.24-30.