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DEPENDENCE OF THE BEGINNING OF GRAPEVINE BLEEDING ON WEATHER CONDITIONS*

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Grapevine bleeding is a sign of the grape plant coming out of a dormant state after winter. Despite this, more attention of scientists is focused on budbreak. According to the literature data, grapevine bleeding begins at air temperatures above 0 ºC. The date of the beginning of grapevine bleeding is also affected by soil temperature. The purpose of this work was a more insightful study of the dependence of the date of the beginning of grapevine bleeding on weather conditions: average, maximum and minimum air temperatures, average amplitude of air temperature, total precipitation and the sum of air temperatures above 0 and +5 ºC. The research was carried out according to the phenological data of the Anapa Ampelographic collection and the Anapa weather station for 2003-2020. The equations of multiple regression of the date of the grapevine bleeding of varieties of various ecological and geographical origin and separately

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ЗАВИСИМОСТЬ НАЧАЛА СОКОДВИЖЕНИЯ ВИНОГРАДА ОТ ПОГОДНЫХ УСЛОВИЙ*

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Сокодвижение является признаком выхода виноградного растения из состояния покоя после зимы. Несмотря на это, большее внимание ученых сосредоточено на распускании почек. Согласно литературным данным, сокодвижение начинается при температурах воздуха выше 0 ºС, также на дату начала сокодвижения влияют температура почвы. Целью данной работы стало более углубленное изучение зависимости даты начала сокодвижения от погодных условий: средней, максимальной и минимальной температур воздуха, средней амплитуды температуры воздуха, суммы атмосферных осадков и суммы температур воздуха выше 0 и +5 ºС. Исследования проводились по фенологическим данным Анапской ампелографической коллекции и метеостанции Анапа 2003-2020 гг. Получены уравнения множественной регрессии даты начала сокодвижения

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of the Western European group are obtained. The coefficients of the paired correlation of the date of the beginning of grapevine bleeding with agrometeorological indicators are determined. The greatest influence is exerted by the average amplitude of air temperatures 10 days before the start of the grapevine bleeding phase – a significant pair correlation coefficient was obtained both for varieties as a whole and for groups, with the exception of intraspecific hybrids. The dependence is moderate inverse. Also, the average amplitude of air temperatures 5 days before the start of the grapevine bleeding phase has the inverse effect, but to a lesser extent. A direct weak and very weak connection of the date of the beginning of the grapevine bleeding is noted with average temperatures, the amount of precipitation for the period with temperatures above 0 ºC and sums of air temperatures above 0 and +5 ºC.

Key words: GRAPEVINE BLEEDING, GRAPE, AIR TEMPERATURE, AIR TEMPERATURE RANGE, TOTAL PRECIPITATION

сортов винограда различного эколого-географического происхождения и отдельно западно-европейской группы. Определены коэффициенты парной корреляции даты начала сокодвижения с агрометеорологическими показателями. Наибольшее влияние оказывает средняя амплитуда температур воздуха за 10 дней до начала фазы сокодвижения – значимый коэффициент парной корреляции получен как для сортов в целом, так и по группам, за исключением внутривидовых гибридов. Зависимость умеренная обратная. Также обратное влияние оказывает средняя амплитуда температур воздуха за 5 дней до начала фазы сокодвижения, но в меньшей степени. Прямая слабая и очень слабая связь даты начала сокодвижения отмечается со средними температурами, суммой атмосферных осадков за период с температурами выше 0 ºС и суммами температур воздуха выше 0 и +5 ºС.

Ключевые слова: СОКОДВИЖЕНИЕ, ВИНОГРАД, ТЕМПЕРАТУРА ВОЗДУХА, АМПЛИТУДА ТЕМПЕРАТУРЫ ВОЗДУХА, АТМОСФЕРНЫЕ ОСАДКИ

Introduction. Grapevine bleeding is the first phase of the growing season, lasts from the beginning of grapevine bleeding movement to budbreak. This phase is externally manifested in the release of sap on the surface of cut or injuring stem. Sap is a transparent liquid containing organic and mineral substances. Although in the world classifications grapevine bleeding is a phase of the beginning of vegetation [1, 2], more attention is paid to budbreak [3-7].

To a greater extent, the beginning of the phase is related to the temperature of the soil, but precipitation also affects it [8, 9]. Grapevine bleeding begins at stable air temperatures slightly above 0 ºC [10], minimum air temperatures below -2.5 ºC have a negative effect on it [9].

The date of the beginning of grapevine bleeding varies by agroecological zones of viticulture. In the vineyards of the Southern Crimea, bleeding can be in the middle of winter after several sunny days due to the heating of the soil on the southern steep slopes [10]. In the conditions of the foothill Crimea, the grapevine bleeding of the Merlot variety on the slopes of the southwestern exposure is observed on average at the beginning of the second decade of March, on the slopes of the northwestern – in the middle [11]. In the Odessa region, the average date of the beginning of the grapevine bleeding in technical and table grape varieties is April 8 [12]. In the mild climatic conditions of Anapa, the grapevine bleeding of varieties of various ecological and geographical origin begins on average on March 20-22 [13]. In the conditions of the Derbent district of the Republic of Dagestan on average in 2012-2020, the sap bleeding began at the end of the second decade of March in the varieties of the Western European, eastern and Black Sea ecological and geographical groups [14]. In the mountain-valley zone of Dagestan, table grape varieties had a date of grapevine bleeding ranging from the middle of the second decade of March to the end of the third. In the plain zone – the first or second decade of March [15]. In the sheltering zone of the steppe with kolkis of the Altai Ob region, grape juice bleeding began under an earthen shelter in the II–III decades of April [16]. The beginning of the grapevine bleeding of table varieties *Vitis vinifera* L. in the conditions of the Sughd zone of Tajikistan was observed on average at the end of the third decade of March – the beginning of the first decade of April [17].

The purpose of this work was to determine the dependence of the date of the beginning of the grapevine bleeding on weather conditions in the Black Sea agroecological zone of viticulture.

Materials and methods. The objects of the study are varieties of various ecological and geographical origin growing on the territory of the Anapa ampelographic collection of AZESV&W – a branch of the NCFSCHVW. Data on the beginning of the grapevine bleeding were taken from 2003 to 2020. The base year is 2019, in numerical format January 1, 2019 is equal to 43466.0 in Excel.

Meteorological data from the Anapa meteorological station from 2003 to 2020 were used [18]. The average, maximum and minimum temperatures, the average amplitude of air temperature, the sum of air temperatures above 0 and + 5 ºC, the total precipitation for certain periods before the start of grapevine bleeding are calculated.

The ridge regression method for creating models was applied in the Statistica program [19,20]. A step-by-step procedure with exception was chosen, an intercept was also included in the model. The Lambda was taken 0.2 to eliminate the effect of multicollinearity between independent variables. Multiple regression equations were considered significant if the actual Fisher criterion was higher than the tabular one. The accuracy of the model was determined by the coefficient of determination (R^2) – if it was higher than 0.15, then the model was considered satisfactory.

Discussion of results. Firstly, the necessary meteorological indicators were calculated for the date of the beginning of sap bleeding for 113 varieties of various ecological and geographical origin, ripening period and direction of use to determine the dependence of the beginning of the grapevine bleeding phase on weather conditions. This complete regression analysis revealed common patterns. The greatest influence is exerted by the average amplitude of air temperatures for 5 and 10 days before the start of the phase, and the dependence is moderate inverse. Correlation coefficients are -0.32 and -0.36, respectively. A direct weak dependence of the date of the beginning of the grapevine bleeding is noted on the total precipitation for the period with temperatures above 0 ºC (r = 0.26). A direct very weak dependence is noted on the sum of air temperatures above 0 ºC and +5 ºC. Correlation coefficients are 0.19 и 0.16, respectively.

The multiple regression equation of the beginning of grapevine bleeding for 113 varieties (1):

$$Date_{GB} = 0.38X_1 - 0.43X_2 - 0.84X_3 - 0.56X_4 + 0.93X_5 - 1.03X_6 - 0.4X_7 - 0.3X_8 + 0.03X_9 - 0.02X_{10} + 0.01X_{11} + 43549.09 \quad (1),$$

where X_1 – the average air temperature for 5 days before the start of grapevine bleeding;

X_2 – the average amplitude of the air temperature for 5 days before the start of grapevine bleeding;

X_3 – the average amplitude of the air temperature for 10 days before the start of grapevine bleeding;

X_4 – the average air temperature for the period from the transition of air temperature upward through 0 ºC to the beginning of grapevine bleeding;

X_5 – the average air temperature for the period from the transition of air temperature upward through +5 ºC to the beginning of grapevine bleeding;

X_6 – the average amplitude of the temperature for the period from the transition of air temperature upward through +5 ºC to the beginning of grapevine bleeding;

X_7 – the maximum air temperature for the period from the transition of air temperature upward through 0 ºC to the beginning of grapevine bleeding;

X_8 – the minimum air temperature for the period from the transition of air temperature upward through +5 ºC to the beginning of grapevine bleeding;

X_9 – the total precipitation for the period from the transition of air temperature upward through 0 ºC to the beginning of grapevine bleeding;

X_{10} – the total precipitation for the period from the transition of air temperature upward through +5 ºC to the beginning of grapevine bleeding;

X_{11} – the sum of the air temperature is greater than 0 ºC to the beginning of the grapevine bleeding.

The equation explains 30.5 % of the variability of this indicator. The multiple correlation coefficient is 0.54. Fischer's criterion is fulfilled. The standard error of regression estimation is 5.63. The observed and predicted dates of the beginning of the grapevine bleeding according to the regression equation (1) are shown in Fig. 1.

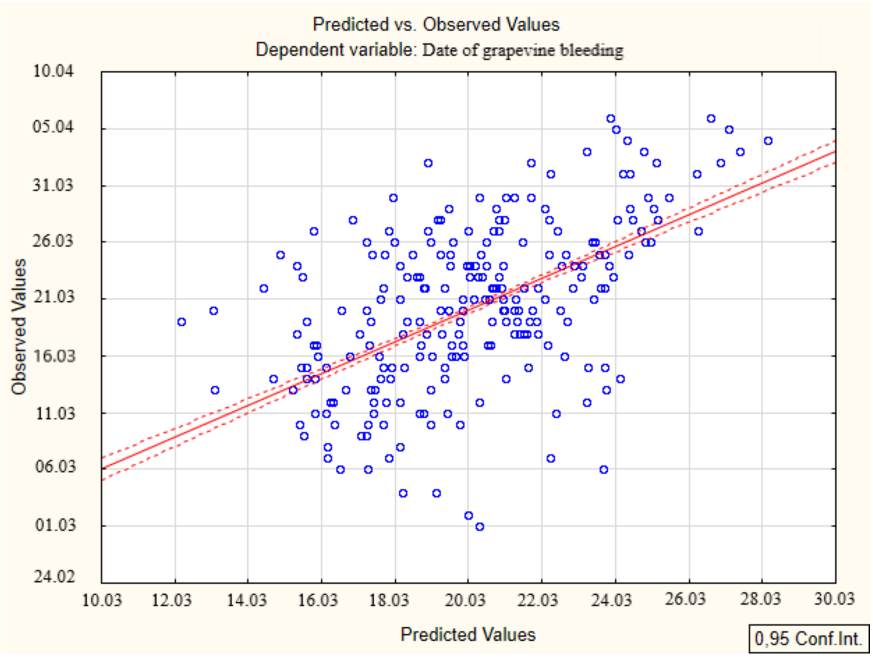

Fig. 1. The observed and predicted dates of the beginning of the grapevine bleeding for 113 varieties of various ecological and geographical origin

The patterns of the influence of weather conditions on varieties by ecological and geographical origin were investigated in addition to the general multiple regression equation for varieties of various ecological and geographical origin.

According to the results of paired regression, there are a significant moderate inverse dependence of the date of the beginning of the grapevine bleeding of Western European grape varieties on the average amplitude of the air temperature for ten days before the start of the grapevine bleeding (r = -0.43), a significant weak inverse dependence on the average amplitude of the air temperature for five days before the start of the grapevine bleeding (r = -0.29), a significant weak direct dependence from the average air temperature for five days before the start of grapevine bleeding (r = 0.28), the average air temperature for the period with temperatures above +5 ºС (r = 0.24) and the total precipitation for the period with temperatures above 0 ºС (r = 0.23).

Also, for the varieties of the Western European ecological and geographical group, the multiple regression equation of the date of the beginning of grapevine bleeding (2) was obtained:

$$Date_{GB\ WE} = 0.84X_1 - 2.11X_2 + 43551.94 \qquad (2),$$

where X_1 – the average air temperature for 5 days before the start of grapevine bleeding;

X_2 – the average amplitude of the air temperature for 10 days before the start of grapevine bleeding.

The multiple regression coefficient is 0.54, the equation explains 29.3 % of the variability of the date of the beginning of grapevine bleeding for varieties of the Western European ecological and geographical group. Fischer's criterion is fulfilled. The standard error of regression estimation is 4.92. The observed and predicted dates of the beginning of the grapevine bleeding according to the regression equation (2) are shown in Fig. 2.

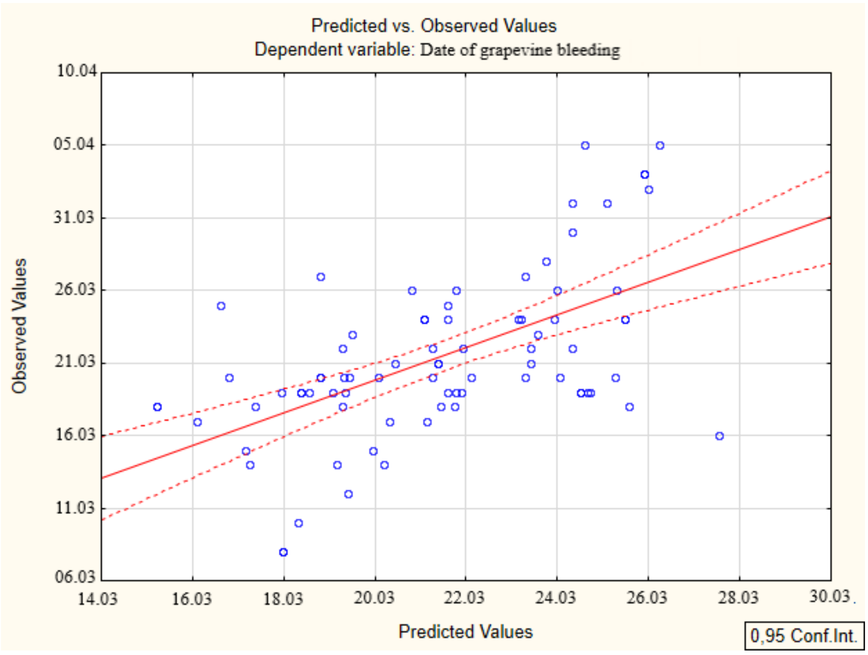

Fig. 2. The observed and predicted dates of the beginning of the grapevine bleeding for the varieties of the Western European ecological and geographical group

The average values of the most important agrometeorological indicators for the beginning of grapevine bleeding were calculated for the varieties of the Western European ecological and geographical group (tab.).

The values of the average air temperature for 5 days before the start of grapevine bleeding and the average amplitude of the air temperature for 10 days before the start of grapevine bleeding for varieties of Western European ecological and geographical origin for the period 2003-2020

Variety	The average air temperature for 5 days before the start of grapevine bleeding, ºC	The average amplitude of the air temperature for 10 days before the start of grapevine bleeding, ºC
Cabernet Franc	7.9	6.1
Cabernet Sauvignon	8.6	6.5
Merlot	7.6	5.5
Riesling Italien	7.7	6
Sauvignon Blanc	7.4	6.2
Cinsault	8	6.8
Roter Traminer	7.7	6.1

For the remaining groups of varieties – the Eastern, the Black Sea basin, interspecific and intraspecific hybrids, the equations obtained by the ridge regression method were not significant according to the Fisher criterion.

There is a significant moderate dependence of the date of the beginning of grapevine bleeding of varieties of the Eastern ecological and geographical group on the average amplitude of air temperature for five and ten days (r = -0.42 and r = -0.44, respectively), direct – with total precipitation for the period with air temperature above 0 ºC (r = 0.40) according to the results of pair correlation.

The date of the beginning of the grapevine bleeding of varieties of the Black Sea basin has a significant moderate dependence on the average amplitude of air temperature for ten days (r = -0.35).

The date of the beginning of the grapevine bleeding of varieties of intraspecific origin *Vitis vinifera* L. it significantly depends on the amplitude of the air temperature for the period from the transition of the air temperature through +5 ºC upward to the beginning of grapevine bleeding (r = -0.26 – weak dependence).

The date of the beginning of sap bleeding of varieties of interspecific origin has a significant moderate dependence on the average amplitude of air temperature for five and ten days before the start of grapevine bleeding (r = -0.31), a significant weak direct – with the total precipitation for the period with air temperatures above 0 ºC before the start of grapevine bleeding (r = 0.24), with the sum of air temperatures above 0 ºC (r = 0.26) and +5 ºC before the grapevine bleeding (r = 0.20).

Conclusions. A multiple regression equation is obtained for the beginning of the grapevine bleeding of varieties of various ecological and geographical origin. The coefficients of the paired correlation of the date of the beginning of grapevine bleeding with agrometeorological indicators are determined. The greatest influence is exerted by the average amplitude of air temperatures for 5 and 10 days before the beginning of the grapevine bleeding phase. The dependence is reversed.

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