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Study of Compatibility of Grape with East-Azerbaijan Climate

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ABSTRACT

One of the major issues of increasing agricultural production, is adaptation of technology to specific climatic variables in cultivated areas. Knowing the weather and climatic condition and periodic yearly and multi-year changes of meteorological phenomena and deviations from normal values are of major requirements of modern agriculture. In this study, daily, monthly and annual weather data of synoptic stations in East-Azerbaijan province was gathered from Iran Meteorological Organization and then, the homogeneity of data were examined by run test method. To study agro-climatic features of viticulture, deviation from optimal conditions and the degree of active days index (GDD) methods are used. Based on the analysis of deviations from optimal conditions at different altitudes in the study area, Malekan station has optimal conditions for planting, among the stations. This is important in terms of development of cultivation areas and commercial production of crops. Based on the agro-climatic analysis, South and Northeast regions (Malekan and Ahar stations) are most suitable areas of viticulture in the province.

Keywords: Climate, grapes, deviation from optimal conditions, phenology, East-Azerbaijan Province

INTRODUCTION

Agriculture is considered as one of the basic measures and foundations of development and self-sufficiency in Muslim countries. In Muslim countries, especially developing countries, agriculture has a vital role in national development, and improving food security would not be feasible, but with an emphasis on increasing domestic production. Holden et al (2004), Kapyrv et al (2002) in their study named “Potential weather conditions associated with the production of grapes in the Columbia Valley” came to this conclusion that the main climatic factor in limited grape production of low temperatures (the critical value range, ≤ -6 ° C to ≤ -23 ° C) occurred in the late October, November, December and February and also reaching temperature ≤ -9° C during the daytime, which is of destructive effects of rainfall in late October happening with the initial movement of the Arctic front, have caused a drop in production of grapes in the Columbia Valley. Allen (2003) in a paper named “Multi-criteria classification climate for growing grapes, all over the world” concluded that the annual variability of the climate in warm areas is performed with more than one harvest a year. This system is a research tool for growing zoning of grapes. Multi-criteria climatic classification system is also capable to work at different scales of regional and global. Antonio and Jorge (2005) studied the climatic potential of

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wine production in tropical north of Meena region in Jrays in Brazil, using MSS method and three references. They concluded that the northern region of Meena state in Jrays in Brazil has great potential for wine-making, especially in autumn and winter. Jones (2005) studied the climatic changes effective on growing grape in the West, the United States and concluded that the analysis of the growing season, average temperature, and degree-days, annual and seasonal has passed the spring and first fall occurrence and duration of main freezing-free season of grape growing areas that happened in California, Oregon and Washington from 1948 to 2002 , on average, have experienced more grape growth in warmer regions. Cherly (2008) studied the breeding of grapes cultivars in easten climate of the United States and concluded that the two cultivation programs of grapes in cold climates, show promising results, and a new group of hybrids have interspecific features that are developed by breeders in Cornell University and the University of Minnesota and are suitable, particularly, for growing in colder climate zones. Balva et al (2010) studied the grape quality aspects and the relationship between water scarcity, growth and concentration of sugar, in two sites in Heliobliana University in Hungary. They concluded that pore adjustment leads to limited carbon absorption in each unit area of leaves. Water deficit leads to yield reduction and decrease of larger grains within the cluster; therefore, grain size is the only factor that can not affect the glucose concentration. Lack of water is also effective in reducing leaf area; consequently, these factors have led to the modification of crown architecture.

MATERIALS AND METHODS

Each scientific reseach requires the application of appropriate methods throughout its scientific proces. It need s accurate data gathering and application of appropriate analytical methods . So, in this study, in order to achieve the objectives and find the answers of research questions , and approve or reject the hypothesis , local climatic elements are analyzed, using methods that would be discussed later . Next, the methods used in the study has been presented. In this study, minimum and maximum daily temperature parameter of 2011-2001 period in East-Azerbaijan province have been used. (Meteorological Organization of East-Azerbaijan Province, 2011-2001), Table (1).

Table 1. Characteristic of East-Azerbaijan Province Meteorological Stations

Altitude, m	Longitude		Latitude		Station
minute	degree	minute	degree	minute	
06	Tabriz	17	38	06	Tabriz
26	Ahar	04	38	26	Ahar
15	Haris	06	38	15	Haris
09	Malekan	05	37	09	Malekan

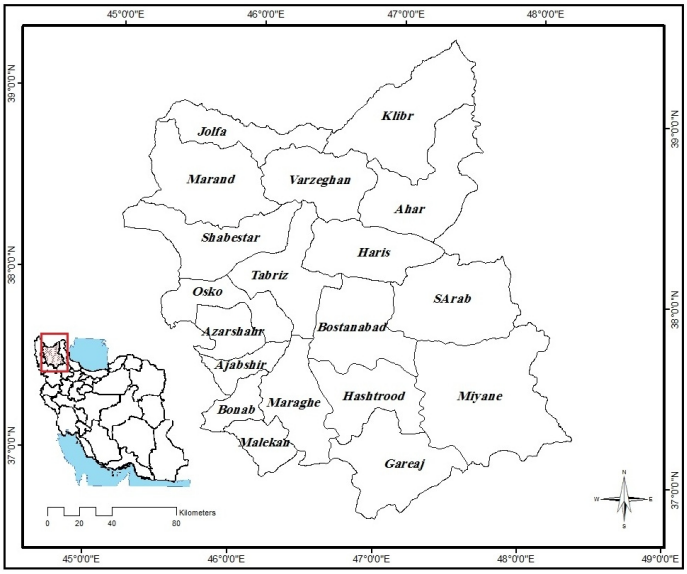

Figure 1. Study area

Method of deviation from the optimal conditions

Determination of the optimal time for each area, based on weather stations' data and daily temperature of crop growth is important. There are four phenological stages for grapes plant and each stage has an optimal temperature, at which the maximum growth rate occurs at this temperature. Identifying and determining the optimal point for each phenological stage and the mean daily temperature resulted from monitoring minimum and maximum daily temperatures; one can determine various optimal times, particularly months of a year, and actually, the time which has the least deviation from the optimal condition, would be considered as the optimal time. In this method, to obtain the optimal of different time intervals, optimal points or optimal temperatures were first determined and then, considering the average of daily data, deviations from the optimal conditions were calculated for 3 decades of each month. For this reason, first, each month was divided into three different decades, and then, the average of each decade was calculated, that in total, the averages of 36 decades are calculated for each station. Next, the deviations of the averages from the optimal points are calculated; consequently, the deviations from the optimal conditions are obtained for the above time intervals and the results are tabulated.

Method of thermal coefficient or total degrees of active days

Most biological changes such as the growth of plants and some hydrological phenomena are a function of the ambient temperature. For this purpose, the index of degree - days will be used as thermal need. Each process is activated from a certain temperature threshold, and the growth value depends on the number of degree - days more than this threshold. If the number of degree – days is zero or a negative value, that day would have no effect on growth. In order to grow in a specific area, each plant requires a certain number of degree-days that the area must be able to supply throughout the growth period. Otherwise, even if water is available in the area, the plant should not be recommended for planting in agricultural projects. Therefore, growth season in each area is defined as the longest continual period in which the number of degrees - days required to supply the plant is provided. To determine the thermal need of plants, method of the sum of effective temperatures is implemented. The principle of this method is to calculate the total summation of effective temperatures, i.e.

temperatures above the base zero biological zero of a plant. This temperature depends on the type of the plant. 0C° for grapes is calculated by the following equation.

$$H_U = \sum_i^n \left[\frac{T_M + T_m}{2} - T_t \right]$$ Equation (1)

H_U : Thermal unit (degree-days) accumulated in N days.

T_M : Maximum daily temperature

T_m : Minimum daily temperature

T_t : Base temperature

N: Number of days in a selected period

Since we intend to grow grapes and according to summation of positive value temperatures, grapes plant should acquire 3750 degree-days. Therefore, in this study we have used the method of calculating degree-days. In this study, the active method, amongst the most common methods to estimate thermal units, is used. To calculate the summation of temperature, there are two main methods including effective sum and active sum, and active sum method is used in this study.

A – Sum of degrees of active days

To sum up the temperature, the values of all daily temperature (without subtracting the base temperature) and during the period of active growth, are added together. Computational equation is as follows.

Equation (2)

$\frac{TMin + Tmax}{2}$ If the $\frac{TMin + TMax}{2} >= Tt$

In this equation, tmin, tmax are the minimum and maximum daily temperature, respectively, and Tt is a biological temperature. In active temperatures method that has been used in this study, the total sum of positive daily temperature is used; but only for the days when the average temperature is greater than the biological threshold or biological zero point. All values more than 5C° will be considered and values less than 5C° will not.

RESULTS

Deviation from optimal conditions

Four phenological stages have been considered in grapes plant which are significant in terms of agro-climatic matters; including: germination stage, flowering stage, stem maturation stage, and grapes ripening stage. Each stage has an optimum temperature, in which, the maximum growth rate occurs. In order to study the grapes plant species, phenologically, according to this study, mid-mature plant varieties which are more common in the region, are condidered as the basis. Table 2 shows the deviation from the optimal conditions for each phenological stage of grapes based on the average daily temperature at selected stations.

According to the results of germination and flowring stage, Malekan station has less deviation and more optimal conditions than the other stations. In the stem-maturation stage, Malekan station has less deviation than the other stations; however, there are not significant differences in terms of deviations from optimal conditions. The fully ripening stage of grapes plant,

Malekan Stations has lower deviations which is followed by Ahar and Haris stations and Tabriz show more deviation; consequently, in all stages, Malekan station has least deviation from optimal condition, this means that this station has the optimum conditions for the grapes plant growth.

Table 2. Determining the deviation from optimal condition of grapes plant phenological stages in selected stations

Total deviations	Grapes ripening		Stem maturation		Flowering		germination		Growth stages / station
	Deviation from condition	optimum	Deviation from condition	optimum	Deviation from condition	optimum	Deviation from condition	optimum	
-48.94	-10.66	25-35	-15.34	25-35	-16.13	25-30	-6.82	15-20	Haris
-51.33	-11.09	25-35	-15.84	25-35	-161.8	25-30	-7.59	15-20	Tabriz
-49.76	-10.32	25-35	-15.61	25-35	-16.39	25-30	-7.44	15-20	Ahar
-47.85	-9.85	25-35	-15.30	25-35	-15.86	25-30	-6.85	15-20	Malekan

Results of phonological analysis

Application of thermal coefficients in agricultural problems and the regulation of agricultural calendars in different areas is of significance. In spite of lack of the extensive phenological studies, using agricultural meteorological studies conducted by Quanta engineers with cooperation of Romanian consultants an applying their methods, active days degree and determination of length of phenological stages were studied according to various thresholds

Optimal time, based on active days degree method

Another method to determine the optimal time for agricultural climate, based on the latest incidence of minimum thresholds at each phenological stage of grapes plant, is active temperatures' method that it is used in this study. The total daily temperatures with positive values are used, but only for the days when the temperature is greater than the average of biological thresholds or zero point of activity. In this study, the basis for calculating the thermal coefficients has two types: one based on a minimum threshold of grapes plants at each stage, and the other is zero degrees Celsius. Thermal thresholds of grapes plants in different phenological stages are illustrated in table 3.

Table 3. Temperature thresholds of grapes plants in phonological stages

Maximum Temperature, degrees Celsius	Favorable Temperature, degrees Celsius	Minimum Temperature, degrees Celsius	Phonological stages
30	15-20	9	Germination
45	25-30	14-15	Flowering
More than 35	25-30	10	Stem maturation
More than 35	25-35	-5	Grapes ripening

Reference: Quanta, 1974

Since plant species are highly dependent on temperature, the monitored daily minimum temperature is used for phenology of the grapes plant. By specifying thresholds of phenological stages of grapes plant and accurate daily temperatures, completion date of each stage is calculated. For all stations, incidence date of minimum threshold of grapes plant activation at greater than 0C° is considered. In order to obtain the completion date of phenological stages of grapes plant in germination stage 320, the flowering stage 475, stem maturation stage 1200 and fully ripening stage of grapes plant, 3750 thermal units are necessary. According to Table 4, the date of germination, flowring and stem maturation of

grapes plant occurs earlier in Malekan and Ahar stations. Completion date of phenological stages of grapes plant in selected stations are shown in Table 4.

Table 4. Completion date phenological stages of grapes plant

Grapes ripening on	Stem maturation date	Flowering date	Germination date	Minimum threshold incidence date	Altitude	Station
7 October	15 June	6 May	22 April	24 March	1373	Haris
10 October	18 June	9 May	26 April	26 March	2142	Tabriz
27 September	12 June	2 May	21 April	21 March	1522	Ahar
23 September	11 June	1 May	19 April	21 March	1883	Malekan

Completion date of each phenological stages is a favorable method to determine the best time of viticulture based on critical threshold, as well. Calculated dates are consistent with the optimum time.

The proposed varieties for viticulture according to climatic conditions

According to the climatic conditions of each region, suitable grape varieties should be selected for cultivation of grapes plant. According to the agro-climatic conditions of the study area, grapes varieties suitable for the cultivation include yellow and red raisin and Fakhri. Suitable varieties of grapes for cultivation in East-Azerbaijan province are raisins, Asgari, Fakhri, Khoshnavar and Rah-Shah.

CONCLUSION

The environment, in which we live, consists of a series of factors including weather conditions and climatic related phenomena Weather conditions, is one of the factors determining the type of plants that are cultivated in any region. Agricultural activities are highly interconnected with natural factors and climate and environmental conditions.

Weather conditions is on top of the natural factors affecting agricultural activities, by which it affect the agriculture, either with a single element or a combination of several elements. Iran, having a special climate in each area, has suitable ground for production of various strategic agricultural crops and climatic parameters, illustrate different types of climates in the territory. Knowing the God-given gifts and the need of the region for researches like this, which shows the local agro-climatic potentials for cultivation of grapes plant, this study is conducted. Based on analysis of deviations from optimal conditions at different altitudes of the stations, Malekan station has the optimum conditions for grapes planting, among selected stations.

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