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STRESS DEVELOPMENT AND MOISTURE DEPLETION IN A VINEYARD UNDER DRY FARMING CONDITIONS OF SOUTHERN IRAN[1]

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ABSTRACT

Soil water depletion (measured by neutron probe) and soil water suction (measured by calibrated gypsum blocks) of a dry farming vineyard were determined for one growing season. The water depletion rate from 100 cm of soil profile was slow during the early part of the growing season, rapid during fruit ripening and slowed again at post-harvest. Soil water suction at 15 cm depth was relatively high at the beginning of growing season, increased rapidly and approached 15 bars in mid-June. The suction in the most concentrated part of the root zone (75 cm depth) was fairly constant in the early growing season, increased rapidly during fruit ripening and approached 15 bars in late summer, causing no sign of wilting. The yiled and the quality of the grapes were comparable to the crops of the same variety being irrigated 2-3 times during the growing season.

INTRODUCTION

Grape production under dry farming condition is very common in Southern Iran where precipitation occurs during the winter and early spring followed by a dry and fairly hot growing season. The vines are usually grown on alluvial soils at the bottom slopes of mountains surrounding agricultural valleys. Under such conditions, the soil profile generally consists of a gravelly coarse-textured layer overlying a deep fine textured stratum. The growing season starts in mid-March, and the time of harvest depends on the variety of the grape. The most common local varieties adapted for dry farming are Yaghuti, Askari and Sahabi, belonging to the species *Vitis Vinifera.* These varieties are harvested approximately in mid-May, early July and late August, respectively. The Askari variety is very similar to the famous 'Thompson seedless' of America, and is used both as a table and raisin grape in Iran.

A grapevine is considered by Winkler (5) Hendrickson and veihmeyer (3), and Kasimatis (4) to be a drought resistant plant. This characteristic is a reflection of the vine's ability to adjust itself to very low available soil moisture. When soil moisture is not sufficient for full growth, the shoots will stop growing, and the leaves will be smaller in size and fewer in number (4, 5). In the extreme case, when the soil moisture throughout the root zone approaches the wilting point, the vine may drop some of its leaves to reduce transpiration (4). Winkler (5) states that vine roots have a unique ability to extract water from the soil. The roots usually draw all of the available moisture from their surroundings, and after that grow in the direction of moisture gradient to extract more water. Therefore as Winkler believes, in a deep and well drained soil with a good moisture holding capacity, vines rarely wilt, provided that the soil water reservoir is completely filled prior to the beginning of the growing season.

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The results of experiments done on the response of vines to a lack of available soil moisture is fully discussed by Kasimatis (4). He concludes that most of the results of such experiments are based on observations, and quantitative measurements of moisture stress vs. plant response are lacking. Nowhere in the literature can one find any experimental results to show the lower limit of moisture suction in the root zone before the vine growth is significantly affected.

The purpose of this investigation was to determine the scheme of stress development and moisture depletion in the root zone of a dry farming vineyard during the growing season.

MATERIALS AND METHODS

The experiment was conducted on a typical vineyard located at the southern slopes of Akbar-Abad foothills, 6 kilometers north east of Shiraz, in 1968. Climatic conditions of the region can be visualized by a tabulation of the mean monthly weather factors (Table 1). The soil profile consists of a top 25 cm of gravelly loam, underline by a 60-70 cm layer of stony sandy loam soil below which there extends a thick layer of fine textured material. Table 2 represents some physical properties of these three distinguished layers.

The vineyard was 5 hectares in size, consisting of Askari and Sahabi varieties of grapes. They were planted irregularly with an average distance of 6 meters between two adjacent vines, giving a plant population of approximately 1100 vines/Ha. The vine roots were dominant down to 100 cm depth, below which they were scarce in number.

Among the Askari Variety in this vineyard, six vines were randomly chosen in early March. Gypsum blocks were installed at 50 cm distance from each vine and at 3 depths of 15, 50 and 100 cm. They were calibrated in the laboratory to give a measure of soil water suction. Resistance measurements of the units were made periodically by a Bouyoucos meter with an average of 10-days intervals. All daily readings were taken just before sunrise to minimize the temperature effect. Soil water content was measured by a neutron probe apparatus manufactured by Troxeler Electronics, Inc.

The use of Neutron scattering technique for measurement of moisture depletion in soil profile is now a standard method (2) and has been used by the author in a previously reported investigation (1). Aluminium access tubes were installed at 0.5 and 3 meter distances from the 6 chosen vines down to a depth of approximately 110 cm. Neutron readings on each tube at depth intervals of 15 cm were made on the same day when the resistance measurements were taken on the gypsum units. Harvesting was started on July Ist and ended on July 15th. Yield measurements were made on each of the six chosen vines. Using the proper calibration curves, electrical resistence data and neutron readings from one meter of soil profile were converted to soil water suction and soil water depth, respectively. During early days of the growing season, some rainfall occured which was taken into account in calculating soil moisture depletion.

RESULTS AND DISCUSSION

Time variation of water content and moisture suction in one meter depth of the soil profile is shown in Figure 1. In this figure curve A represents moisture depletion from the soil profile due to evapotranspiration. Each point is the average of 6 single figures measured at 0.50 and 3 meter distances from the 6 chosen vines. The curve shows that there appears to be no difference between values for the two distances from the trees, indicating a laterlly uniform moisture removal. The curve is relatively flat at both ends and fairly sharp in the middle. The middle part of the curve corresponds to the time of berry formation and fruit ripening; and greater evaporative demand of the warmer days of the summer. After the harvest, moisture depletion seems to slow down indicating a lower rate of water use by the plants.

Curves B and C represent the time variation of average moisture suction at 15 and 75 cm depth, respectively. There is a sharp increase in moisture suction at 15 cm depth just at the beginning of the growing season indicating a rapid water loss due to surface evaporation. After June 8, the value of misture suction at 15 cm depth was very high. Figures for curve C were obtained by taking the average of measured suctions for 50 and 100 cm depths and was considered as the average moisture suction at 75 cm depth. The best fitted curve to the observation points has an S shape, indicating a very small increase in suction during the vegetative growth and for the most part of the flowering and fruiting periods, followed by a sharp increase approximately 2 weeks prior to harvesting. Subsequently, the curve is leveling off in late summer, as evapotranspiration is reduced. The maximum of 14 bars moisture suction was measured in early October. No sign of wilting was observed on any of the vines when the last observations were taken. However, the sign of moisture stress could be seen on all vines. The average yield for the six chosen vines was 11.3±0.9 kg per plant (approximately 12.4 Tons/Ha) which is comparable to the same vine variety receiving a small amount of irrigation. The quality of the grape, as it was observed by the fruit size and taste, was also comparable to the irrigated vines in the vicinity.

The scheme of moisture removal by vines as is reported here, is in general agreement with the findings of previous investigators. The results of Hendrickson and Veihmeyer's (3) studies on the water use pattern of the Thompson seedless variety, coincides fairly well with curve A of figure 1. However, the total moisture loss for the growing season under the conditions of this experiment is considerably smaller than that in the experiment reported by Hendrickson and Veihmeyer (3). This can be explained partly by the climatic differences of the two locations; but the main reason for the difference might be the fact that the moisture measurements in the experiment reported here, was limited only to 100 cm depth, and therefore some upward moisture flow might have occurred from the lower fine textured layer to the vine root zone layer. If this is the case, the total plant moisture used would have been greater than what is measured. Further investigations is needed to clear this point.

The pattern of water suction increase in the vine root zone, as is reported here, corresponds fairly well with the moisture use pattern at different stages of plant growth. It is also indicative of the fact that the suction in the vine root zone approached the conventional 15 bars wilting point without causing the actual wilting and serious adverse effects on the yield.

Table 1. Average monthly weather data for a nearby Station, Akbar-Abad, 1968[3]

Months	Mean Max. Temp. C	Mean Min. Temp. C	Mean Relative Humidity%	Precipitation mm.
January	13.7	-2.8	38	18.6
February	9.8	-1.3	60	88.4
March	19.1	3.2	45	46.6
April	21.3	5.9	38	41.2
May	28.2	10.5	27	0.7
June	35.3	14.1	16	0
July	36.2	17.5	15	0
August	36.8	17.8	19	0
September	33.4	12.4	14	0
October	28.4	6.9	15	1.6
November	21.4	3.3	30	6.7
December	14.7	1.7	49	104.0
				318.8

3. The station was located at Bajgah, 6 Km North of the Experimental site.

Table 2. Some Physical Properties of the Soil Profile

Depth (Cm)	Texture	Bulky density $^{g}/cm^{3}$	PWP[4]
0-25	Gravelly loam	1.44	9
25-90	Stoney sandy loam	1.47	7
90-105	Silty clay loam	1.26	12

4. Permanent wilting percentage based on dry weight water content corresponding to 15 bars suctions.

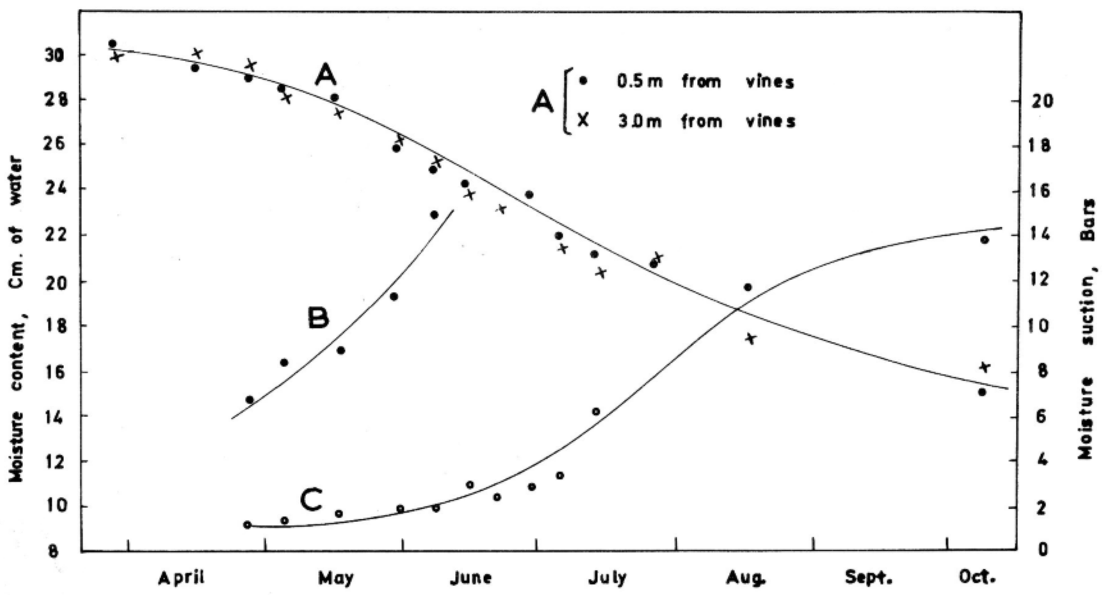

Figure 1: Time variation of soil water depletion and soil water suction. (A) water depletion down to 100 cm depth. (B) Average water suction at 15 cm depth. (C) Average water suction at 75 cm depth.

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