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DYNAMICS OF SOIL MOISTURE IN VINEYARDS UNDER WATER AND THERMAL STRESS CONDITIONS

DINAMICA UMIDITĂȚII SOLULUI ÎN PLANTAȚIILE VITICOLE ÎN CONDIȚII DE STRES HIDRIC ȘI TERMIC

ZALDEA Gabi¹, NECHITA Ancuța¹, DAMIAN Doina¹,
ALEXANDRU L. C.¹

e-mail: gabizaldea@yahoo.com

Abstract. At the Copou - Iasi viticulture center, in recent years we witnessed a decrease in the multi - annual average rainfall regime, this being of 579.6 mm and of 398.1 mm (1981-2010) during the vegetation period. Between 1992 - 2014, the driest years were 2000, 2007, 2009 and 2012. Drought conditions were also in 2015 and 2016, having different characteristics. In 2015, there were few precipitations accompanied by high temperatures, often above 30°C. The amounts of rainfall recorded in 2016 were very unevenly distributed, thus there were recorded months with very low quantities, well below the normal values and months when quantities were higher than the normal values. Low rainfall and high temperatures have led to a sharp decline in accessible soil moisture values, well below optimal humidity levels for the vine, and to increased deficit.

Key words: temperatures, low rainfall, soil moisture, vineyard

Rezumat. În centrul viticol Copou - Iași, în ultimii ani, asistăm la o scădere a regimului de precipitații media multianuală fiind de 579,6 mm, iar în perioada de vegetație de 398,1 mm (1981-2010). În perioada 1992 - 2014, cei mai secetoși ani au fost 2000, 2007, 2009 și 2012. Condiții de secetă au fost și în ani 2015 și 2016, cu caracteristici diferite. În 2015 au fost precipitații puține coroborate cu temperaturi ridicate, frecvent peste 30°C. Cantitățile de precipitații înregistrate în anul 2016 au fost foarte neuniform repartizate, astfel au fost luni în care s-au înregistrat cantități foarte mici, cu mult sub valorile normale și luni în care s-au înregistrat cantități mai mari decât cele normale. Cantitățile mici de precipitații, și temperaturile mari înregistrate au dus la scăderea accentuată a valorilor umidității accesibile din sol, cu mult sub valorile optime de umiditate ale viței de vie și creșterea deficitului.

Cuvinte cheie: temperaturi, precipitații scăzute, umiditate sol, plantații viticole

INTRODUCTION

The vine is a great water-consuming, and if in some dry years suffer less than annual plants, this is due to the fact that it has a deep root system that explores a large volume of soil in the deep layers, where there is a large reservoir of water. In the long periods of drought of 2-3 years, when the water reserve in

¹Viticulture and Oenology Research and Development Station in Iasi, Romania

the deep layers of soil decreases, the vine suffers the same as the annual plants (Alexandrescu *et al.*, 1998).

The optimum soil moisture content for vineyards is between 50-80% of the useful soil water capacity (UWC), with higher values being favorable for the growth of smaller shoots and for grain maturation (Moțoc, 1968). In the dry years, high temperature values in conjunction with soil deficiency have led to the accentuation of atmospheric and pedological drought with adverse effects on the vegetation status of the vines by overcoming the phenophases of growth and fructification, wart hunting, prematurely yellowing of the leaves, the grapes remained small with small and wilted berries and decreasing the available moisture from the soil to the depths deep at 100-150 cm deep (Zaldea *et al.*, 2013; Enache *et al.*, 2016). Drought affects primarily young vines (1st and 2nd year), aging, less vigorous vines and those with large eye loads left to cut. The stems and cords are dehydrated, deep longitudinal cracks appear, causing the vines to dry.

MATERIAL AND METHOD

For the analysis of rainfall and temperatures were used the data recorded by automatic station Agroexpert of Research and Development Station for Viticulture and Vinification Iași and from Moldova Regional Meteorological Center. To determine soil moisture, the samples were taken in layers from 10 to 10 cm up to 150 cm depth for each month during the growing season. Results were expressed first in percentage compared to dry soil weight, then into percent by volume. With hydrophysical indices values were calculated the accessible moisture existing in soil at a time (Uacc) expressed in mm and the deficit in mc/ha and %. To establish the insurance degree with available water supply for plants was reported the momentary humidity (Uacc) to useful water capacity (AUC), previously calculated for Iași Copou viticultural center

RESULTS AND DISCUSSIONS

Drought periods of 2-3 years are those with serious consequences for vineyards, because the disastrous effects of the drought are recorded in the second or third year of the drought, and the restoration of plantations lasts for another two to three years, which means that over a period of about six years no grape production can be obtained to cover the expenses incurred. Such a situation has been recorded over the last three years, each year with different characteristics.

The year 2015 was characterized as *excessively dry* with a warmer spring than normal, with few and uneven rainfall distributed and a very dry summer, with few precipitations combined with very high temperatures, often above 30°C. Almost all months were recorded smaller amounts of precipitation than normal. Thus, during the vegetation period, only 180.6 mm was accumulated, well below the multiannual average, which is 398.1 mm in the Copou Iasi wine center, representing only 45% of the necessary, and the annual rainfall was 365,5 mm compared to 579.5 mm (tab. 1).

The statistics show that between 1972 and 2014, only in one year was recorded a quantity of less than 200 mm, namely in 1973 by 156.3 mm. It is also

noteworthy that even in the months of the vegetative repose period very few precipitations were recorded, for example in December it was only 1.6 mm compared to the normal month of 31.0 mm being the most drought December for the last 40 years. A similar amount of precipitation was recorded in December 1989, namely 1.8 mm.

Table1

The pluviometric regime in the period 2015-2016

| Month | Multiannual values | Raifalls 2015 (mm) | | | Raifalls 2016 (mm) | | | | |
|-------------------|--------------------|--------------------|-----------|-----------|--------------------|--------------|-----------|-----------|-----------|
| | | 2015 | >0.1 | >5 | >10 | 2016 | >0.1 | >5 | >10 |
| I | 26.7 | 14.7 | 10 | - | - | 16.0 | 13 | - | - |
| II | 24.9 | 23.2 | 8 | - | 1 | 25.0 | 10 | 1 | - |
| III | 29.2 | 66.4 | 10 | 2 | 2 | 31.8 | 6 | 1 | 1 |
| IV | 46.6 | 31.6 | 9 | 1 | 1 | 77.6 | 4 | 1 | 2 |
| V | 61.4 | 13.8 | 7 | - | - | 90.2 | 8 | 3 | 3 |
| VI | 82.5 | 46.8 | 4 | 3 | 2 | 107.0 | 4 | 3 | 4 |
| VII | 83.8 | 40.8 | 7 | 1 | 1 | 15.4 | 3 | 2 | - |
| VIII | 62.7 | 28.0 | - | - | 2 | 31.4 | 4 | 2 | 1 |
| IX | 61.1 | 19.6 | 7 | 1 | - | 12.2 | 5 | 1 | - |
| X | 38.9 | 54.4 | 3 | 1 | 2 | 182.8 | 12 | - | 6 |
| XI | 30.8 | 24.6 | 9 | 1 | - | 50.2 | 5 | 2 | 2 |
| XII | 31.0 | 1.6 | 5 | - | - | 7.2 | 6 | - | - |
| Annual | 579.5 | 365.5 | 79 | 10 | 11 | 646.8 | 80 | 16 | 19 |
| Vegetation | 398.1 | 180.6 | 34 | 6 | 6 | 333.8 | 28 | 12 | 10 |

Low rainfall, as well as high temperatures, have led to a sharp decline in soil moisture (9 to 30%), well below optimal moisture levels (50 - 80%) and increased deficit (fig. 1).

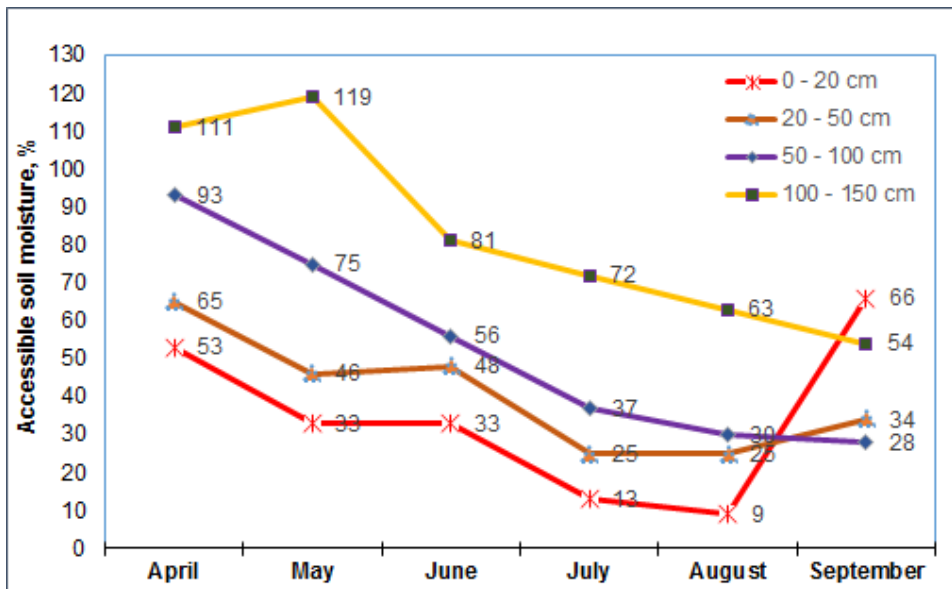


Fig.1 Grade of water available in the soil during the vegetation period of 2015

At the end of August, water deficit in the soil, up to a depth of 100 cm, ranged between 70-91% (tab. 2).

Table 2

Water deficit of soil during vegetation period of 2015

| Depth, cm | Month | | | | | | | | | | | |
|-----------|--------------------|----|--------------------|----|--------------------|----|--------------------|----|--------------------|----|--------------------|----|
| | IV | | V | | VI | | VII | | VIII | | IX | |
| | m ³ /ha | % | m ³ /ha | % | m ³ /ha | % | m ³ /ha | % | m ³ /ha | % | m ³ /ha | % |
| 0 – 20 | 221 | 47 | 319 | 67 | 318 | 67 | 412 | 87 | 434 | 91 | 163 | 34 |
| 20 – 50 | 257 | 35 | 398 | 54 | 382 | 52 | 554 | 75 | 556 | 75 | 486 | 66 |
| 50 - 100 | 78 | 7 | 265 | 25 | 471 | 44 | 675 | 63 | 746 | 70 | 768 | 72 |
| 100 - 150 | - | - | - | - | 124 | 19 | 181 | 28 | 237 | 37 | 296 | 46 |

The rainfall amounts recorded in 2016 were very unevenly distributed, so months were very small, well below normal values, such as January, July, August, September, December, and months when - they recorded higher quantities than normal, such as April, May, June, October and November.

The annual rainfall regime was greater than normal, 646.8 mm versus 579.5 mm, but during the vegetation period (April to September) it was only 333.8 mm from the normal of 398.1 mm in the Copou Iasi wine center. These conditions led to the year being characterized as a *little more dry*.

As a result of the small rainfall from July to September and the high temperatures there was a sharp decrease of the soil humidity values, well below the optimum moisture values of the vine and the increase of the deficit, with a negative influence on the growth and maturation of the grapes (fig. 2, tab. 3).

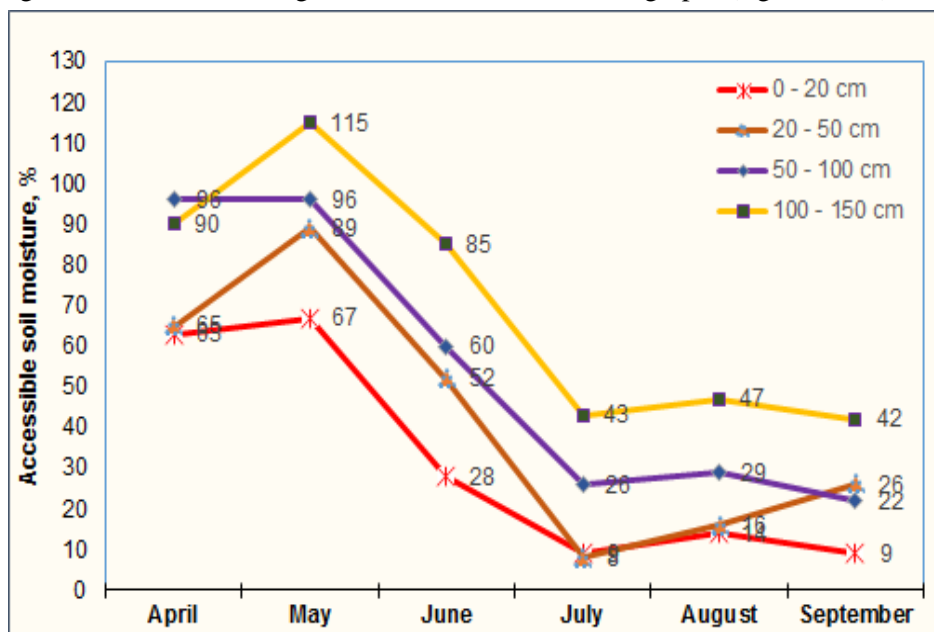


Fig. 2 Grade of water available in the soil during the vegetation period of 2016

At the end of September, the available humidity values, in the first layer 0-20 cm, were below the wilting coefficient, and from 20 to 150 cm deep they were well below the optimum values for the vine. Soil water deficiency ranged from 58 - 78% (tab. 3).

Table 3

Water deficit of soil during vegetation period of 2016

| Depth, cm | Month | | | | | | | | | | | |
|-----------|--------------------|----|--------------------|----|--------------------|----|--------------------|----|--------------------|----|--------------------|----|
| | IV | | V | | VI | | VII | | VIII | | IX | |
| | m ³ /ha | % | m ³ /ha | % | m ³ /ha | % | m ³ /ha | % | m ³ /ha | % | m ³ /ha | % |
| 0 - 20 | 174 | 37 | 158 | 33 | 341 | 72 | 433 | 91 | 408 | 86 | 432 | 91 |
| 20 - 50 | 258 | 35 | 82 | 11 | 358 | 48 | 680 | 92 | 619 | 84 | 548 | 74 |
| 50 - 100 | 41 | 4 | 47 | 4 | 432 | 40 | 795 | 74 | 758 | 71 | 832 | 78 |
| 100 - 150 | 62 | 10 | - | - | 97 | 15 | 365 | 57 | 341 | 53 | 377 | 58 |

Year 2017, is the third consecutive year of drought, with precipitation below normal and high temperatures, often above 30°C. The precipitation deficit was recorded in the winter months: January (18.1 mm compared to 26.7) and February (22.7 mm compared to 24.9 mm) and in the months of the vegetation period: May (47.8 mm compared to 61.4 mm), June (49.0 mm compared to 82.5 mm), July (67.6 mm compared to 83.8 mm), August (24.0 mm compared to 62.7 mm) and September (26.6 mm compared to 61.1 mm).

Small rainfall and high temperatures have led to a sharp decline in available soil moisture across the soil depth (0 - 150 cm), from one month to the next, reaching the end of the vegetation period at values ranging from 8 and 45% (fig. 3).

In these conditions, the deficit of water in the soil showed values between 55 and 92% (tab. 4).

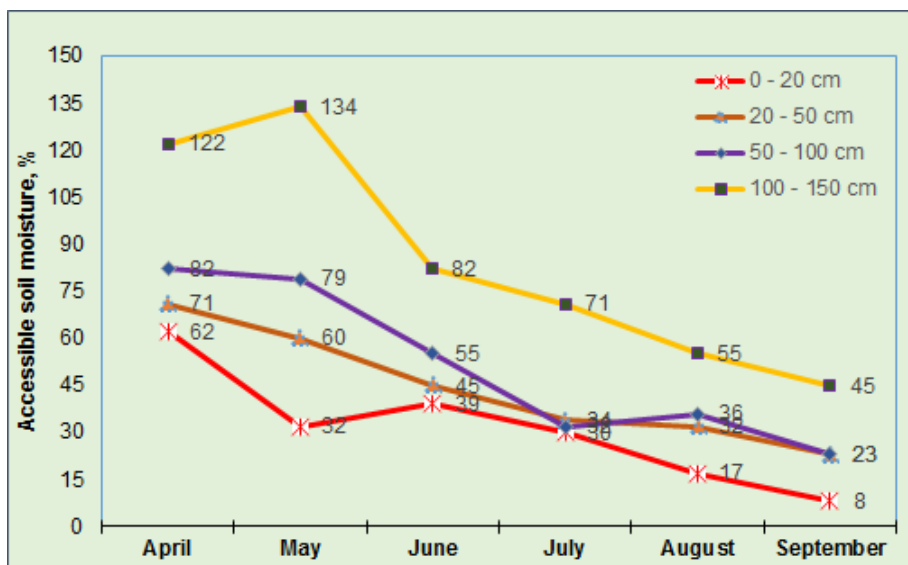


Fig. 3 Grade of water available in the soil during the vegetation period of 2017

Table 4

Water deficit of soil during vegetation period of 2017

| Depth cm | Month | | | | | | | | | | | |
|-------------|--------------------|----|--------------------|----|--------------------|----|--------------------|----|--------------------|----|--------------------|----|
| | IV | | V | | VI | | VII | | VIII | | IX | |
| | m ³ /ha | % | m ³ /ha | % | m ³ /ha | % | m ³ /ha | % | m ³ /ha | % | m ³ /ha | % |
| 0 – 20 | 179 | 38 | 324 | 68 | 289 | 61 | 333 | 70 | 395 | 83 | 440 | 92 |
| 20 – 50 | 217 | 29 | 297 | 40 | 409 | 55 | 486 | 66 | 504 | 68 | 567 | 77 |
| 50 – 100 | 194 | 18 | 224 | 21 | 484 | 45 | 725 | 68 | 687 | 64 | 830 | 77 |
| 100 - 150 | - | - | - | - | 116 | 18 | 186 | 29 | 293 | 45 | 356 | 55 |

CONCLUSIONS

1. Drought can be a destructive phenomenon for vineyards when there is a rainfall in the autumn and winter of the previous year, and the quantities recorded in the spring fail to restore the water reserve from the deep layers of soil from which vine vines are fed. Periods of 2-3 consecutive years with precipitation deficiency have the most serious consequences, with disastrous effects occurring, especially in the second or third year of drought.

2. From the recorded data, in recent years there is an increase in the frequency of the drought phenomenon, which greatly affects the vineyards. In these conditions, it is increasingly necessary to create Vinifera varieties and drought resistant rootstocks, as well as to generalize and extend the irrigation system at national level.

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