THE DYNAMICS OF SOIL MOISTURE IN THE VINEYARD PLANTATIONS IN THE IAȘI VINEYARD UNDER CONDITIONS OF WATER AND THERMAL STRESS

DINAMICA UMIDITĂȚII SOLULUI ÎN PLANTAȚIILE VITICOLE DIN PODGORIA IAȘI ÎN CONDIȚII DE STRES HIDRIC ŞI TERMIC

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Abstract. *Drought periods lasting 2-3 years are those with serious consequences for wine plantations, because the effects are felt from the following year, and the restoration of the plantations takes another two to three years. From the analysis of the multiannual data recorded at the SCDVV Iaşi, an increase in the frequency of dry years is noted. The lack of precipitation and their uneven distribution associated with the ever-higher temperatures, led to a sharp decrease in the accessible moisture values from the soil and an increase in the deficit, in certain periods, up to a depth of 150 cm. The paper presents the precipitation regime in the viticultural ecosystem of the Iași vineyard from 2022 to 2024, compared to the multi-year averages, as well as the dynamics of accessible humidity and soil water deficit in conditions of water and thermal stress.*
Key words: precipitation, vines, accessible moisture, soil

Rezumat. *Perioadele de secetă cu durata de 2-3 ani sunt cele cu urmări grave pentru plantaţiile viticole, deoarece efectele se resimt încă din anul următor, iar refacerea plantaţiilor durează alți doi – trei ani. Din analiza datelor multianuale înregistrate la SCDVV Iaşi se constată o creştere a frecvenţei anilor secetoşi. Lipsa precipitaţiilor şi distribuţia lor neuniformă asociată cu temperaturile tot mai ridicate, au dus la scăderea accentuată a valorilor umidităţii accesibile din sol şi creşterea deficitului, în anumite perioade, până la adâncimea de 150 cm. În lucrare este prezentat regimul de precipitaţii din ecosistemul viticol al podgoriei Iaşi din perioada 2022 – 2024, comparativ cu mediile multianuale, precum și dinamica umidității accesibile şi deficitul de apă din sol în condiţii de stres hidric şi termic.*
Cuvinte cheie: precipitații, viță-de-vie, umiditate accesibilă, sol

INTRODUCTION

Vine plantations that are in their fruit-bearing stage are quite resistant to drought due to their deep root systems, which explore the soil for water supply,

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especially if sufficient moisture accumulated in the soil during the autumn and winter, derived from rain and snow [Alexandrescu *et al.*, 1998].

In the Copou Iași vineyard center, in recent years, we have witnessed a decrease in the amount of precipitation and a very uneven distribution of it throughout the year. It has also been observed that after rainy periods of 1-2 years, 1-2 dry or excessively dry years follow, interspersed with normal years [Zaldea *et al*., 2008].

The increasing frequency of drought events can have destructive effects on vineyards when there is a precipitation deficit in the autumn and winter of the previous year, and the quantities recorded in the spring are not sufficient to replenish the water reserves in the deep soil layers from which the vine stumps draw their water [Zaldea *et al*., 2017; Zaldea *et al*. 2021].

The optimal soil moisture for vine cultivation is between 50-80% of the soil's available water capacity (UWC), with higher values being favorable for shoot growth and lower values for berry ripening [Moțoc, 1968].

MATERIAL AND METHOD

For the analysis of precipitation and temperatures, data recorded at the Agroexpert automatic station of SCDVV Iași and the Moldova Iași Regional Meteorological Center were used. To determine soil moisture, samples were taken in layers every 10 cm down to a depth of 150 cm, for each month during the growing season. The results were first expressed as percentages relative to the weight of the dry soil, then as volume percentages.

Using the values of hydro-physical indices, the accessible moisture present in the soil at a given time (Macc) was calculated, expressed in mm, and the deficit in m³/ha and %. To determine the level of available moisture for plants, the current moisture (Macc) was compared to the available water capacity (UWC), previously calculated for the Copou Iași vineyard center

RESULTS AND DISCUSSIONS

Drought periods lasting 2-3 years have serious consequences for vineyards because the disastrous effects of drought are recorded in the second or third year of the drought period, and the recovery of the plantations takes another two to three years. This means that for a period of about six years, grape production cannot cover the expenses incurred. Such a situation has occurred in the last three years, with each year having different characteristics.

The precipitation amounts recorded during the period 2022-2024 were far below normal, resulting in a very uneven distribution. There were months when very low amounts of precipitation were recorded compared to normal, only 4.8 mm in January and 8.2 mm in March 2022, as well as only 5.8 mm in March and 8.6 mm in September 2023 (Table 1).

The rainfall regime during the active growing season (April – September) was only 295.8 mm in 2022 and 349.3 mm in 2023. In 2024, the rainfall regime was 400.2 mm, compared to the normal 384.3 L/m², due to the very large amounts

of rain that fell in September (150.2 mm compared to the normal 56.9 mm).

The total amount of precipitation in 2022 was only 416.8 mm, resulting in a deficit of 172 mm compared to the normal (588.8 mm), while in 2023 it was 509.1 mm, with a deficit of 79.7 mm. It is also worth noting that in the northeastern part of the country, atmospheric and soil drought began in September - October 2021, continued through the winter months, and persisted during the first seven months of 2022. According to our statistics, between 1971 and 2021, a similar situation occurred in 1973, when a precipitation deficit was recorded in every month.

Table 1

Rainfall regime during the period 2022 - 2024

Month	Multiannual value	Rainfall, mm / Year		
		2022	2023	2024
January	27.3	4.8	12.1	61.4
February	26.8	10.0	23.3	15.6
March	34.4	8.2	5.8	53.8
April	46.5	73.6	157.7	34.6
May	63.9	29.2	25.6	59.6
June	81.1	26.6	33.2	65.4
July	81.8	27.8	107.8	61.4
August	54.1	69.0	16.4	29.0
September	56.9	69.6	8.6	150.2
October	49.6	12.6	16.2	-
November	34.1	69.2	92.4	-
December	32.3	16.2	10.0	-
Annual precipitation	**588.8**	**416.8**	**509.1**	**-**
Precipit. vegetation period	**384.3**	**295.8**	**349.3**	**400.2**
Year characteristics		**Very dry**	**Excessively dry**	

Based on the annual and growing season precipitation amounts, as well as the alternation of dry months with normal or rainy ones, the observed years were characterized as "very dry" (2022) and "excessively dry" (2023) [Topor, 1964].

The lack of precipitation during the growing season, combined with high temperatures, often exceeding 30°C, led to the occurrence of atmospheric drought followed by soil drought.

In the Iași vineyard, the lack of precipitation at the end of 2021 and in the first months of 2022, specifically from January to March, resulted in very low levels of accessible moisture starting in April, down to a depth of 150 cm.

Under normal conditions, accessible soil moisture values at the beginning of the growing season should range between 70–90% at depths of 0–100 cm, with an excess of moisture at 100–150 cm. However, the water reserves in the soil were not replenished during the dormant period, as would have been normal (Table 2).

In June, the lack of precipitation led to the worsening of soil drought. Accessible soil moisture at depths of 0–100 cm recorded values between 6–22%, falling within the range between 25% of the active moisture interval (AMI) and the wilting coefficient (WC), which is characterized as "*severe water stress*".

In the following period, the soil water reserve gradually decreased from

month to month due to the increasingly low amounts of precipitation recorded, far below normal values (50–80%), and the soil water deficit increased (Table 3). Thus, in June, July, and August, accessible moisture in the 0–20 cm layer was close to the wilting coefficient (6–17%), and at depths of 20–150 cm, water was difficult or very difficult for plants to access.

Table 2

Accessible soil moisture during the growing season

Depht, cm	IV		V		VI		VII		VIII		IX	
	mm	%	mm	%	mm	%	mm	%	mm	%	mm	%
2022												
0 - 20	32.75	69	22.79	48	2.63	6	6.30	13	7.99	17	11.25	24
20 - 50	50.79	69	44.59	60	9.49	13	30.22	41	13.50	18	16.84	23
50 -100	71.23	66	50.56	47	24.10	22	42.35	40	30.50	28	33.97	32
100 - 150	45.82	71	45.25	70	17.10	27	34.62	54	30.69	48	25.19	39
2023												
0 - 20	23.96	50	13.63	29	23.61	50	14.19	30	9.87	21	1.88	4
20 - 50	48.64	66	51.80	70	41.84	57	26.02	35	16.96	23	8.63	12
50 -100	105.08	98	84.68	79	59.16	55	57.06	53	18.86	18	24.28	23
100 - 150	94.31	146	89.33	139	47.87	74	61.98	96	33.61	52	23.34	36
2024												
0 - 20	29.64	62	24.25	51	13.01	27	9.01	19	2.44	5	30.78	65
20 - 50	50.10	68	38.63	52	14.46	20	6.93	9	10.26	14	58.88	80
50 -100	80.82	75	57.73	54	52.93	49	14.24	13	16.56	15	74.93	70
100 - 150	69.23	107	52.91	82	54.51	85	26.82	42	27.29	42	43.42	67

A similar situation regarding precipitation amounts and accessible soil moisture was recorded in the first months of 2023. However, in April, the first month of the growing season, solid precipitation was recorded in the form of snow (157.7 L/m² compared to the 46.5 L/m² multi-annual average). This helped restore the soil water reserve, and accessible moisture values were in the range of easily and very easily accessible water at depths of 0–100 cm, with excess moisture from 100–150 cm (Table 2).

In May, accessible moisture values dropped significantly in the first layer (0–10 cm), falling within the range of very difficultly accessible water, with values around 29%. In the 10–100 cm layer, accessible moisture values were within optimal limits for the vine, while at 100–150 cm there was an excess of moisture, with values over 90% (Table 2).

Based on the level of accessible water for the vine, in June, accessible soil moisture values were within optimal parameters, between 50–74%.

In July, despite large amounts of precipitation being recorded (107.8 L/m²), accessible moisture values in the 0–70 cm depth dropped below 50%. From this point, we can say that the phenomenon of soil drought was established (Table 2).

In August and September, soil drought worsened due to very low precipitation amounts -16.4 mm compared to 54.1 mm and only 8.6 mm compared to 56.9 mm, respectively. Accessible moisture continued to decrease, reaching values close to the wilting coefficient (WC) in the 0–20 cm layer. In the 20–90 cm

layer, moisture values were between 25% of the active moisture interval (AMI) and the wilting coefficient (WC), which is characterized as "*severe water stress*". From 90–150 cm, soil moisture ranged between 50% and 25% of AMI, described as "*incipient water stress*". The soil water deficit gradually increased along the depth of the profile, up to 150 cm (Table 3).

Table 3

Soil water deficit during the growing season

Depht, cm	IV		V		VI		VII		VIII		IX	
	mc/ha	%	mc/ha	%	mc/ha	%	mc/ha	%	mc/ha	%	mc/ha	%
2022												
0 - 20	148	31	247	52	449	94	412	87	396	83	363	76
20 - 50	232	31	294	40	645	87	438	59	605	82	571	77
50 -100	359	34	566	53	831	78	648	60	767	72	732	68
100 - 150	186	29	192	30	474	73	298	46	338	52	393	61
2023												
0 - 20	236	50	339	71	239	50	334	70	377	79	457	96
20 - 50	254	34	222	30	321	43	480	65	570	77	654	88
50 -100	21	2	225	21	480	45	501	47	883	82	829	77
100 - 150	-	-	-	-	166	26	25	4	309	48	411	64
2024												
0 - 20	179	38	233	49	345	73	385	81	451	95	168	35
20 - 50	239	32	354	48	595	80	671	91	637	86	151	20
50 -100	264	25	495	46	543	51	929	87	906	85	322	30
100 - 150	-	-	115	18	100	15	376	58	372	58	210	33

In 2024, at the beginning of the growing season, due to precipitation levels close to normal in the Copou Iași viticultural center, accessible soil moisture in the 0–100 cm layer was optimal, between 62–75%, and from 100–150 cm, there was excess moisture.

In the following months (May–August), as a result of increasingly low precipitation levels, soil moisture gradually decreased from month to month. By the end of August, accessible soil moisture levels were far below optimal for the vine throughout the soil profile. The presented data shows that average values in the 0–100 cm layer ranged between 5–15%, placing them in the range of water very difficultly accessible for the vine, between 25% of AMI and the wilting coefficient (WC), which is characterized as "*severe water stress*".

In September, due to very large amounts of precipitation being recorded - more than double the normal values (150.2 mm compared to 56.9 mm) - soil moisture was restored throughout the soil profile (0–150 cm), with values in the range of very easily accessible water (65–80%).

CONCLUSIONS

1. Drought can be predicted as a destructive phenomenon for the vine, especially when a precipitation deficit is recorded in the fall and winter of the

previous year, and spring rainfall is insufficient to restore water reserves in the deeper soil layers from which the roots draw nourishment.

2. In the years 2022–2024, the lack of precipitation during the growing season, combined with high temperatures, often exceeding 30°C, led to the occurrence of atmospheric drought followed by soil drought. Thus, the observed years were characterized as "*very dry*" and "*excessively dry*".

3. Drought periods lasting 2–3 years are particularly detrimental to vineyards, as the effects on vegetative growth and productive potential of the vines are noticeable starting from the second or third year of drought.

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