THE EFFECTS OF THE TREATMENT WITH FUNGICIDES ON THE PHYSIOLOGICAL PROCESSES IN *VITIS VINIFERA* L. ATTACKED BY *UNCINULA NECATOR* (SCHW.) BURR. PATHOGEN

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ABSTRACT

The effects of treatment with fungicides on the physiological processes were observed in Vitis vinifera L. plants cultivated in the climatic conditions in Oltenia region.The physiological analyzes were performed on July 18th 2021, both for plants treated with Dithane M-45 (0,2%), in four phases, at 12 days interval and also for the plants attacked by Uncinula necator (Schv.) Burr. in which treatments have not been performed. In the Vitis vinifera L. plants attacked by Uncinula necator (Schv.) it was observed that the physiological processes intensity is lower as a result of the reduction of the assimilation surface due to the covering of the leaves with the mycelium of the fungus, the appearance of whitish spots and the browning of the tissues, in comparison with the plants in which fungicide treatments have been performed.

INTRODUCTION

The fungus *Erysiphe necator* Schw. (syn. *Uncinula necator* (Schw.) Burr.) that causes the occurrence of powdery mildew is an obligatory parasite that infests plant species belonging to the family *Vitaceae* (Gadoury et al., 2012).

The ascomycete fungus, *Erysiphe necator* (syn. *Uncinula necator*), the causal agent of grapevine powdery mildew (PM) disease, was inadvertently introduced into Europe from North America in the 1850s and caused significant losses to viticultural production (Campbell, 2004).

The majority of grapevine cultivars used for wine, table grape, and dried fruit production are derived from the Eurasian grape species *Vitis vinifera* because of its superior aroma and flavor characteristics. However, this species has little genetic resistance against *E. necator* meaning that grape production is highly dependent on the frequent use of fungicides (Qiu et al., 2015).

A good control of powdery mildew fungi is an important part of the management of vineyards and of all viticultural operations (Austin and Wilcox, 2012), because the majority of commercial grapevine cultivars are rather sensitive to this pest (Ramming et al., 2011; Miclot et al., 2011). Due to this fact, commercial grapevine growers use both fungicides and agrotechnical interventions to protect their plants against powdery mildew (Cadle-Davidson et al., 2011).

The high point in the photosynthesis for the grapevine is achieved at its base leaves in the period preceding the ripening phase and during this phase, around 1 o'clock p.m. During the ripeness phase, the photosynthesis intensity came before 1 o'clock p.m. and the greatest photosynthesis intensity was established at the apical leaves (Hunter et al., 1994).

The photosynthesis intensity process varies between 13.8 μmol CO_2 / m^2 / s in August and 7.5 μmol CO_2 / m^2 / s in September (Williams and Biscay, 1991).

The chlorophyll content was higher in plant leaves analyzed after made treatments with fungicide, compared with the attacked leaves by pathogen, being a positive correlation between the pigments chlorophyll content and the photosynthetis intensity (Nicolae and Camen, 2012). The transpiration intensity, within adequate ground humidity conditions, has a dynamic characteristic with a high point in the afternoon and two low points in the morning and evening (Alleweldt et al., 1982).

MATERIAL AND METHODS

The physiological analyzes were performed in the grapevine *Moldova* variety cultivated in the climatic conditions in Oltenia region. The grapevine *Moldova* variety was created in the Republic of Moldova and is a middle or late ripening varieties. Leaves are medium-sized, 3-5 lobed. The grapes are conical or cylindrical-conical, midsize. The flesh is crispy and the taste was neutral.

The treatments with the fungicide *Dithane* M-45 (0.2%) were applied in four phases at 12 days interval (June 2nd 2021, June 14th 2021, June 26th 2021 and July 8th 2021) and the physiological researches were performed on July 18th 2021, in leaves treated with fungicide and in leaves attacked by pathogen in which treatments have not been performed.

The photosynthesis and transpiration's intensity and the physiological parameters were determined with the ultra compact photosynthesis measurement system-LCi. The water and the dry substance content were determined by the gravimetric method and the chlorophyll content were analysed with the help of the Minolta SPAD 502 chlorophyllmeter.

The estimation of the attack was made using the calculation formulae elaborate by Săvescu and Rafailă (1978).

RESULTS AND DISCUSSIONS

Uncinula necator (Schw.) Burr. attacks leaves, shoots and grapes, from spring to autumn. A fine, dusty-looking mycelium appears on the leaves, which stretches and forms whitish spots on both surfaces of the leaf, and under the mycelial felt, the tissues turn brown (Figure 1). The non-lignified shoots have the same whitish spots, sometimes dusty and the leaves wrinkle. The grapes turn brown, cover with mycelial felt and crack due to the increase in volume (Figure 2).

Figure 1. The leaves of the grapevine *Moldova* variety attacked by *Uncinula necator* (Schw.) Burr. (Original).

Figure 2. The fruit of the grapevine *Moldova* variety attacked by *Uncinula necator* (Schw.) Burr. (Original).

Figure 3. *Uncinula necator* (Schw.) Burr. - conidiophores with conidia (oc. 10 x ob. 20) - Original.

Towards autumn, on the mycelial felt and on the attacked organs, the presence of resistance fructifications is sometimes observed, as small, black dots.

Uncinula necator (Schw.) Burr. overwinters as a resistant mycelium that can remain on stem or buds, and in spring, with the onset of vegetation, the mycelium expands and differentiates conidiophores and conidia through which primary infections occur (Figure 3).

The physiological researches were performed, both for leaves of the grapevine treated with *Dithane* M-45 fungicide and also for the attacked leaves by pathogen (without treatments with fungicide).

The estimation of the attack (frequency, intensity and degree of attack) produced by *Uncinula necator* (Schw.) Burr. in the *Vitis vinifera* L. is presented in Figure 4.

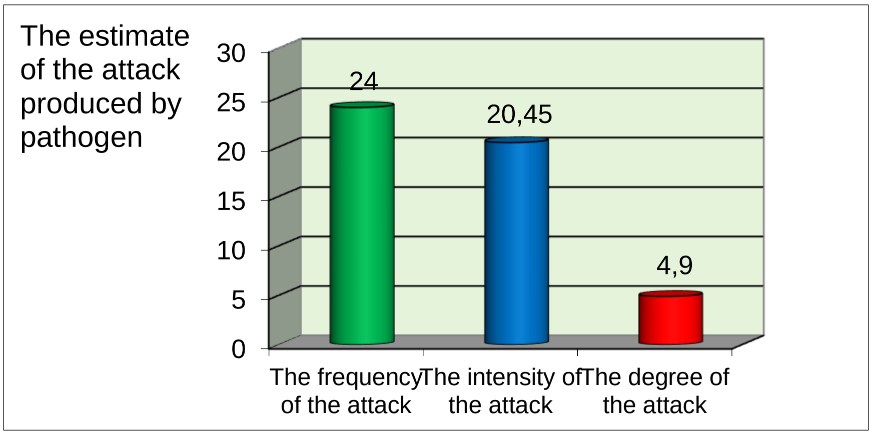

Figure 4. The estimation of the attack produced by *Uncinula necator* (Schw.) Burr. in the *Vitis vinifera* L.

The photosynthesis and transpiration's intensity has a lower value in the attacked leaves, compared to the leaves treated with *Dithane* as a result of the reduction of the assimilation surface due to necrosis of the spots on the leaves (Figure 5 and Figure 6).

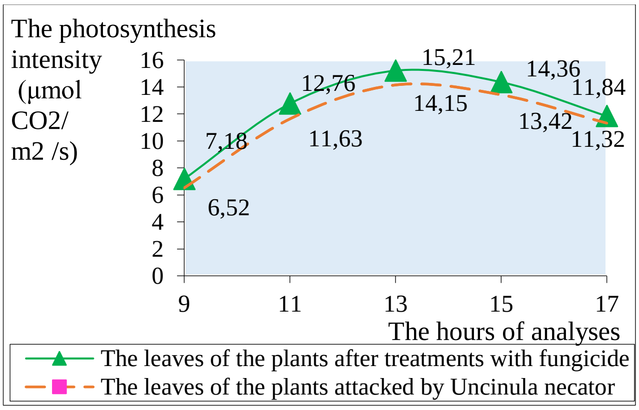

Figure 5. The photosynthesis intensity in the leaves of the *Vitis vinifera* L.

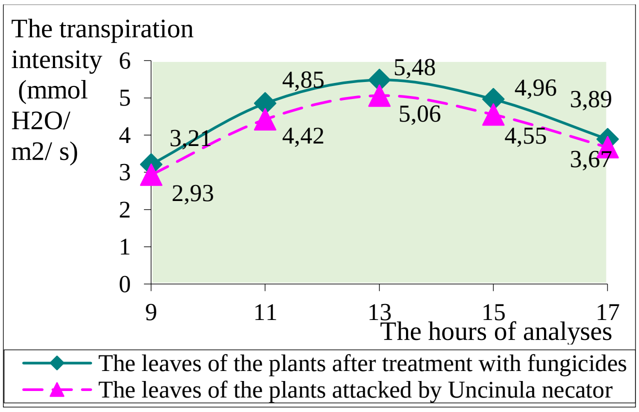

Figure 6. The transpiration intensity in the leaves of the *Vitis vinifera* L.

The photosynthesis and transpiration's intensity are correlated with the physiological parameters (photosynthetic active radiation, leaf temperature and stomatal conductance). The obtained results regarding the photosynthetic active radiation, leaf temperature and stomatal conductance in the leaves are presented in the Table. 1.

Linear regression made between the photosynthesis intensity and photosynthetic active radiations shows a positive correlation between these, the coefficient of determination

(R^2) was 0.99 for the leaves of the plants after treatments with fungicide and 0.97 for the attacked leaves of the plants; linear regression made between the transpiration intensity and photosynthetic active radiations shows a positive correlation, the coefficient of determination R^2 was 0.90 for the leaves of the plants after treatments with fungicide and 0.96 for the leaves of the plants attacked by pathogen (Figure 7 and Figure 8).

Table 1

The physiological parameters registered in the leaves of the *Vitis vinifera* L.

The physiological parameters	**The analysis of the leaves of the plant**	**The hours of the analyses' performance and the recorded values (July 18th 2021)**				
		9^{00}	11^{00}	13^{00}	15^{00}	17^{00}
The photosynthetic active radiation *(µmol / m² / s)*	The leaves of the plants after treatments with fungicide	1345	1582	1715	1684	1538
	The leaves of the plants attacked by pathogen (plants without treatments)	1280	1524	1630	1576	1458
The leaf temperature *(°C)*	The leaves of the plants after treatments with fungicide	28.7	31.8	34.2	32.6	31.3
	The leaves of the plants attacked by pathogen (plants without treatments)	28.3	31.3	33.9	32	31.1
The stomatal conductance *(mol / m² / s)*	The leaves of the plants after treatments with fungicide	0.13	0.16	0.2	0.18	0.16
	The leaves of the plants attacked by pathogen (plants without treatments)	0.11	0.13	0.17	0.16	0.13

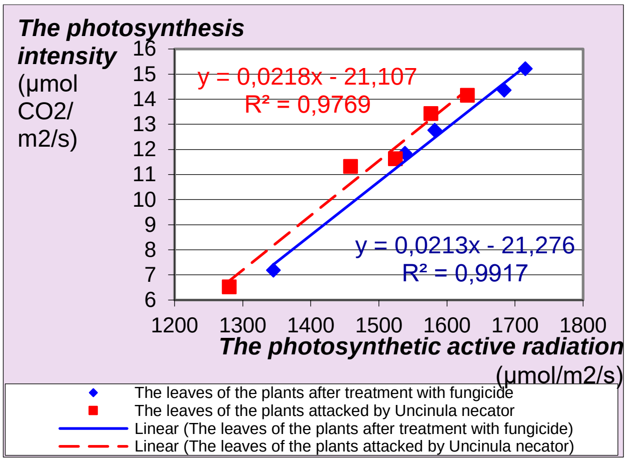

Figure 7. The correlation between the intensity of photosynthesis and the photosynthetic active radiation in the leaves of the *Vitis vinifera* L.

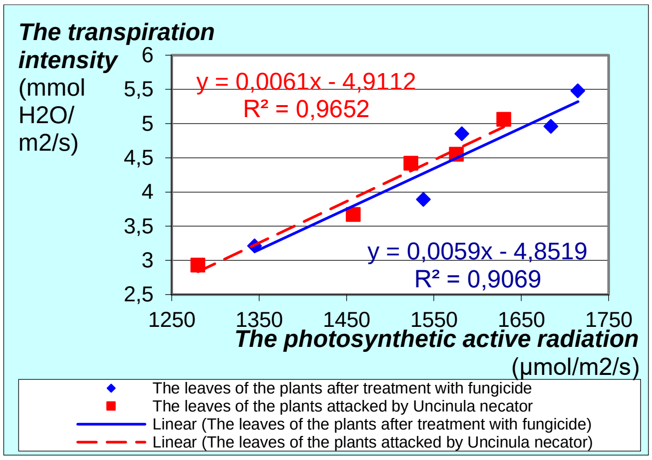

Figure 8. The correlation between the intensity of transpiration and the photosynthetic active radiation in the leaves of the *Vitis vinifera* L.

The photosynthesis intensity and leaf temperature shows a positive correlation, the coefficient of determination (R^2) was 0.94 for the leaves of the plants after treatments with fungicide and 0.93 for the leaves of the plants attacked by pathogen; the transpiration intensity and leaf temperature shows a positive correlation, the coefficient of determination R^2 was 0.91 for the leaves of the plants after treatments with fungicide and 0.90 for the attacked leaves of plants (Figure 9 and Figure 10).

Linear regression performed between photosynthesis intensity and stomatal conductance shows a positive correlation, the coefficient of determination (R^2) was 0.91 for the leaves of the plants after treatments with fungicide and 0.84 for the leaves of the plants attacked by pathogen; linear regression made between the transpiration intensity and stomatal conductance shows a positive correlation, the coefficient of determination R^2 was

0.85 for the leaves of the plants after treatments with fungicide and 0.82 for the attacked leaves of plants (Figure 11 and Figure 12).

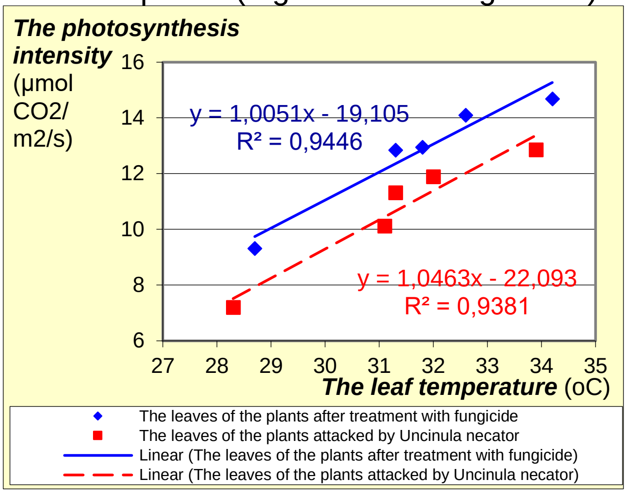

Figure 9. The correlation between the intensity of photosynthesis and the leaf temperature in the leaves of the *Vitis vinifera* L.

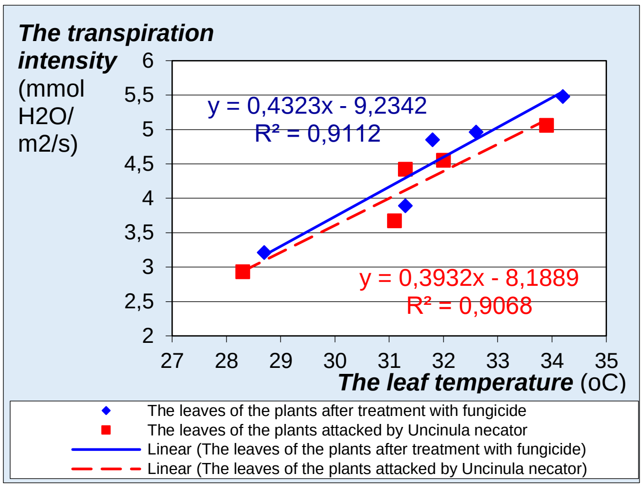

Figure 10. The correlation between the intensity of transpiration and the leaf temperature in the leaves of the *Vitis vinifera* L.

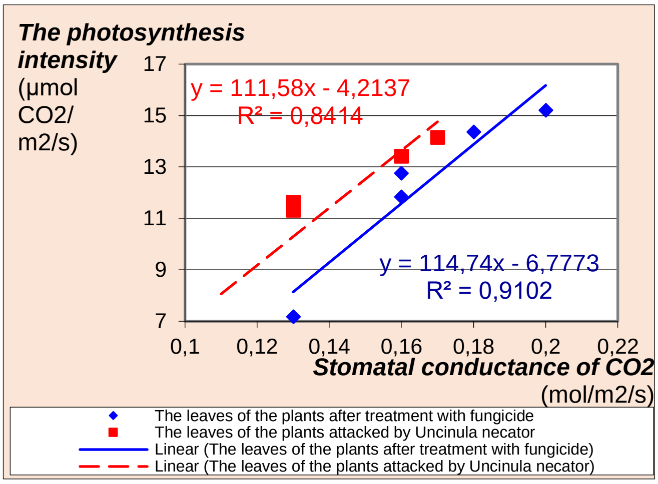

Figure 11. The correlation between the intensity of photosynthesis and the stomatal conductance in the leaves of the *Vitis vinifera* L.

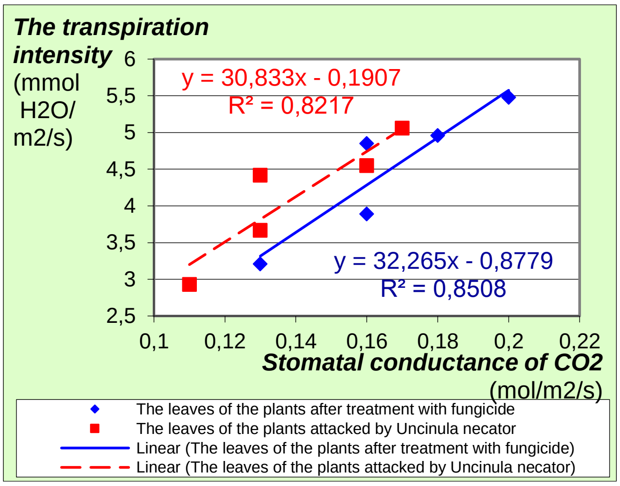

Figure 12. The correlation between the intensity of transpiration and the stomatal conductance in the leaves of the *Vitis vinifera* L.

In the attacked leaves by the pathogen it was registered a lower water content and a higher dry substance content compared with the leaves analysed after performing treatments with fungicide (Figure 13). In the attacked leaves by *Uncinula necator* (Schw.) Burr. it registers a lower chlorophyll content, compared with the leaves after performing treatments with fungicide, which correlates with photosynthesis intensity (Figure 14).

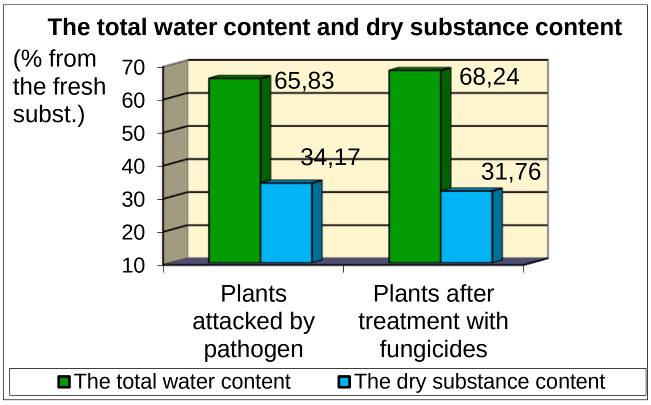

Figure 13. The water content and the dry substance content in the leaves of *Vitis vinifera* L.

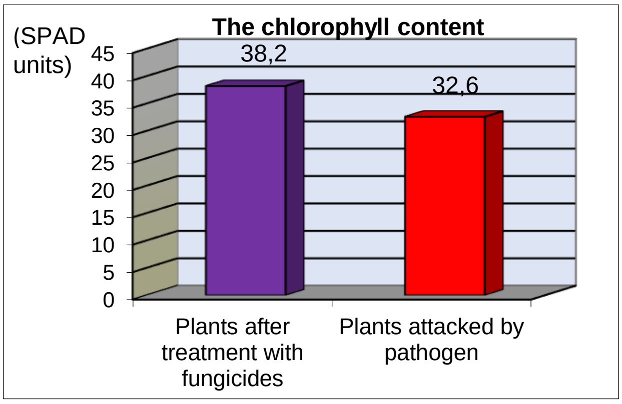

Figure 14. The chlorophyll content in the leaves of the *Vitis vinifera* L.

CONCLUSIONS

In the *Vitis vinifera* L. it was observed that the physiological processes intensity is lower in the attacked plants by the pathogen, compared with the plants treated with fungicide, a result of the reduction of the assimilation surface due to the covering of the leaves with the mycelium of the fungus and the appearance of whitish spots and the browning of the tissues.

The photosynthesis and transpiration's intensity are positively correlated with the photosynthetic active radiation, leaf temperature and stomatal conductance, but present different values in the leaves of the plants attacked by pathogen, in comparison with the leaves of the plants after treatments with fungicide.

In the leaves of the attacked plants one can observe a decrease of chlorophyll content and the water content, which is manifested by withering and drying of the leaves with consequences on the quality and quantity of grapes.

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