INFLUENCE OF POLLUTANTS' CONCENTRATIONS ON THE DEVELOPMENT OF PHYSIOLOGICAL PROCESSES AT GRAPEWINE

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Abstract: *At the beginning of this millennium, vineyards located near industrial areas are feeling the impact of anthropogenic factors (crop technology and industrial pollution) in the inter-agrobiological peculiarities of some species and varieties, in terms of physiological, biochemical and also in terms of obtaining superior and healthy production both quantitative and qualitative (SOUCHÈRE V. et al., 2005). Vineyards can be affected by exposure to variable concentrations of air pollutants coming from power plants, cement plants and lime, road, etc., such as carbon dioxide, carbon monoxide, sulfur dioxide, nitrogen oxides, fluorine, carbon powder, and suspended powders, etc. (IONESCU AL., 1982). Environmental pollution in recent years has manifested itself with increased intensity, characterized by values of pollutant concentrations exceeding the established standards and regulations in force. Reducing the polluting effect is a major concern for all economic agents as a result of technological processes producing pollutants and of those monitoring the environmental factors. The present research aims to assess the contribution of energy production plants to background pollution with specific pollutants and to identify the effects of pollutants on vineyard agroecosystems in order to assess physiological processes in plants when in the atmosphere is a certain amount of polluting emissions. In order to attain this objective - determining photosynthesis and transpiration at plants under the influence of climate and air quality - monitoring campaigns were conducted of the pollutants immissions which from, both the legislative point of view and in terms of environmental effects, are of particular interest. There have been also carried out analyzes and measurements in order to establish correlations between the concentrations of pollutants found in ambient air in vineyards and the conduct of physiological processes at vine. Loss of commercial productivity or the appearance of visible injury is the end results of perturbation to physiological processes in the plants, particularly in the leaves. In order to develop rational air quality objectives, it is desirable to understand the extent to which plant processes are influenced by the accession of a pollutant.*

Key words**:** *SO_2, NOx, photosynthesis, transpiration, grapevine.*

INTRODUCTION

Pollution and damage injuries of vineyards agroecosystems are caused by a growing number of factors and sources and can affect the soil, crop and air. Pollution has a certain typology, a hierarchy, depending on the way of manifestation, area expansion, natural resources contaminated and environment in which it operates (TATE A.B., 2001). Pollutants acting on vineyards depend on their nature and concentration, causing damage to surface of green or reproductive organs and inside the parenchymal tissues, so in the essence of the anatomical, physical, chemical and physiological structure (WEINSTEIN L.H., 1984).

Effects of pollutant factors can be assessed in relation to general environmental changes of the planet as global effects, and the response of organisms to each factor or group of pollutants to those specific effects (WEBB L.B. et al., 2005). Specific effects of each factor or complex combination of pollutants are usually analyzed in terms of morpho-physiological and genetic at individual and population levels and in terms of cenotic at the level of the ecosystem (GLADSTONES J., 1992).

Ecological peculiarities of the vines are important in the draft and set performance of

technical activities in vineyards.Vine is a multiannual plant, and therefore the influence of organic annual supply on production, particularly on the qualitative side, has a special importance. Environmental conditions from the vineyards, and environmental or agrotechnical factors influence or can affect activity and productivity, growth and production phenomena, determining crop and its quality.

Unfavorable climatic factors are acting on the vine with different intensities, causing both structural and functional disorders. Functional disorders disrupt the normal functioning of metabolic processes, which has repercussions detrimental to the plant development.

According to G.E.O. 195/2005 regarding environmental protection, with additions and modifications approved by Law 265/2006, it aims to prevent, limit damage and improve air quality in order to avoid the occurrence of adverse environmental impacts.

The most numerous researches are dedicated to the pollution-vegetation interactions and they are testing resistance of different species, varieties and lines to a particular pollutant or a mixture of pollutants. The problem is particularly important, its solution can offer two great ways to mitigate the damage caused to viticulture ie, choosing species, cultivated crops to make the best choice in the terms of air pollution and choosing plants for building protection curtains.

MATERIAL AND METHODS

The influence of climatic factors and air quality on the development of physiological processes has been measured in Banu Maracine vineyard and in a vineyard located in Şimnic area, by observations made with the portable equipment to determine photosynthesis and transpiration - LCI, which allows observations using non-destructive methods. Preserved leaves offered the possibility to make all determinations on plants at the same leaves located on fertile sprig near the inflorescence or grape.

To determine the values of pollutants' emissions were made measurements of gaseous pollutants - NOx, SO_2 - in vineyard areas. Measurements were made during the main phenophases in the years 2007 and 2008 in Banu Maracine vineyard and in a vineyard located in Şimnic area, area that is subject to the influence of pollution from power plants.

Measurements were made every two hours between 8-18 hours using a portable gas analyzer for determining the concentration of gaseous pollutants from the environment-MX 21 Plus Oldham manufacture.

Measurements of physiological processes deployment in vine plants were made in phenophases of blooming, intense growth, firstfruits and ripening. Monitoring the daily deployment of photosynthesis and transpiration dynamics was achieved by determining the intensity of physiological processes every two hours between the hours 8-18.

RESULTS AND DISCUSSIONS

In 2007, following the measurements made to determine the concentrations of SO_2 and NOx in ambient air in the vineyards, have been noticed the following: average concentrations of SO_2 pollutant measured during the growing season recorded higher values in the vineyard located in Şimnic, compared with lower concentrations in the ambient air from Banu Maracine. While for NOx pollutants, the situation is opposite: the average values were higher in Banu Mărăcine, compared with the values measured in Şimnic vineyard.

The 2008 follows the same dynamics of pollutants measured during different phenophases of the vine as the year 2007, ie higher values for SO_2 pollutant were determined in Şimnic, while NOx pollutants had the highest concentrations in the ambient air of Banu Maracine. As a result, the average concentrations during the growing season for the pollutants

analyzed in the two vineyards have the same trend as the average concentrations determined during each phenophase.

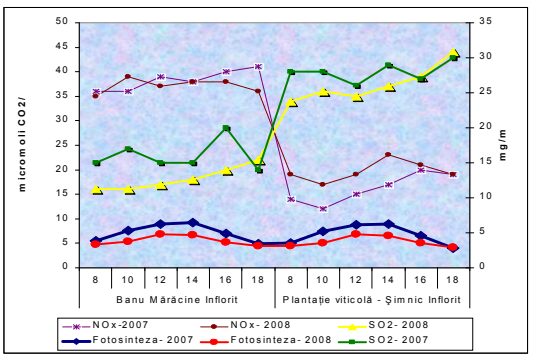

Figure 1: The process of photosynthesis at the Royal Feteasca variety compared to SO_2 concentrations during the blooming phenophase

The dynamics of daily blooming at Royal Feteasca variety conduct photosynthesis to take place after a curve with a maximum at 12-14 hours and minimum at 8 and 18.

The intensity of photosynthesis, expressed as micromoles $CO_2/m^2/s$ presents the following values at hours 12-14: 9-9.3 micromoles $CO_2/m^2/s$, in 2007, at Banu Maracine and 8.8-8.9 micromoles $CO_2/m^2/s$ in the vineyard located in Şimnic area, near the power plant, compared with 2008, when they recorded the following values: 6.8 - 6.7 micromoles $CO_2/m^2/s$ in Banu Mărăcine and 6.9 -6, 6 micromoles $CO_2/m^2/s$ in Şimnic vineyard.

As regards the concentrations of pollutants, there have been registered at hours 12-14: 15 mg/mc SO_2 and 39-38 mg/mc NOx in 2007 at Banu Mărăcine compared with levels of 26-29 mg/mc SO_2 and 15-17 mg/mc NOx measured in Şimnic vineyard.

In 2008, concentrations of pollutants measured were: 17-18 mg/mc SO_2 and 39-37 mg/mc NOx in Banu Mărăcine and 35-37 mg/mc SO_2, respectively 19-23 mg/mc NOx for Şimnic vineyard.

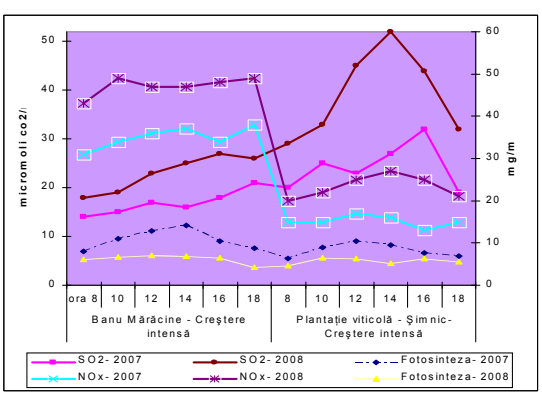

Figure 2: The process of photosynthesis at Royal Feteasca variety compared with SO_2 concentrations in the intense growth phenophase

At intense growth phenophase, in a situation where in the ambient air were registered concentrations of 17-16 mg/mc SO_2 and 36-37 mg/mc NOx in 2007 at Banu Mărăcine

vineyard, compared to concentrations measured in Şimnic, a vineyard near the power plant, where there were at hours 12-14, values of 23-27 mg/mc SO_2 and 17-16 mg/mc NOx, photosynthesis intensity has higher values for vine plants from Banu Maracine, reaching a maximum value of 12.3 micromoles $CO_2/m^2/s$ in 2007.

In 2008, it is noticed a higher value of the process of photosynthesis in Banu Maracine, photosynthesis values recorded in Şimnic vineyard being smaller than those registered in previous phenophase. There are also observed, higher values of pollutants' concentrations.

In 2008, daily dynamics of photosynthesis has lower intensities, registered values not exceeding 6.5 micromoles $CO_2/m^2/s$, process deployment curve showing a peak at 10-12 hours.

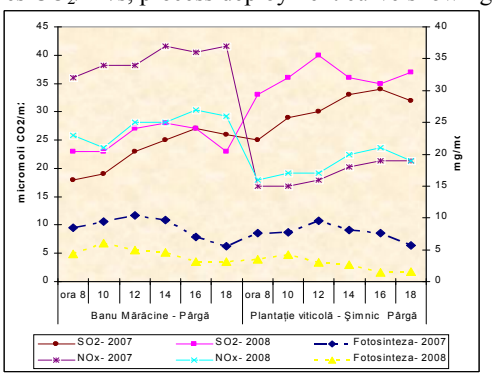

Figure 3: The process of photosynthesis at Royal Feteasca variety compared with SO_2 concentrations during the phenophase of firstfruits

Over to ripening phenophase, favorable growing conditions from 2007 have led the normal course of photosynthesis with a maximum at 12 p.m. in both vineyards.

In the year 2008, photosynthesis values are much lower than in 2007, increasing in intensity just before 10 a.m., especially in the vineyard situated near the power plant. In ambient air from this vineyard, were recorded higher values for SO_2 pollutant.

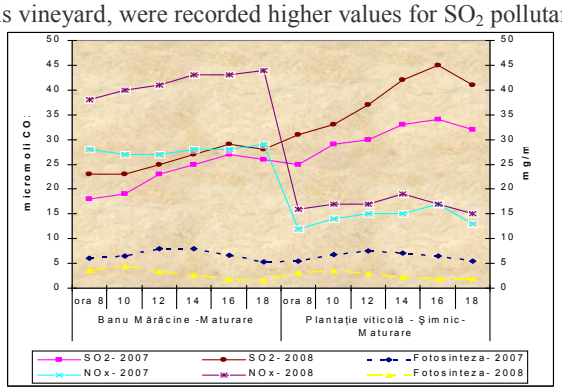

Figure 4: The process of photosynthesis at Royal Feteasca variety in relation to SO_2 concentrations during the ripening phenophase

The dynamics of photosynthesis process during the ripening phenophase is similar in terms of ongoing curve with the previous phenophase, but in this phenophase, intensity values

of photosynthesis are much lower. In these conditions both SO_2 and NOx concentrations measurements presented the highest values in 2008.

The dynamics of transpiration at Royal Feteasca variety in the flowering phenophase are carried out after similar development curve of photosynthesis: in 2007, the maximum is observed at 14 p.m. - 5.9 moles $H_2O/m^2/s$ at Banu Maracine and 5.5 moles $H_2O/m^2/s$ in Şimnic vineyard. In 2008, there is noticed a reduction in the transpiration intensity between hours 12-14, being recorded values from 2.9 - 2.7 moles $H_2O/m^2/s$ at Banu Mărăcine and 1.7 to 1.5 moles $H_2O/m^2/s$ between hours 10-12 hours at Şimnic.

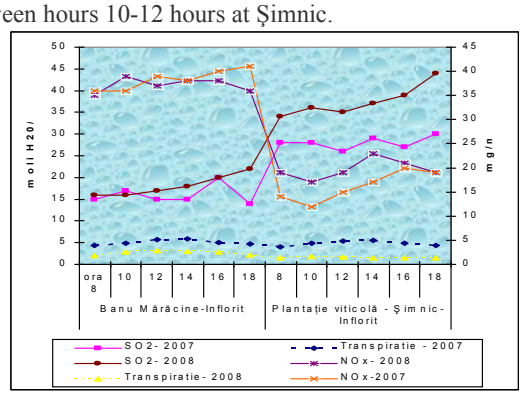

Figure 5: The process of transpiration at Royal Feteasca variety compared with SO_2 concentrations in blooming phenophase

In intense growth phenophase are observed higher values of transpiration intensity in 2008 compared with previous phenophase, in both vineyards.

In 2007, the dynamics of transpiration registered values highly close to those of the previous phenophases in Banu Mărăcine vineyard. Instead, in Şimnic vineyard, transpiration intensity values are lower in the intense growth phenophase compared to blooming phenophase.

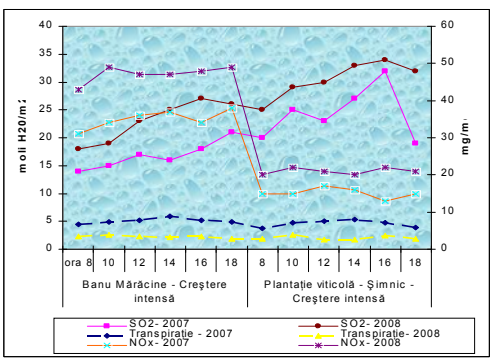

Figure 6: The process of transpiration at Royal Feteasca variety compared to SO_2 concentrations in the intense growth phenophase

Over to maturation, concentrations of pollutants from 2007 led to normal course of the transpiration process, with a maximum between hours 12-14, pointing out that in this phenophase the intensity of transpiration presents lower values compared with previous phenophase.

Climatic conditions and concentrations of pollutants from 2008 had an inhibitory influence on the development process of transpiration, whose intensity was much reduced compared with 2007. Therefore the dynamics of transpiration show a distinct curve, characterized by an increase until 10 a.m., after which the intensity decreases continuously up to 16-18 p.m., when a slight increase in the intensity of transpiration is observed.

At maturation, the difference between those two years is increasing, and as a result, in 2007, transpiration presents the highest intensities, at 12 p.m. being recorded a value of 3.6 moles $H_2O/m^2/s$ in Banu Maracine and 3.7 moles $H_2O/m^2/s$ in Şimnic vineyard.

In 2008, the maximum intensity of transpiration was achieved at 10 a.m. - 1.95 moles $H_2O/m^2/s$ in Banu Maracine vineyard and 1.9 moles $H_2O/m^2/s$ at Şimnic, and then due to the partial closure of stomata, the intensity of transpiration decreases continuously until 18 p.m.

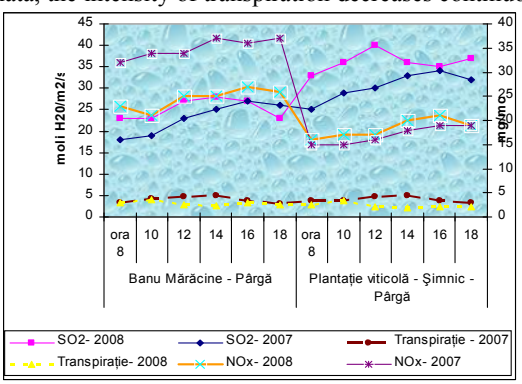

Figure 7: The process of transpiration at Royal Feteasca variety in relation to concentrations of SO_2 in the phenophase of firstfruits

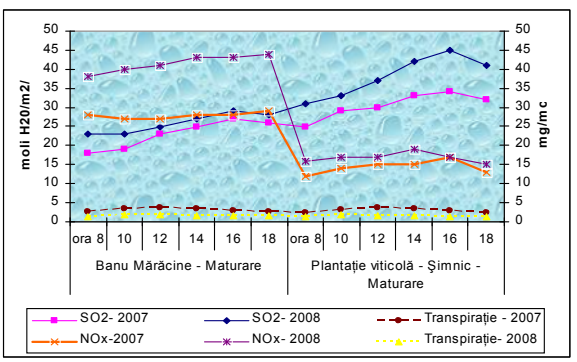

Figure 8: The process of transpiration at Royal Feteasca variety in corelation with SO_2 concentrations in the ripening phenophase

The following figures present the evolution of photosynthesis and transpiration processes at Merlot correlated with the concentration of SO_2 and NOx in different phenophases.

At Merlot, the dynamics of photosynthesis and transpiration, as recorded in the same days and environmental conditions, have similar progress curves to those of Royal Feteasca variety. At blooming, daily dynamics of photosynthesis and transpiration were normal, higher

values of photosynthesis occurred in 2008, while the intensity of transpiration was higher in 2007.

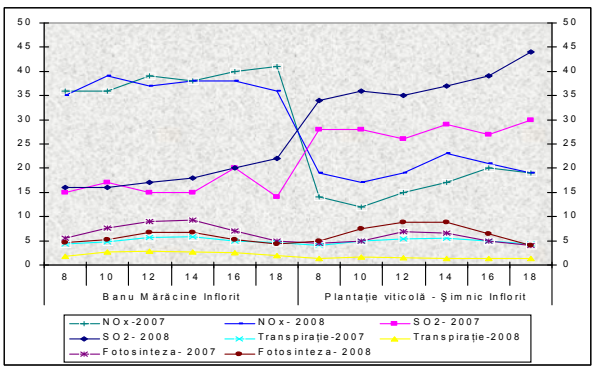

Figure 9: The dynamics of metabolic processes at Merlot variety in relation with SO_2 and NOx concentrations in the blooming phenophase

In intense growth phenophase, photosynthesis presented higher values during 2007, the highest values has been recorded in Banu Maracine vineyard. Regarding the transpiration process in this phenophase, higher intensities were determined in 2007 compared to 2008. This evolution of transpiration process, with higher values during 2007 compared to 2008 is encountered in the following phenophases: intense growth and firstfruits.

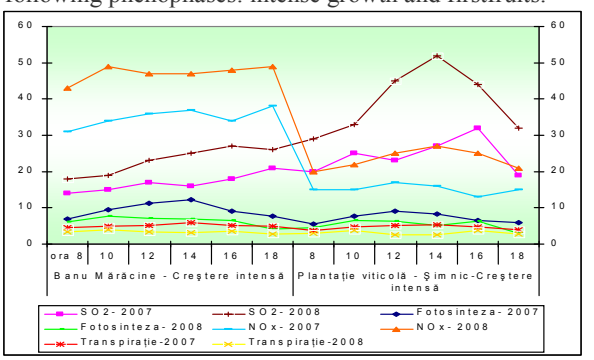

Figure 10: The dynamics of metabolic processes at Merlot variety in relation with concentrations of SO_2 and NOx in intense phenophase

In intense growth phenophase, in 2008, the intensity of metabolic processes is much lower than in 2007, increasing in intensity until 10 a.m., and then it decreases progressively until 18 p.m.

In Şimnic vineyard, there is a slight increase in the intensity of transpiration and photosynthesis processes at 16 p.m.

Over to ripening, favorable growing conditions from 2007 have led the normal course of photosynthesis with a maximum at 12 p.m., both in Banu Maracine and in Şimnic vineyard. In the year 2008, the process of photosynthesis values are much lower than in 2007, showing a trend similar to the previous phenophase.

As regards, the process of transpiration in Banu Maracine vineyard, are observed, lower intensity values in 2008 compared to 2007, when the intensity of transpiration has the highest value at 14 p.m..

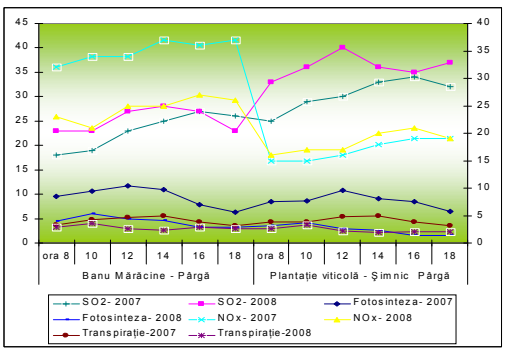

Figure 11: The dynamics of metabolic processes at Merlot variety in relation with concentrations of SO_2 and NOx in the phenophase of firstfruits

In 2007, the maximum intensity of transpiration was recorded at 10 and then decreases continuously up to 16-18 hours, when an increase in the intensity of the process of transpiration was noticed.

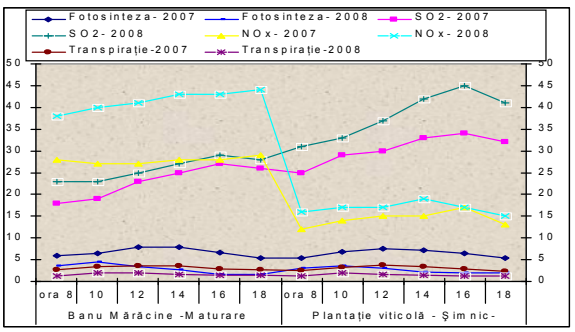

Figure: 12.The dynamics of metabolic processes at Merlot variety in relation with concentrations of SO_2 and NOx in the phenophase of ripening

The dynamics of photosynthesis and transpiration processes in the ripening phenophase are similar in terms of curve evolution, with the previous phenophase, but in this phenophase intensity values of photosynthesis are much lower.

CONCLUSIONS

Regarding the influence of pollutants concentrations on the development of physiological processes in plants, were observed the following:

In the phenophase of blooming, the dynamic processes of photosynthesis and transpiration, being registered in the same days and environmental conditions, have similar progress curves in both species studied. In this phenophase, under normal physiological processes, higher values of photosynthesis were recorded in 2007, for Royal Feteasca variety, and in 2008 for Merlot. The transpiration process was intense for 2007, both at Merlot and Royal Feteasca variety.

In intense growth phenophase, the highest values of photosynthesis intensity were recorded at the Royal Feteasca variety from Banu Mărăcine vineyard during 2007. While the intensity of transpiration, at this variety, had the highest values in 2008. The same dynamic of the processes of photosynthesis and transpiration was recorded also for Merlot in this phenophase.

Over the phenophase of firstfruits, favorable growing conditions from 2007 have led the normal course of photosynthesis with a maximum at 12 p.m. in both vineyards, both for Royal Feteasca and Merlot variety. During 2008, photosynthesis values are much lower than in 2007, increasing in intensity just before 10 a.m., especially at Royal Feteasca and Merlot in the vineyard from Şimnic.

Climatic conditions and concentrations of pollutants in 2008 had an inhibitory influence over the transpiration proces, whose intensity was much lower than in 2007, in both varieties studied. Therefore, the dynamics of transpiration present a special curve, characterized by an increase at 10 a.m., after which the intensity decreases continuously up to 16-18 hours, when a slight increase in the intensity of transpirations is noticed.

In the phenophase of ripening, at Royal Feteasca and Merlot variety, differences between the two years are increasing, and as a result, in 2007, higher values of photosynthesis and transpiration were recorded in Banu Maracine vineyard.

BIBLIOGRAPHY

1. GLADSTONES J., 1992, „Viticulture and Environment", Winetitles, Adelaide.
2. IONESCU AL., 1982, „Fenomenul de poluare şi măsuri antipoluante în agricultură", Ed. Ceres, Bucureşti.
3. SOUCHÈRE V., CERDAN O., DUBREUIL N., LE BISSONNAIS Y., KING C., 2005, „Modelling the impact of agri-environmental scenarios on runoff in a cultivated catchment (Normandy, France)", CATENA**,** Soil Erosion under Climate Change: Rates, Implications and Feedbacks, Volume 61, Issues 2-3, pag. 229-240, doi:10.1016/j.catena.2005.03.010.
4. TATE A.B., 2001, „Global warming's impact on wine", Journal Wine Res. 12, pag. 95-109.
5. WEBB L.B., WHETTON P.H., BARLOW E.W.R., 2005, „Impact on Australian Viticulture from Greenhouse Induced Temperature Change", International Congress on Modelling and Simulation. Modelling and Simulation Society of Australian and New Zealand, pag. 170-176.
6. WEINSTEIN L.H., 1984, „Effects of air pollution on grapevines", EPA, USA.