VARIABILITY OF SOME ECOPHYSIOLOGICAL PARAMETERS AT WOODY SPECIES IN CERTAIN FOREST PLANTATIONS FROM CENTRAL MOLDAVIAN PLATEAU

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Abstract

The purpose of this paper is to assess the variability of some ecophysiological parameters of the woody species as a measure of stability of the certain forestry ecosystems from North-eastern Romania. Some analyzed forestry stands from Moldavian Central Plateau were mostly grown in degradated soils by erosion with large slopes. Ecophysiological researches were made in plant species in several representative plantations for Moldovan Central Plateau (plantations with *Robinia pseudoacacia, Salix alba*, *Populus alba,* etc). Were analyzed relative variation of photoassimilatory pigments (chlorophylls and carotenoids) and sugars parameters of carbohydrate metabolism (mono-, di-, polysaccharides soluble and insoluble). Foliar gas-exchange parameters as photosynthesis rate, transpiration rate and stomatal conductance were determined *in situ* condition from mid-July. Analyses of coefficient of variation for photosynthesis showed a relatively large fluctuation, especially in young plantations (Fereşti-Săratu, Fereşti-Velniţa), meanwhile a smallest variation obtained at coefficient of variation for transpiration in biotope with constant humidity in riverside coppice(Soleşti). It could be observed a smaller increasing along age of analyzed coefficients of variation(CV of photosynthesis, and respectively, CV of transpiration), between 15 years old until 30 years old.

Key words: photosynthesis, transpiration, forest plantations, Central Moldavian Plateau

A distinct unit of Moldavian Plateau, Central Moldavian Plateau is characterized by a rugged, hilly landscape with vegetation typically for silvosteppe. Lithologyc substrate is represented by loesssands and bedrocks. Soils that vegetation grows is represented by chernozem (moderate slopes) and regosols (steep slopes), humic gleysol (moist plains). Plantations are established on degraded (eroded, Gravitational) soil water deficit, so installing forest vegetation is quite hard to achieve. The role known of plantations with different tree species have been used to prevent soil erosion and degradation, being an important part in vegetation restoration and ecosystem regeneration. For degraded soils, *Robinia pseudoacacia* L. as the pioneer tree species have been widely planted for its adaptability and rapid growth. Moreover, black locust(*Robinia pseudoacacia* L.) can well improve soil fertility and fix nitrogen (Zheng Y et al., 2012).

Physiological performances are processes influenced by many factors, micro-environmentals (solar radiation, air temperature, soil moisture) greatly affecting plant photosynthesis under field conditions (Acatrinei L, 2009) and also specific factors as age, because the foliar photosynthetic capacities decrease with increasing tree age and size (Zheng Y et al., 2012). As a result, new informations of photosynthetic and physiological characteristics for black locusts on the Central Moldavian Plateau are required. The previous studies were carried out to the natural forests from Moldavian Central Plateau(Antohe A et al., 1995).

This work approached also, the behaviour and physiological analysis of the variability coefficient of some gas-exchange parameters in tree stands from plantation of different biotope conditions from NE Romania. The concept of stability was observing that mature ecosystems are more stable and resistant to stress conditions, while poor communities (removal of species) lose their ability to compensate the fluctuations in microclimate(Fóti Sz, 2002; Acatrinei L., 2010). Considering these studies, we pursued the variation of ecophysiological parameters in tree species of plantations with different ages and biotope conditions(slope, soil moisture, tree species).

MATERIAL AND METHOD

Biological material used consisted of fresh leaves of woody species from studied forest stands. Collections of material were made in July,

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the middle of summer. It were analyzed the following indicators: chlorophylls a and b, total carotenoids and sugars content from leaves(mono-, di- and polysaccharides). Spectrophotometric method for determination of pigments was solving in 85% of fresh leaves of the species investigated (Meyer-Berthrand Ştirban, 1985). Results were expressed in mg/g of fresh weight (mg/g fr.w). Bertrand method combined with method Borel, 1953, made determination of carbohydrates in dried plant material. Results were expressed as g% of dry matter. Photosynthesis, transpiration and stomatal conductance were determined with LCi analyzing portable system (ADC Bioscientific, U.K). The indicator WUE (water use efficiency) was calculated by the ratio of A (rate of photosynthesis)/E (rate of transpiration).

Characterization of stations: it were including the five forest plantations in the Moldavian Central Plateau geographical unit (Vaslui County): 1-Movila lui Burcel (46° 51' 17.64"-N, 27° 47' 54.39"-E, altitude-150m) with black locust plantation aged 20 years on a slope with west exposition, 2 - Soleşti (46° 50' 1.23"-N, 27° 47' 47.43"- E, altitude-127m) riverside coppice with white willow -30 year old and poplar white-15 years old, 3 - Fereşti Săratu (46° 45' 59.35"-N, 27° 42' 47.21"-E, altitude-210m)-young black locust plantation of 6 years old, Eastern exposition, 4 –Fereşti-Velniţa (46° 47' 28.10"-N, 27° 43' 51.29"-E, altitude-220m) - young black locust plantation with 5-6 years old, Western exposition and 5-Buhăieşti (46° 47' 34.40"-N, 27°34'27.41'-E, altitude-113m)-heterogeneous plantation 10-15 years, black locust and black pine. Statistical analysis included the arithmetic mean, standard deviation and coefficient of variation calculated for tree species. Soil classification is evaluated after WRB, 2006.

RESULTS AND DISCUSSIONS

Analysis of assimilating pigments in leaves wood species reflects their photosynthetic capacity and habitat adaptation to the conditions offered by the station. Chlorophyll a ranged from 1.72 mg/g fr.w recorded in the leaves of *Robinia pseudoacacia* (Fereşti-Velniţa) and 1.13 mg/g fr.w (Movila lui Burcel)(*fig.1*). Chlorophyll b showed a variation between 0.3 mg/g fr.w (black locust tree-at Movila lui Burcel and also at Buhăieşti) and 0.63 mg/g fr.w (black locust tree-Fereşti-Velniţa). In *Robinia psedoacacia,* total carotenoids pigments were recorded with a variation ranging from 0.2 mg/g fr.w (Movila lui Burcel and respectivelly, Buhăieşti) to 0.45 mg/g fr.w (Fereşti-Velniţa). Relatively, closed values of the pigments registered in species stands of floodplain plantation-Soleşti, *Salix alba* and *Populus alba*. As could be seen in Figure 1, the highest values of the parameters were recorded assimilating leaves of *Robinia pseudocacia* in Velniţa-Fereşti, young plantation (fig.1). The higher photosynthetic capacity in leaves of young tree is already known in ecophysiological tree literature.

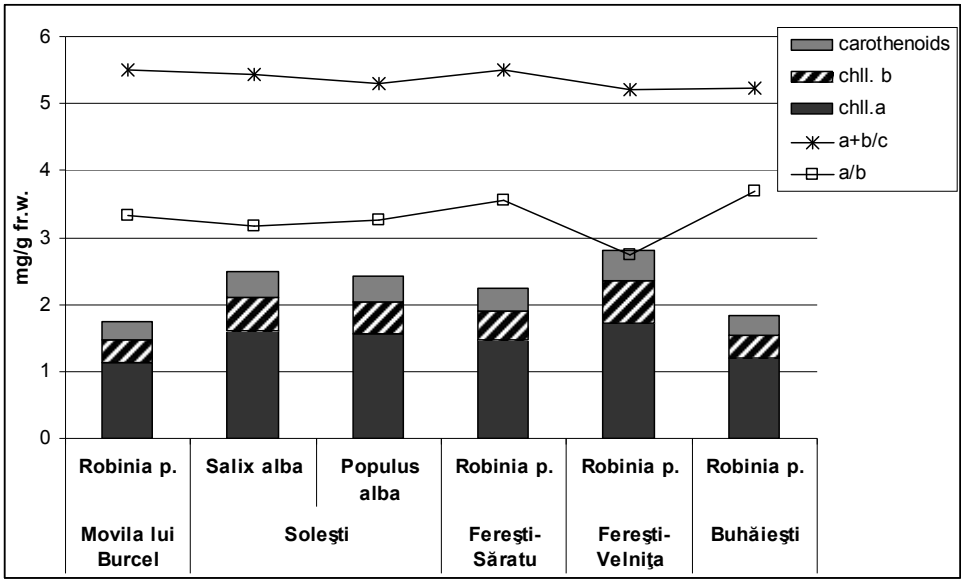

Figure1 **Variation of photoassimilatory pigments in woody species from plantations of Moldavian Central Plateau**

Chlorophyll a/chlorophyll b ratio(a/b), the indicator of photosynthetic efficiency has have an average of 3.29, which is normal for sunny leaves; a smaller values by 2.73 has obtained in leaves of *Robinia pseudoacacia* from Fereşti-Velniţa plantation with an higher degree of shadings(*fig. 1*). The weight ratio of Chl *a* and *b* to total carotenoids (*a*+*b*)/(c), an indicator of the greenness of plants has have the average of 5.36 which is normally for sun-exposed plants(*fig. 1*). According with previous work, in other forest ecosystems from this part of Romania, in this case the function of photosynthetic apparatus is absolutely normal there is no indication of

senescence, stress or damage of the plants in condition of biotope of Central Moldavian Plateau (Acatrinei L., 2008). Analysis of carbohydrate fractions from the leaves of the species studied showed the highest concentration of insoluble polysaccharides, in this phenophase, they dominate the proportion of carbohydrate compounds (*fig 2*). Their range varied between 21.45 g% (*Robinia pseudoacacia*-Buhăieşti) and 31.7 g% (*Salix alba*-Soleşti)(fig. 2). Disaccharide concentration ranged from 9.7 g% (*Robinia pseudoacacia* -Buhăieşti) -0.6 g% (*Salix alba* - Solesti). The remaining part of range was recorded the approximate 2.5 g %. Monosaccharides were recorded only in black locust (*Robinia pseudoacacia*) leaves in Movila lui Burcel(fig. 2). Analyzed tree species from plantations accumulated insoluble polysaccharides the approximately value of 26 % (with backup role and structure of organs) during this period, the rest of carbohydrate compounds is very little represented.

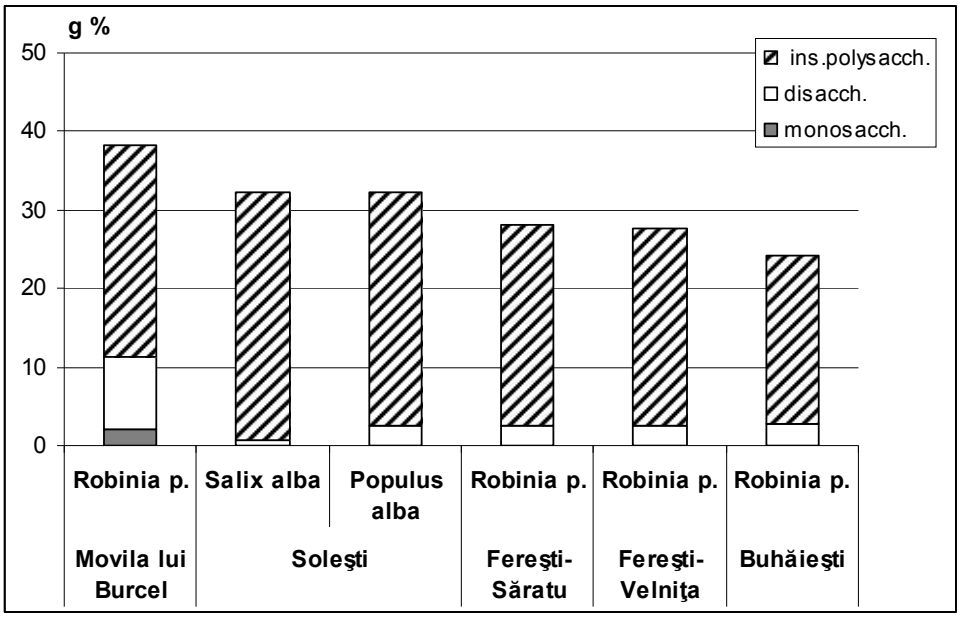

Figure 2 **Variation of carbohydrates indicators in woody species from plantations of Moldavian Central Plateau**

Parameters at leaf gas exchange registered variations by species, age of tree and biotope resources, the soil moisture, etc. Rate of photosynthesis registered a range between 1.802 µmol m^{-2} s^{-1} (*Populus alba*-Soleşti plantation) to 0.43 µmol m^{-2} s^{-1} (*Robinia pseudoacacia*-Fereşti Velniţa plantation) (*tab.1*). Transpiration rate registered a range between 2.696 mmol m^{-2} s^{-1} (*Populus alba*-Soleşti plantation) to 0.384(*Robinia pseudoacacia*-Movila lui Burcel plantation). Transpiration and photosynthesis intensity that were interpreted according to the WUE ratio(A/E), which establishes management of water in the dry matter photosynthetic assimilation(Reinhard F., 1996)(*tab.1*). Thus, it was observed that a highest value of this parameter by 2.15 was recorded in Buhăieşti station in leaves of *Robinia pseudoacacia*. Values close to 1.3 registered in the same specie(plantations from Movila lui Burcel and respectively, from Fereşti-Săratu) and in Soleşti station at *Salix alba*. These plantations are mature, 15 years old (Buhăieşti) and even 20 years old (Movila lui Burcel). A particular situation has registered in white poplar where photosynthesis intensity value (1.802 µmol m^{-2} s^{-1}) and transpiration (2.696 mmol m^{-2} s^{-1}) are the highest but the value of WUE is quite low, 0.668(*tab.1*). This species has ecological role in water drainage; dry assimilation is performed with high water consumption. In this case internal conductance(gs) is also highest with a value of 0.130 mmol m^{-2} s^{-1} which stimulated the gas-exchange parameters (photosynthesis and transpiration) through a mechanism of stomatal adjustment. Coefficient of variation for photosynthesis rate (CV of A) showed a range between 24% (*Populus alba*, Soleşti plantation) and 83 % (*Robinia pseudoacacia*, Fereşti-Velniţa plantation) (tab.2). In the middle of range are situated the black locust with values of 41.65-45% from Buhăieşti and respectively, from Movila lui Burcel plantations. These plantations are matured, over 15 years old, but could be observed the increasing of the coefficient of variation along with age of plantation (*tab.2)*.

Table 1

Variation of foliar gase-exchange parameters in forest plantation from Moldavian Central Plateau

Station	Specie	Qleaf(µmol m^{-2} s^{-1})	Tch (°C)	Ci(µmol m^{-2} s^{-1})	A(µmol m^{-2} s^{-1})	E(mmol m^{-2} s^{-1})	gs (mmol m^{-2} s^{-1})	WUE (A/E)
Movila lui Burcel	*Robinia pseudoacacia*	134	36	281	0.502±0.005	0.384±0.01	0.009	1.304
	Salix alba	126	35	300	0.630±0.07	0.480±0.016	0.019	1.313
Soleşti	*Populus alba*	128	35	331	1.802±0.119	2.696±0.02	0.130	0.668
Fereşti-Săratu	*Robinia pseudoacacia*	105	34	327	0.755± 0.108	0.606± 0.017	0.0285	1.245
Fereşti-Velniţa	*Robinia pseudoacacia*	120	36	332	0.433±0.095	0.585±0.033	0.02	0.740
Buhăieşti	*Robinia pseudoacacia*	101	32	312	1.164± 0.125	0.541±0.008	0.032	2.153

Legend: Qleaf-PAR(photosynthetic active radiation), Ci- CO_2 concentration in substomatal cavity, A-photosynthesis rate, E-transpiration rate, gs- stomatal conductance, Wue-water use efficiency. Mean ± SE.

In correlation with this observation is the value of the CV of A, by 50 % in leaves from *Salix alba*, 30 years old from Soleşti station. The highest value of 83 % for this parameter is obtained in young trees of *Robinia pseudoacacia* from Fereşti-Velniţa and respectively of 59 % from Fereşti-Săratu.

Table 2

Coefficient of variation of some ecophysiological indicators in different forest plantations from Moldavian Central Plateau

Station	**Type of soil Level of soil fertility**	**Tree species(age of stands)**	**CV of A(%)**	**CV of E(%)**
Movila lui Burcel	-Arenic-eutric regosol, Under moderate level of fertility	*Robinia pseudoacacia(20 years old)*	45	12.8
Soleşti	-Eutric humic, gleysol Moderate level of fertility	*Salix alba(30 years old)*	50	14.91
	Eutric humic, gleysol Moderate level of fertility	*Populus alba(15 yers old)*	24	4.23
Fereşti-Săratu	Haplic phaeozem hyposalic Moderate level of fertility	*Robinia pseudoacacia(*6 years old)	59	12.857
Fereşti-Velniţa	Haplic vertic phaeozem High level of fertility	*Robinia pseudoacacia (*5-6 years old)	83	25
Buhăieşti	Haplic vertic chernozem High level of fertility	*Robinia pseudoacacia(*15 years old)	41.65	7.38

Legend: Cv- coefficient of variation for rate of photosynthesis (A), respectively, rate of transpiration (E)

The photoassimilatory activity(chlorophylls and total carotenoids) is higher in leaves of *Robinia pseudoacacia* from Fereşti-Velniţa, totals of them being around 3 mg/g fr. w.(*fig.1*). Despite of this, water use efficiency(WUE) is quite low, in comparison with other older trees by regulating leaf-level photosynthetic processes that occurred in young plantations. Photosynthesis rate has had a higher range which conducts to a higher CV of A. In trees, shading of leaves, assimilates transport and maybe the other factors(slope, height of tree, wood mass) controlling the photosynthesis mechanism. Coefficient of variation for transpiration rate has a smaller range between 4.23 % (*Populus alba*-Soleşti plantation) and 25% (*Robinia pseudoacacia*, Fereşti-Velniţa station). The rest of interval has have the values are between 12.8-15 %, in tree with different ages(young-Fereşti-Săratu and mature-Soleşti) and different biotope conditions(soil moisture-Soleşti plantation). It could be observed a smaller of CV of E increasing along the age, between 15 years old until 30 years old, but rate of transpiration have not some large differences between plantations like was observed at CV of A. Transpiration rate is linked with soil evapotranspiration, air temperature, and air humidity than soil type or its fertility. In young ages such is in *Robinia pseudacacia*(black locust) from Fereşti-Velniţa, transpiration registered a higher(0.585 mmmol m^{-2} s^{-1}) and fluctuant values of CV of E(25 %), mostly because of intensive processes of growth. After 15 years old, the values are smaller fluctuant and assimilation is higher than water lost through transpiration(WUE parameter) that which be seemed the optimal age

for ecophysiological parameters in condition of Moldavian Central Plateau plantations. The soil type and its fertility may be optimize the ecophysiological behaviours that is observed in Buhăieşti plantation(*tab.2*) but not influenced in anyway the processes of growth.

CONCLUSIONS

The highest values of the photosynthetic parameters(chlorophylls a, b and total carotenoids) were recorded in leaves of *Robinia pseudocacia* in Velniţa-Fereşti, young plantation, meanwhile the smaller weight of them registered in mature trees form Buhăieşti and respectively, Movila lui Burcel plantations.

Analyzed tree species from plantations accumulated the insoluble polysaccharides compounds, in approximate value of 26 % during this period; the rest of carbohydrate compounds have had very lower weight. Thus, disaccharides has have the highest value of 9 g % in black locust –Movila lui Burcel and a smallest value of 0,6 % in *Salix alba*-Soleşti, the rest of range having a small weight, in average around 2 g %.

Coefficient of variation for photosynthesis rate (CV of A) showed a range between 24%(*Populus alba*, Soleşti plantation) and 83 %(*Robinia pseudoacacia*, Fereşti-Velniţa plantation). In the middle of range is situated the black locust with values of 41.65-45% from Buhăieşti and respectively, Movila lui Burcel plantations. These plantations are matured, over 15 years old and the increasing of the coefficient of variation along with age of plantation could be occurred. Thus, small values of CV of A and CV of E were observed in mature plantations, over 15 years old, such as Buhăieşti and even Movila lui Burcel. In these plantations, water use efficiency has had supraunitar values. Age factor influenced the ecophysiological parameters stronger than biotope condition, situation observed in Soleşti station(Eutric humic, gleysol) where *Salix alba*-30 years old has had a higher coefficients of variation than *Populus alba*-15 years old.

Populus alba, with especially higher values of rate of transpiration not showed supraunitar value of WUE(A/E ratio), even the value of photosynthesis rate was higher. The importance of *Populus alba* in water drainage is quite demonstrate because of connection between stomatal conductance (gs) and transpiration rate(E).

ACKNOWLEGMENTS

This study was supported by BIODIV Research Programme developed under coordination of National Institute of Research and Development for Biological Sciences Bucharest. Thank to Mr. Lazar Bireescu for analysis of soil and his courtesy to makes them available for this paper.

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