VARIABILITY OF SOME ECOPHYSIOLOGICAL PARAMETERS IN THE MAIN CROP PLANTS OF CENTRAL MOLDAVIAN PLATEAU AGROECOSYSTEMS

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Abstract

Ecophysiological studies of species grown in agroecosystems of Central Moldavian Plateau were assessed by analysis of metabolic parameters specific to highlight potential resource recovery biotope on which these plants are grown. Parameters were analyzed at foliar gas exchange: intensity of photosynthesis-A, intensity of transpiration -E and water use efficiency in photosynthetic assimilation, WUE (ratio A/E, indicators of hydric metabolism (relative water content) and of carbohydrate metabolism (mono- , di -and polysaccharides) in the leaves of the studied species. Analyzed species were winter wheat (cult. *Triticum aestivum*), sunflower (*Helianthus annuus*), maize (*Zea mays*) and alfalfa (*Medicago sativa*), investigating the annual and perennial crops in four stations: Şerbesti (Iasi County), and respectively, Cănţălăreşti, Buhăieşti and Rebricea (Vaslui County) from the Northeastern Romania. Such studies are continuing those carried in other natural and anthropic ecosystems of Central Moldavian Plateau (forests, plantations, meadows and pastures). This work approached also, the analyzing the coefficient of variation of gas-exchange parameters in crop plants of different biotope conditions from NE Romania. The results were found that analyzed maize hybrids and cultivars of winter wheat, improve in optimal terms of ecophysiological, resources the stations biotope at Central Moldavian Plateau (mainly cambic chernozem and vertic subtype soils on slopes) in the climatic conditions of the year 2013 (with more precipitation in May-June). Water use efficiency showed an increased values during growth stage in Zea mays on the haplic chernozem; meanwhile when character vertic showed in soil type as well as haplic vertic chernozem, water use efficiency registered fluctuations.

Key words: agroecosystems, coefficient of variation, gas-exchange parameters

A large part of the territory of the Central Moldavian Plateau is comprised of slopes less favorable to crop conditions; many fields have been misused for grazing. The increasing of degraded lands has contributed much the old system of tillage, transversal from hill to valley. Arable hold over 50% of the total land of Central Moldavian Plateau, but soil quality is partly mediocre, especially on slopes. Soils is represented by chernozem (moderate slopes) and regosols (steep slopes), humic gleysol (moist plains). Analyzed soils are considered typical for steppe zone in Central Moldavian Plateau, NE Romania. In rainy springs stagnation can occur at surface and anaerobic processes with negative influences on young plants root system. In the summer season due to its high clay content, pedological drought manifested by the appearance of cracks intensified the evapotranspiration. These soils require technological works to 40 cm deepth for raising, air and water circulation and also, for the adjustment of biological activity of aerobic microorganisms (Bireescu L. et al, 2010).

This ecophysiological study is the continuation of previous were carried out to the natural forests (Antohe A. et al, 1995), forest plantations (AcatrineiL., 2013), grasslands (Acatrinei L., 2010) from certain type of ecosystems of Moldavian Central Plateau. In these studies were also approached the coefficient of variation of gas-exchange parameters in different crops in relation with biotope conditions as an instrument of indirect analysis of water availability from soil.

MATERIAL AND METHOD

It were analyzed sugars indicators content from leaves (mono-, di- and polysaccharides) by using Bertrand method combined with method Borel, 1953, 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).

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Relative water content was calculated after relative turgidity method.

Characterization of stations: it were including four observations point in the Moldavian Central Plateau geographical unit (Vaslui County and Iaşi County)

1-Şerbeşti- Iaşi Conty(46° 53' 12,99"-N, 27° 48' 58,08 "-E), in annual crops of *Triticum aestivum* (winter wheat), *Helianthus annuus* (sunflower), *Zea mays* L. (maize) and perennial, *Medicago sativa* (alfalfa); *2-Cănţălăreşti, Ştefan cel Mare-Vaslui County (46° 45,57' 98-N, 27° 35' 28,86 "-E),* in annual crops of *Triticum aestivum* (winter wheat), *Zea mays* L. (maize); *3-Rebricea-Vaslui County (46° 53,14' 77"-N, 27° 35' 51,55 "-E)*, in annual crops of *Triticum aestivum* (winter wheat), *Helianthus annuus* (sunflower), *Zea mays* L.(maize); *4 - Buhăieşti (46° 47' 41,23"-N, 27° 34' 8,73 "-E),* Vaslui, in perennial crop of *Medicago sativa* (alfalfa). First analyses were carried out in May, in July, when winter wheat was yellow, ready for the harvest was no more observation in that specie.

Statistical analysis included the arithmetic mean, standard deviation and coefficient of variability was calculated.

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RESULTS AND DISCUSSIONS

Foliar gas-exchange parameters provide information about the rate of photosynthesis, stomatal conductance and transpiration recorded on the field in each of agroecosystem type. Photosynthetic active radiation intensity, Q leaf (PAR) is fluctuating, as recorded for each crop plant separately. Average parameters at leaf gas exchange, obtained during the period studied were synthesized in two tables given below.

In May, it can be observed that intensity of photosynthesis registered values between 2.43 to 5.54 µmol $m^{-2}s^{-1}$ at cult. *Triticum aestivum*, from 1.93 to 8.36 µmol $m^{-2}s^{-1}$ in hybrids of *Zea mays* and from 5.44 to 6.13 µmol $m^{-2}s^{-1}$ in varieties of *Helianthus annuus*, at variable active radiation (Q leaf). The greater variation of the rate of photosynthesis (A) was registered in *Zea mays* and the smaller in *Helianthus annuus,* both being in vegetative phenophase (*table1*). The transpiration in generally, has a smaller variation interval, cultivars of *Triticum aestivum*, winter wheat(at beginning of the earing phenophase) is around 0.6 mmol $m^{-2}s^{-1}$ in all studied stationaries; from 0.5 to 1.05 mmol $m^{-2}s^{-1}$ was recorded at *Zea mays* (vegetative growth, six leaves) and between 0.76 to 1.04 mmol $m^{-2}s^{-1}$ in *Helianthus annuus* (vegetative growth stage 7-8 leaves) (*table 1*). WUE ratio (A/T) gives information on the use of water in the photosynthetic assimilation, more specifically refers to the amount of dry matter produced per unit of water lost by transpiration. Water use efficiency has almost the value around 5 in cult. *Triticum aestivum* in all stationaries because of the earing phenophase (the products of assimilation were used for the ear formation and grains filling).

Table 1

Variation of foliar gas-exchange parameters in various agroecosystems from Moldavian Central Plateau in May 2013

Station	Specie	Ci (µmol m^{-2} s^{-1})	E (mmol m^{-2} s^{-1})	gs (mmol m^{-2} s^{-1})	A (µmol m^{-2} s^{-1})	WUE (A/E)
Şerbeşti	*Triticum aestivum*	226±35.59	0.67±0.12	0.08±0.03	3.63±0.83	5.45
	Zea mays	250±31.85	0.5±0.08	0.09±0.01	1.93±0.78	3.86
	Helianthus annuus	212±17.15	0.76±0.03	0.1±0.02	5.44±0.65	7.19
Cănţălăreşti	*Triticum aestivum*	149±14.53	0.69±0.04	0.08±0.01	5.54±0.31	8.04
	Zea mays	221±25.07	0.98±0.07	0.48±0.19	5.1±0.39	5.18
Rebricea	*Triticum aestivum*	250±13.56	0.52±0.03	0.07±0.006	2.43±0.19	4.73
	Zea mays	116±25.47	1.05±0.04	0.11±0.01	8.36±0.88	8.00
	Helianthus annuus	150±21.52	1.04±0.10	0.12±0.02	6.13±0.48	5.91

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.

On July, the maize, in the emergence phenophase of tasseling (male flower) and even stigma (at Şerbeşti and Rebricea stations) photosynthesis intensity increased, which leads to higher organic mass values ratio A/E (WUE) than was registered in May (*table 2*). In hybrids of *Helianthus annuus*, although the intensity of photosynthesis is up from the previous month analyzes is observed an increase in respiration intensity, which leads to lower organic mass (WUE values given by A/E) because of higher water consumption (*table 1, table 2*). An increasing of water use efficiency was observed in *Zea mays* at Cănţălăreşti from 5.18 (May) to 7.10 (July) and at Şerbeşti from 3.86 (May) to 9.34 (July) meanwhile *Helianthus annuus* hybrids showed a slight decreasing (*table 2*).

Table 2

Variation of foliar gas-exchange parameters in various agroecosystems from Moldavian Central Plateau in July 2013

Station	Specie	Ci ($\mu mol\ m^{-2}\ s^{-1}$)	E ($mmol\ m^{-2}\ s^{-1}$)	Gs ($mmol\ m^{-2}\ s^{-1}$)	A ($\mu mol\ m^{-2}\ s^{-1}$)	WUE (A/E)
Şerbeşti	*Medicago sativa*	369±1.17	0.435±0.032	0.27±0.162	0.13±0.01	0.29
	Zea mays	186±21	0.67±0.05	0.16±0.067	6.26±0.72	9.34
	Helianthus annuus	201±12.48	1.05±0.06	0.29±0.098	6.79±0.59	6.50
Buhăieşti	*Medicago sativa*	258±5.09	0.83±0.053	0.14±0.026	3.12±0.22	3.78
Cănţălăreşti	*Zea mays*	126±13.18	0.83±0.09	0.08±0.08	5.89±0.74	7.10
Rebricea	*Zea mays*	156±17.6	1.2±0.087	0.36±0.107	7.38±0.74	6.15
	Helianthus annuus	178±15.66	1.1±0.102	0.14±0.03	5.33±0.32	4.84

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 *table* 3, the variation coefficient of gas-exchange parameters was analyzed at different growth stage of crop plants in dependency with type of soil. In vegetative period of crop plants (May), coefficient of variation for photosynthesis (CV of A) varied into an interval between 15.9 % (cult. *Triticum aestivum*- Cănţălăreşti) to 39.44 % (*Helianthus annuus*-Şerbeşti). In the same growth stage, Cv of E varied between 13.73 % (*Helianthus annuus*-Şerbeşti) until 40 % (cult *Triticum aestivum*-Şerbeşti). Variation of transpiration is due to a mechanism of opening or closure stomata during daytime, intensity of light, air humidity as other environmental parameters. In May of 2013 registered a large amount of precipitation (85 mm/mp. according to ANMH). Close values of coefficient of variation for photosynthesis (Cv of A) and also, transpiration (Cv of E) were observed in cult. *Triticum aestivum* (Cănţălăreşti and Rebricea), *Zea mays* (Cănţălăreşti) and *Helianthus annuus* (Rebricea) (*table 3*). The high clay content in soil, as well as the presence of vertic character represents processes which affect his abilities much favourable of chernozem (subtype haplic vertic). At Şerbeşti station because of clay, consistency of dry soil is hard and in summer is forming lumps, which is an ecological determinant excessive and negative. Its chemical characteristics, soil reaction, nutrient and also, humus content are perfect favourable compared to those negative physical. Soil from Cănţălăreşti station is haplic chernozem with a better texture, moderately fine, medium aeration porosity. Chemical characteristics are very good (neutral reaction low alkaline, medium humus content and well supplied with nutrients. Vertic character not shows and thus does not degrade soil structure. Photosynthesis reaction in light phase requires the water photolysis for the electronic transport. Water availability from soil in different growth stage of plant could be a stressful factor. The stressor that limited the photosynthesis rate could be this negative determinant character revealed by haplic vertic chernozem, a degraded chernozem. Coefficients of variation Cv of A and also, Cv of E having the closer values showed an uniformity of resources of biotope (intensity of light, availability of water and nutrients, etc) which is happening in Cănţălăreşti stationary with haplic chernozem (*table 3*). The influence of biotope observed also in *Medicago sativa* when Cv of A (25.4 %) and Cv of E (27.8 %) have closer values (small variation) showed in Buhăieşti station, in moisture plains with haplic gleic chernozem.

Soil of Rebricea station is haplic vertic chernozem with a high content of clay which is swelling in moisture (retain water) and during drought is cracked. Thus, estival consistency is very hard forming clods and medium to low aeration porosity, comparable with that of Şerbeşti. At the surface, on the first 40 cm, the texture is good, medium-fine and not fine as Şerbeşti, Humus and nutrient content is higher than Şerbeşti and the soil reaction is still weak acid to neutral, but with lower values on surface than Şerbeşti (Bireescu et al,. 2010).

During the studied period, in all studied crop plants, carbohydrate metabolism is characterized by the increased accumulation of the polysaccharide, especially those insoluble (*figure 1*). Polysaccharides ranged 90-70 % in May and between 75-65 % in July of total sugars fraction (*figure 1*). In May, insoluble polysaccharides recorded values between 27.87 g % (*Zea mays*-station I) to 39.10 g % (*Zea mays*-station II). Soluble polysaccharides ranged from 1.90 g % -*T. aestivum* (station I) to 6.43 g %- *Helianthus annuus* (station I) (*figure1*). Analyzed disaccharides in leaves crop plants are between 2.45 g % - *Helianthus annuus* (station I) and 12.44 g % - *Triticum aestivum* (station II) *(figure1*). Monosaccharides have the lowest proportion of these recorded values between 1.53

g % in *Helianthus annuus* (station I) and 4.79 g % in *Helianthus annuus* (station III)) (*figure 1*). Close values of total content of polysaccharides in leaves has a range between 32 g% (station I. Şerbeşti) -39 g % (station II, Cănţălăreşti) in cultivars of winter wheat (*T. aestivum*).

In early July, the accumulation of total carbohydrate content were recorded a range in varieties of *Helianthus annuus* between 25.19 g % (station I) to 32 g % (station II-) in the vegetative growth phenophase, emergence of capitulum (inflorescence) (*figure 1*).

Table 3

Coefficients of variation for photosynthesis and transpiration in different crop plants in Moldavian Central Plateau

24May	**Station** Type of soil	**Specie**	**Growth stage**	**CV of E(%)**	**CV of A (%)**
	Şerbeşti (Haplic vertic chernozem)	*cult. Triticum aestivum* (winter wheat)	Boots swollen (4 leaves)	40	31.22
		Zea mays	Vegetative (6 leaves)	33.02	22.5
		Helianthus annuus	Vegetative (6-7 leaves)	13.73	39.44
	Cănţălăreşti (Haplic chernozem)	*cult. Triticum aestivum* (winter wheat)	Boots swollen (4 leaves)	17.9	15.9
		Zea mays	4 leaves	25.34	26
	Rebricea (Haplic vertic chernozem)	*cult. Triticum aestivum* (winter wheat)	Boots swollen (4 leaves)	23.8	27.6
		Zea mays	4-6 leaves	14.05	35
		Helianthus annuus	Vegetative (6-7 leaves)	29.83	23.74
3 July	**Şerbeşti** (Haplic vertic chernozem)	*Zea mays*	12 leaves Silks are visible.	26.51	33.42
		Helianthus annuus	The inflorescence begins to open (18 leaves)	19.31	31.41
		Medicago sativa	Flowering (after the first scythe)	25.61	38.13
	Cănţălăreşti (Haplic chernozem)	*Zea mays*	8-10 leaves fully emerged	36.04	32.27
	Buhăieşti (Gleic haplic chernozem)	*Medicago sativa*	Flowering (after the first scythe)	25.4	27.86
	Rebricea (Haplic vertic chernozem)	*Helianthus annuus*	Beginning of flowering (19-20 leaves)	34.78	22.98
		Zea mays	12 leaves Silks are visible	25.15	28.40

Legend: coefficient of variation (CV) for rate of transpiration (A). rate of transpiration (E)

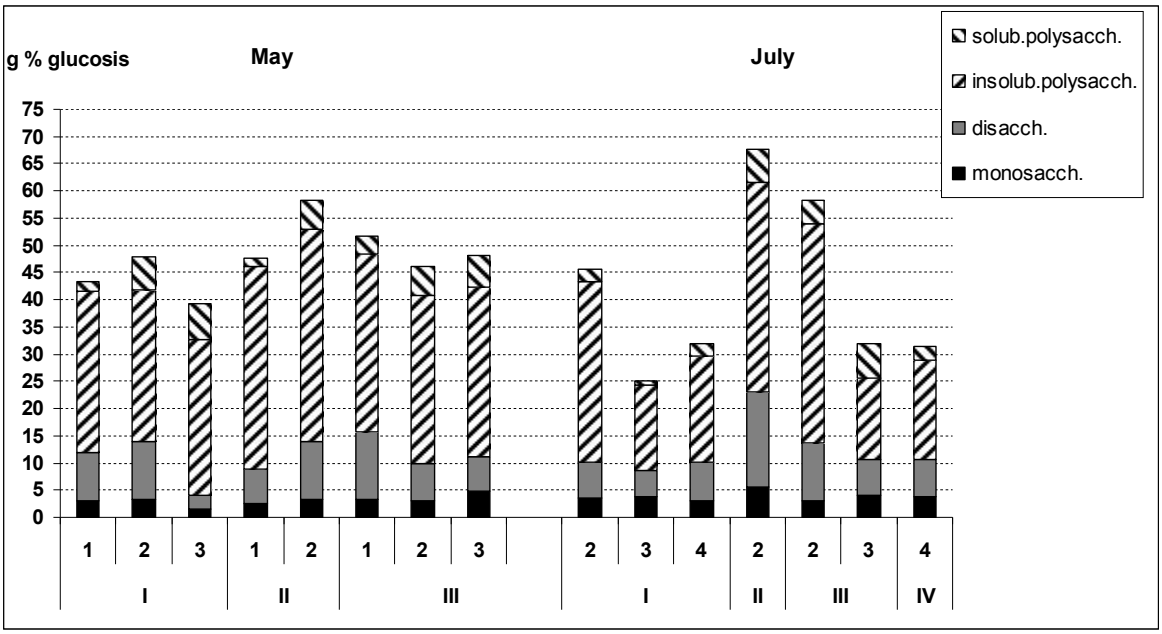
Medicago sativa alfalfa (after the first stitch) accumulate in leaves total carbohydrate a low amount with a relatively constant value of 31 g% glucose, a higher value was registered in station IV (Buhăieşti station) with gleic haplic chernozem, moisture and salted soil.

On May. analysis of relative water content (RWC). as a measure of water status/deficit in relation with soil quality (quantity of clay). showed a variations in winter wheat between 76% (Rebricea station) - 91% (Şerbeşti station), in maize between 78% (Şerbeşti station) - 92% (Rebricea station) and in sunflower between 58% (Şerbeşti station) until 67% (Rebricea station) (*figure 2*).

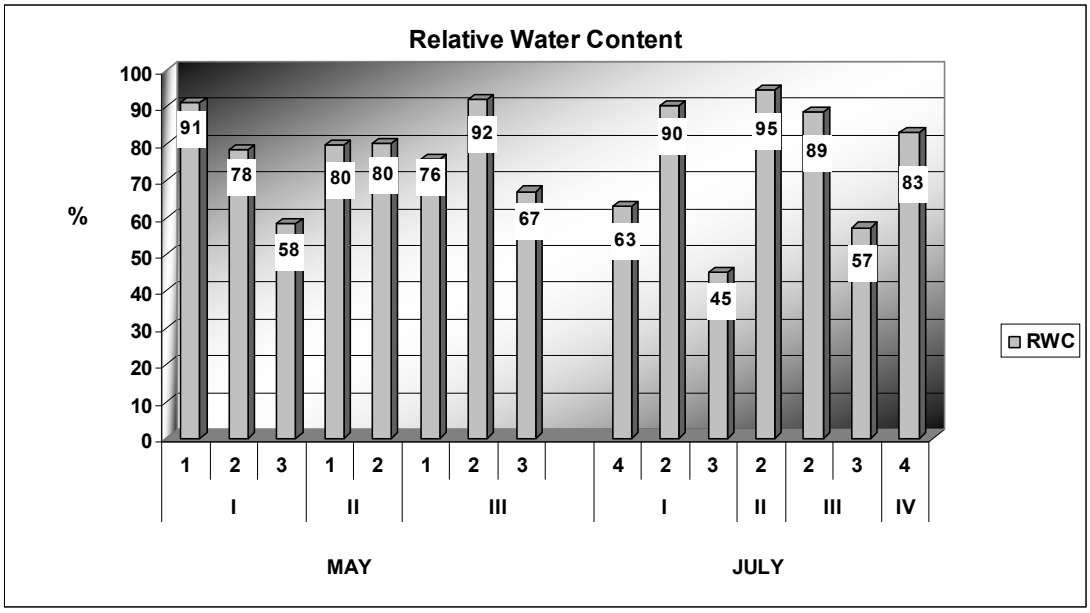
In Canţălareşti station, RWC registered close values in maize and winter wheat, around 80%. In vegetative growth stage, water status in cells is higher in all analyzed crop plants.

On July, relative water content has a range of variation in maize between 89% (Rebricea station) until 90-95% (Şerbeşti, respectively. Cănţălăreşti station), sunflower between 45% (Şerbeşti) -57 % (Rebricea) and alfalfa between 63% (Şerbeşti station) until 83% (Buhăieşti station). During this period is a small variation of this relative water content, especially in maize. Relative water content increased from the previous growth stage in maize and decreased in sunflower which is smaller water consumption, even the both species were having the same days

after sowing.



Legend: 1-cult. *Triticum aestivum*. 2-*Zea mays*. 3-*Helianthus annuus*.
4-*Medicago sativa*. I-Şerbeşti (Iaşi County). II-Cănţălăreşti. III-Rebricea. IV-Buhăieşti (Vaslui County).
Figure 1 Variation of carbohydrates indicators in leaves of main crop plants from Central Moldavian Plateau



Legend: 1-cult. *Triticum aestivum*. 2-*Zea mays*. 3-*Helianthus annuus*.
4-*Medicago sativa*. I-Şerbeşti (Iaşi County). II-Cănţălăreşti. III-Rebricea. IV-Buhăieşti (Vaslui County).
Figure 2 Relative Water Content in main crop leaves at agroecosystems from Moldavian Central Plateau

CONCLUSIONS

Investigation in crop plants of agroecosystems from Central Moldavian Plateau showed that coefficients of variation Cv of A and also, Cv of E with the close values indicate an uniformity of resources of biotope (intensity of light, availability of water and nutrients, etc) which is happening in Cănţălăreşti stationary with haplic chernozem without stressor as vertic character. The influence of biotope resources, also was observed in *Medicago sativa*, when Cv of A (25.4 %) and Cv of E (27.8 %) have close variation in Buhăieşti station, in a moisture plains with haplic gleic chernozem.

During the studied period (May-July 2013), carbohydrate metabolism is characterized by increased accumulation of the polysaccharide, especially those insoluble in all analyzed crop

plants. The high accumulations of insoluble polysaccharides between 70-90% of total carbohydrates fractions registered also in plantations from Central Moldavian Plateau which was reported in previous work. This is mainly due to the specific type of soil with higher quantity of clay, haplic chernozem, subtype vertic. In July, relative water content registered a higher values in *Zea may* which need more quantity of available water from soil in phenophase of flowering than *Helianthus annuus.*

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