EFFECT OF GROWTH MEDIA ON SOME LEAF GAS EXCHANGE PARAMETERS OF HIGHBUSH 'BLUERAY' GROWN IN POTS

DINAMICA UNOR PARAMETRI AI SCHIMBULUI DE GAZE LA FRUNZELE AFINULUI CU TUFĂ ÎNALTĂ SUB INFLUENȚA SUBSTRATULUI DE CREŞTERE

ELENA DELIAN[1], LILIANA BĂDULESCU[1], I. BURZO[1], AURELIA DOBRESCU[1], C. BĂDESCU[2], CRISTINA BĂDESCU[2]

[1]University of Agronomical Sciences and Veterinary Medicine Bucharest

[2]Research and Development Fruit Growing Station, Voinesti

Abstract: *An experiment was carried out in 2007 with two-year-old blueberry (Vaccinium corymbosum L.) plants cv. Blueray. One year before the trial was started plants were propagated by wood cuttings and in the second year five plants were selected presenting the same leaves number and similar height, size of leaves and were planted in pots on different substrata. Sixteen experimental variants were organized with different percent of peat, waste, sawdust, green manure and distillation residues. Experiments were conducted to elucidate the relationship between different ingredients of the pot substrate on some gas exchange parameters (photosynthesis, transpiration and respiration rate) in dynamic, during the vegetation period, as a means to characterize the best conditions for rapidly and efficiently young plants stabilizing. Photosynthesis rate varied across substrata variants and measurement dates, between -0.52 µmol $m^{-2}s^{-1}$ (October beginning) and 3.82 µmol $m^{-2}s^{-1}$ (July beginning) Transpiration rate generally presented low values with a decreasing dynamic starting from 0.59 mmol H_2O $m^{-2}s^{-1}$ (June beginning). The same trend was noticed for the apparent quantum yield, with higher values for the first decade of July, thereafter values were generally decreased in relation with the used substrate. A significantly decreasing was registered for variant V4 (50% peat + 50% sawdust) at the end of July. At the opposite site there were variants V6 (50% peat+50% green manure), V8 (50% peat+50% distillation residues). In the case of V6 it was registered even a slightly quantum yield increase. Respiration rate values were generally low for the young leaves (around 100 mg CO_2 $kg^{-1}h^{-1}$), excepting V8 possible related at a high metabolic activity, thereafter the values surpassed 200 mg CO_2 $kg^{-1}h^{-1}$ and for the first October decade (leaves less or more senescent) there were noticed significantly differences between variants, with lower values especially at V4 leaves with the cell almost collapsed.*

Rezumat. *Au fost organizate şaisprezece variante folosind plante de afin Vaccinium corymbosum L.) cv. Blueray, în vărstă de doi ani, în vase cu diferite procente de turbă, gunoi de grajd, rumeguş, litieră şi reziduuri de distilarie, cu scopul elucidării relațiilor dintre diferitele ingrediente ale substratului asupra dinamicii parametrilor schimbului de gaze, ca mijloc de a caracteriza cele mai eficiente condiții pentru stabilizarea plantelor tinere. Rata fotosintezei a variat în funcție de substrat şi data determinării: între -0.52 µmol CO_2 $m^{-2}s^{-1}$ (octombrie) şi 3,82 µmol CO_2 $m^{-2}s^{-1}$ (iulie). Rata transpirației a prezentat valori mici, cu o dinamică în scădere începând de la 0.59 mmol H_2O $m^{-2}s^{-1}$ (iunie). Acelaşi trend s-a înregistrat şi pentru "quantum yield", cu valori mari pentru prima decadă a lunii iulie, apoi valorile au scăzut în general, în relație cu substratul utilizat. O scădere semnificativă s-a înregistrat pentru varianta V4 (50% turbă, 50% rumeguş), comparativ cu V6 (50% turbă, 50% litieră), V8 (50% turbă, 50% reziduuri de distilărie). Valorile ratei respirației au fost în general mici pentru frunzele tinere (in jur de 100 mg CO_2 $kg^{-1}h^{-1}$), cu excepția V8 posibil relativ la o activitate metabolică* *mai intensă, apoi valorile au depăşit 200 mg CO_2 $kg^{-1}h^{-1}$. Pentru prima decadă a lunii octombrie (frunze mai mult sau mai puţin senescente) s-au înregistrat diferenţe semnificative în privinţa comportamentului plantelor din diferite variante, cu rate mai mici ale respiraţiei, în special la frunzele V4 cu celulele aproape în colaps.*

INTRODUCTION

In Romania, highbush blueberry has been introduced at Bilcesti Research Station and first German and American originated cultivars have been planted in 1968 (Bădescu, 1985). As members of the *Rhododendron* family blueberries are distinguished from other crops, they are calcifuge (lime-avoiding) plants, which show optimum growth in the pH range 4.5 -5.5. There are several reasons for this requirement: the efficiency with which blueberries take Fe is low; consequently, acid conditions are required to increase the quantity of Fe available in soil solution. Additionally, acid conditions also ensure that N is able to exist in the form of ammonium (NH_4^+) which is more readily utilised by blueberries than other N sources, such as nitrate (NO_3^-) (Burzo et al., 2005). Some areas as for instance those on mine spoils soils are mineral soil types, which need to be modified. The nursery industry is searching for methods to decrease the content of nutrients times in effluent from production areas, reduced fertiliser consumption and costs, and maintain a level of available nutrients that does not limit productivity (Scagel, 2005). So, there are preoccupations to study soil characteristics and others treatments effects on different blueberry plant indicators (Sutton and Dick, 1987; Claussen and Lenz, 1999; Szwonek, 2004; Scagel, 2005; Li et al., 2006; Heiberg and Lunde, 2006; Lee et al., 2006; Bryla et.al., 2007). However, little research has been reported on the production of horticultural crops. The aim of the present study was to evaluate effects of different substrata on some blueberry leaves gas exchange parameters, as a potential means of rehabilitation of abandoned surface mine soils, for highbush blueberry culture.

MATERIAL AND METHODS

Two-year-old "Bluecrop" highbush blueberry plants have been planted in 4 -L pots and growth in the outdoor growing area at the Experimentally Tree Fruit Growing Field of the Faculty of Horticulture, U.S.A.M.V.Bucharest starting in June of 2007. Sixteen experimental variants were organized with different percent of peat, waste, sawdust, green manure, and distillation residues (*Table 1*), with five replicates per variant.

Table 1.

Experimental variants

Variants	Substrata composition
1	50.00 % peat, 50.00 % waste
2	66.70 % peat, 33.30 % waste
3	75.00 % peat, 25.00 % waste
4	50.00 % peat, 50.00 % sawdust
5	50.00 % peat; 25.00 % waste; 25.00 % sawdust
6	50.00 % peat, 50.00 % green manure
7	50.00 % peat; 25.00 % waste; 25.00 % green manure
8	50.00 % peat; 50.00 % distillation residues
9	50.00 % peat; 25.00 % waste; 25.00 % distillation residues
10	50.00 % peat; 12.50 % waste; 12.50 % sawdust; 12.50 % green manure; 12.50 % distillation residues
11	50.00 % peat; 12.50 % waste; 25.00 % sawdust; 12.50 % green manure;
12	50.00 % peat; 12.50 % waste; 12.50 % sawdust; 25.00 % green manure;
13	57.10 % peat; 14.30 % waste; 14.30 % sawdust;14.30 % distillation residues
14	57,10 % peat; 14.30 % waste; 28.60 % sawdust
15	57.10 % peat; 14.30 % waste; 14.30 % green manure; 14.30 % distillation residues
16	50.00 % peat; 12.50 % waste; 25.00 % green manure; 12,50 % distillation residues

Gas exchange variables: photosynthesis (A: µmol $m^{-2}s^{-1}$), transpiration (E: mmol H_2O $m^{-2}s^{-1}$), respiration rate (mg CO_2 $kg^{-1}h^{-1}$), water use efficiency (WUE) (A/E) and quantum yield

(A/PPFD ratio) have been determined. Photosynthesis and transpiration rate were recorded in dynamics using an infrared gas analyzer (IRGA; LCA-4, Analytical development Company - ADC- Ltd. U.K.), a portable photosynthesis system. Water use efficiency (WUE) was calculated by dividing the photosynthetic rate (A) by the transpiration rate (E) of the leaf portions (Sinclair et al., 1984). The first determination period of gas exchange was recorded on July 2, at 32 days after transplantation on different substrata (32 DAT), the second one on July 30 (60 DAT), the third on September 10 (112 DAT) and the last one on October 2 (124 DAT). Measurements were taken between 0900 and 1100 h, chamber air temperature was not controlled during the measurements, so generally ranged between 28 and 33 ^{o} C and photosynthetic photon flux density (PPFD) was corresponding with naturally conditions. Values presented are the means of five leaves from five plants per sampling period. Respiration rate has been measured three times, July 2 (32 DAT), September 7 (99 DAT) and October 11 (133 DAT) using a CO_2 analyzer (Ricken) taking mean leaves samples from the mid portion of the one-year old branches and results were expressed as mg CO_2 $kg^{-1}h^{-1}$.

RESULTS AND DISCUSSIONS

As regard as photosynthesis rate it can observe that values are generally low (ranging between 3.82 μmol $m^{-2}s^{-1}$ June beginning and -0.52 μmol $m^{-2}s^{-1}$ at the senescent phase) (*Fig.1*) and it has to be considered that plants grown in the experiment carried out were only two years old, the obtained data being first of all in relation with plants age and especially leaves age. Also, it can be noticed a large variability from one to another variant in function of the substrata.

There will be mentioned that in the case of our experiment the limiting factors such as high temperatures, and high light especially during July induced decreases of photosynthesis mainly due to stomata closure, rather than to the direct effect on the capacity of the photosynthetic apparatus as earlier Genty et.al. (1987) showed. Such sudden increase in light intensity, to which the plant is not acclimated (as is the blueberry case), results in an increase in excitation energy in excess (EEE) of that required for photosynthetic metabolism and between typical abiotic stresses conditions that promote an increase in EEE are extremes temperatures (Guidi et al., 2002). Lee et al. (2006) noticed that in the case of water stressed "Rancocas" blueberry leaves photosynthesis rate was 3-5 μmol $m^{-2}s^{-1}$ depending on photosynthetic photon flux density (PPFD) ranged from 0 to 2000 μmol $m^{-2}s^{-1}$, as compared with well watered plants with a maximum CO_2 assimilation rate of 8.8 μmol $m^{-2}s^{-1}$. At the same cultivar, apparent quantum yields appeared to be similar in well watered and water stressed plants, while dark respiration rate were higher in the case of stressed plants (Kim et.al., 2004)

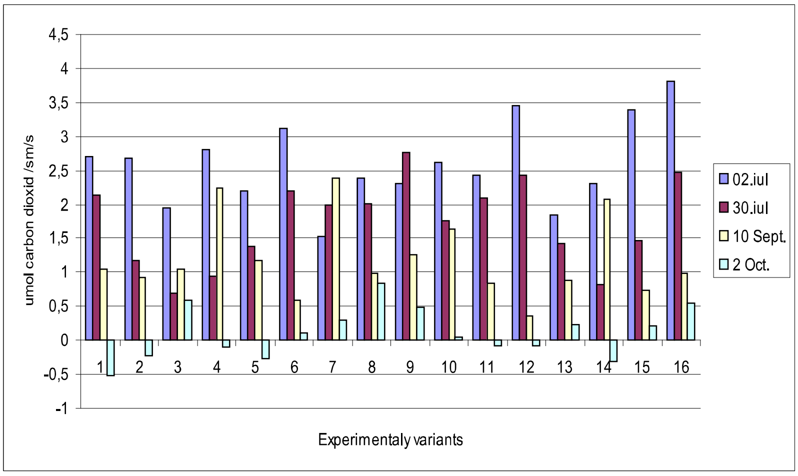

Fig.1. Dynamics of blueberry leaves photosynthesis rate (μmol $m^{-2}s^{-1}$)

Transpiration rate generally presented low values with a decreasing dynamic starting from 0.59 mmol H_2O $m^{-2}s^{-1}$ (June beginning) in the case of younger leaves without waxes, following a values decreasing as leaves became nature (*Fig.2.*).

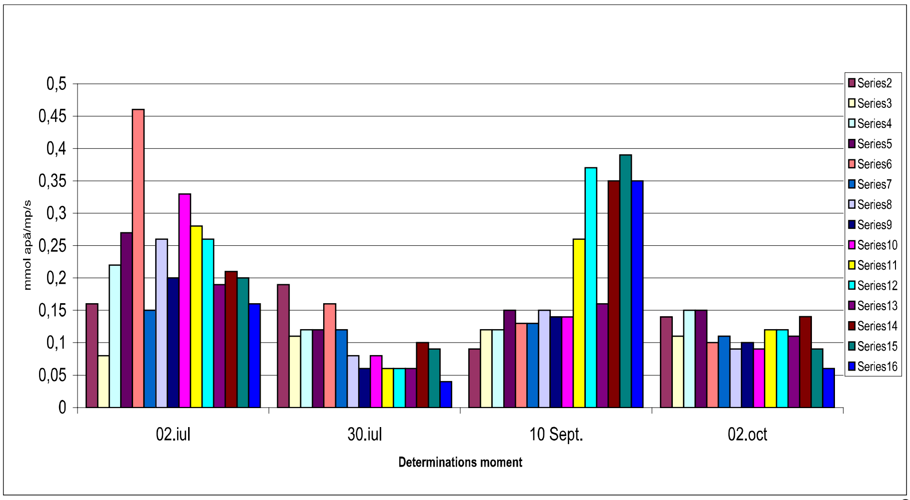

Fig.2. Dinamics of the blueberry leaves transpiration rate (mmol H_2O m^{-2} s^{-1})

The same trend was noticed for the apparent quantum yield and water use efficiency, with higher values for the first decade on July, thereafter values were generally decreased in relation with leaves age and the used substrate. A significantly decreasing of QY was registered for variant V4 (of about tree times) at the end of July. At the opposite site there were variants V6 and V8 where values are almost the same (*Table 2*). Thereafter, QY values decreased significantly for the majority of the variants, excepting V3, V8 (for instance 124 DAT), corresponding with higher values of water use efficiency too. Respiration rate values were generally low for the young leaves (around 100 mg CO_2 $kg^{-1}h^{-1}$), excepting V8 possible related at a high metabolic activity, thereafter the values surpassed 200 mg CO_2 $kg^{-1}h^{-1}$ and for the first October decade (leaves less or more senescent) there were noticed significantly differences between variants, with lower values especially at V4 leaves with the cell almost collapsed (*Fig. 3*).

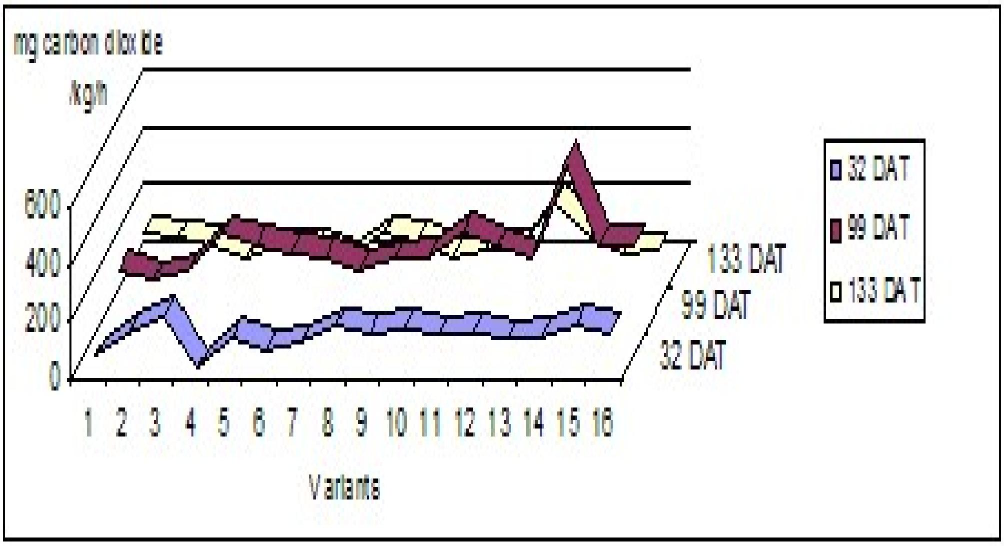

Fig.3. Dynamics of blueberry leaves respiration rate

Recently, Li et al.(2006) also confirmed earlier research, which showed that *Vaccinium* spp. planted in mineral soil of pH above 5.5 typically respond to the addition of elemental S and organic material with increased growth and yield. On the other hand, Heiberd and Lunde (2006) concluded that highbush blueberry plants are not very sensitive to ingredients in the growth substrate and the plants grow well in containers. Scagel (2005) showed that colonization with ericoid mycorrhizal fungi was typically higher when plants were grown with organic fertilizers and inoculation with EMF may not only improve productivity and quality of nursery plants, it also may reduce the amount of fertilizer used during nursery production.

Table 2.

Dynamics of some blueberry leaves physiological indicators (Quantum yield - QY – A/PPFD; Water use efficiency – WUE- A/E) at different days number after trnsplantation on different substrata (DAT)

Det. Date Variant	32 DAT		60 DAT		112 DAT		124 DAT	
Indicator	QY	WUE	QY	WUE	QY	WUE	QY	WUE
1	0.0027	11,7827	0,0020	15,2857	0,0008	5,7778	-0,0029	-3,4667
2	0,0028	16,8125	0,0013	6,2105	0,0007	10,2222	-0,0002	-1,5714
3	0.0018	24,375	0,0007	6,2727	0,0008	8,6667	***0,0005***	**5,2727**
4	0.0029	12,7727	0,0009	7,9167	0,0017	18,75	-8,4E-05	-0,6667
5	0.0022	8,1111	0,0014	11,5	0,0009	7,8667	-0,0002	-1,7333
6	0.0032	6,8043	0,0028	13,6875	0,0004	4,5386	7,16E-05	1
7	0.0014	10,2	0,0024	16,5833	0,0018	18,3846	0,0002	2,6364
8	0.0023	9,1538	0,0021	25,125	0,0008	6,6	***0,0006***	**9,4444**
9	0.0023	11,55	0,0028	46	0,0010	9	0,0004	4,9
10	0.0027	7,9394	0,0019	22	0,0016	11,7143	4,25E-05	0,5556
11	0.0026	8,6786	0,0023	34,8333	0,0007	3,1923	-8,4E-05	-0,6667
12	0.0036	13,3077	0,0021	40,5	0,0003	0,9459	-7,8E-05	-0,75
13	0.0017	9,6842	0,0014	23,8333	0,0005	5,5	0,0002	2,0909
14	0.0020	11	0,0007	8,1	0,0014	5,9143	-0,0003	-2,2143
15	0.0035	17	0,0014	16,2222	0,0005	1,8718	0,0002	2,3333
16	0.0037	23,875	0,0022	62	0,0007	2,8286	0,0005	9

CONCLUSIONS

1. Blueberry leaves photosynthesis rate varied across substrata variants and measurement dates, between -0.52 µmol $m^{-2}s^{-1}$ (124 DAT) and 3,82 µmol $m^{-2}s^{-1}$ (32 DAT).

2. Transpiration rate generally presented low values related to this specie leaves specifically characteristics, with a decreasing dynamic starting from 0.59 mmol H_2O $m^{-2}s^{-1}$ on June beginning (young leaves without waxes).

3. The same trend was noticed for the apparent quantum yield and water use efficiency, with higher values for the first decade of July, thereafter values were generally decreased in relation with leaves age, the used substrate and the summer 2007 specifically climatic conditions. High values have been registered for V3, V8 (50% peat + 50% green

manure or distillation residues), as compared with lower values for V4 (50% peat+50% sawdust).

4. Respiration rate values were generally low for the young leaves (around 100 mg CO_2 $kg^{-1}h^{-1}$), excepting V8 (possible related at a high metabolic activity). Thereafter values surpassed 200 mg CO_2 $kg^{-1}h^{-1}$ and for the first October decade there were noticed significantly differences between variants, with lower values especially at V4 leaves with the cell almost collapsed.

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