# THE INFLUENCE OF WATER DEFICIT AND LIGHT INTENSITY ON BLACKBERRY FRUIT YIELD AND QUALITY

## INFLUENȚA STRESULUI HIDRIC ȘI A LUMINII ASUPRA PRODUCȚIEI ȘI CALITĂȚII FRUCTELOR DE MUR

***CIOBOTARI Gh.[1], EFROSE Rodica[1], BRÂNZÃ Maria[1], PAŞCU D.D.[1], SFICHI-DUKE Liliana[1]***
e-mail: lilianasfichi@gmail.com

***Abstract.*** *An overwhelming body of research has now firmly established that the dietary intake of berry fruits has a positive and profound impact on human health, performance, and disease. This work aimed to investigate the effects of light intensity and water deficit on fruit quality and productivity in two blackberry cultivars, Thornfree and Lochness. Plants were grown for two consecutive years during summer under 100% (HL) and 25% (LL) sunlight conditions with (WW) and without (LW) irrigation. Both cultivars produced large amounts of fruits under HL+WW conditions. Under water deficit the fruit yield and weight decreased in Thornfree while it increased in Lochness plants grown under LL conditions. Soluble solids content did not change in plants exposed to HL but it decreased slightly in both cultivars under LL conditions. Soluble sugars decreased only in Thornfree under LL.In both cultivars fruits harvested from non-irrigated plants showed lower titrable acidity values than irrigated plants. Light and water treatment did not affect the amount of total phenolics, but water deficit decreased anthocyanins in both cultivars when plants were grown under LL conditions. The potential use of both cultivars in future breeding programs is discussed.*
***Key words:*** *blackberry, soluble sugars, SSC, acidity, phenolics, anthocyanins.*

***Rezumat.*** *Numeroase cercetări au dovedit faptul că includerea fructelor de pădure în alimentație are un impact pozitiv și profund asupra sănătății umane, performanței și stării de boală. Accentuarea gustului, îmbunătățirea aspectului, creșterea fermității și termenului de valabilitate al fructelor contribuie la stimularea consumului fructelor de pădure. Prezenta lucrare a avut ca scop investigarea efectelor intensitatii luminii și deficitului de apă asupra calitatii fructelor și productivității la două soiuri de mur, Thornfree și Lochness. Plantele au fost cultivate timp de doi ani consecutivi în timpul verii în condiții de 100% (HL) și 25% (LL) lumină solară cu (WW) și fără (LW) irigare. Ambele soiuri au produs cantități mai mari mari de fructe în condiții de HL+WW. Deficitul de apă a dus la scăderea producției si greutății fructelor la Thornfree și la creșterea lor la Lochness în condiții de LL. Conținutul de substanță solidă nu s-a schimbat în plantele expuse la HL, dar a scăzut ușor în ambele soiuri în condiții LL. Zaharurile solubile au scăzut doar în Thornfree expus la LL. La ambele soiuri fructele recoltate de la plante neirigate au înregistrat valori de aciditate titrabilă mai mici decât cele colectate de la plantele irigate. Regimul de lumină și apa nu a afectat conținutul de fenoli totali, dar deficitul de apă a scăzut antocianii în*

[1] University of Agricultural Sciences and Veterinary Medicine of Iasi, Romania

*ambele soiuri atunci când plantele au fost cultivate în LL. Utilizarea potențială a soiurilor respective în viitoare programe de ameliorare este discutabilă.*
***Cuvinte cheie:*** *mur, zaharuri, SUS, aciditate, compuşi fenolici, antociani.*

## INTRODUCTION

Blackberries are a good source of natural antioxidants (Wang et al., 1996). In addition to vitamins and minerals, extracts of blackberries are also rich in anthocyanins, flavonoids, and phenolic acids which demonstrated considerable scavenging properties of reactive oxygen species (Heinonen et al., 1998). They are effective in inhibiting oxidation of human low-density lipoproteins and thus have potential effects in preventing various human diseases (Steinberg, 1991).

The composition of nutraceuticals in blackberries is dependent on the cultivars and growth conditions. Therefore, blackberry adaptation to the environment is a fundamental process in plant breeding (Finn and Hancock, 2008). For instance, breeding plants with better drought resistance could improve the economic yield of blackberry production.

This work aimed to investigate the effects of water deficit and light microenvironment on fruit quality and yield in two blackberry cultivars in order to evaluate their potential for future breeding programs.

## MATERIAL AND METHOD

Blackberry (*Rubus fruticosus* L.) fruits of two cultivars (Thornfree and Lochness) were harvested in July 2012. The experimental orchard was established in 2011 in Iasi, Romania; it was divided in two categories: HL, plants grown in full sunlight and LL, plants grown in shade conditions by covering them with a net which retained 75% sunlight (LL). Each experimental category was divided in two lots, irrigated (WW) and non-irrigated (LW). All variants (HL+WW; HL+LW; LL+WW; LL+LW) were grown under natural conditions of precipitations but the WW plants were irrigated when the field capacity dropped under 90%. Mature berries assessed by full color development were harvested from 5 plants/variant. The berries were transported to the laboratory in the same day for weighting, sample preparation and analysis. Fruit size was analyzed using ImageJ. Sugar accumulation and SSC (soluble solids content) were determined by refractometric method. Titrable acidity (TA) was estimated by potentiometric method. The content of total phenolics was determined by Folin-Ciocalteu method using gallic acid as a standard compound (Singleton et al., 1999). The total anthocyanin content was measured using the pH-differential method (Giusti and Wrolstad, 2001). At least three analyses were run for each experimental category for SSC, soluble sugars, TA, total phenolics and anthocyanins. Each analysis consisted of triplicate measurements of each sample and data were averaged over the three measurements.

## RESULTS AND DISSCUSIONS

In both cultivars, the fruit yield was higher in HL+WW than in LL+WW conditions. However, Thornfree gave a higher fruit yield than Lochness, irrespective of the treatment. Under water deficit the fruit yield decreased in Thornfree (86% in HL+LW and 59% in LL+LW conditions) while it increased

about 200% in Lochness plants grown under LL+LW conditions (Fig. 1). In Thornfree, the fruit size did not significantly differ among treatments. In Lochness, non-irrigated plants produced larger fruits (about 15%) than irrigated plants (Fig. 2, Picture 1 and 2).

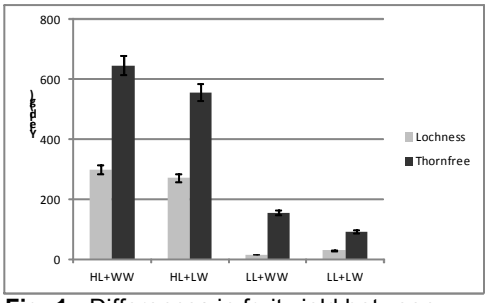



**Fig. 1** - Differences in fruit yield between irrigated and non-irrigated blackberry plants grown under two different light conditions.

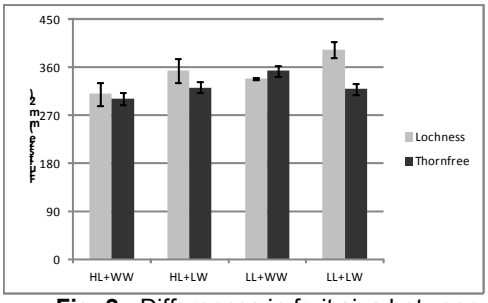
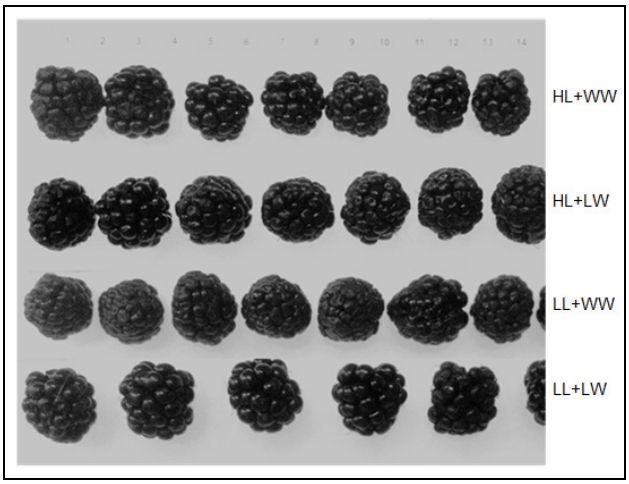
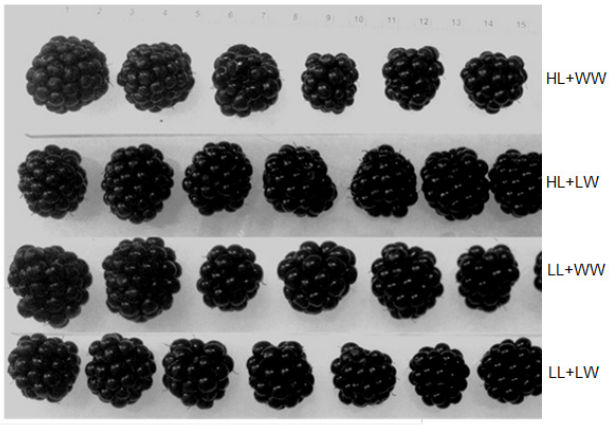



**Fig. 2** - Differences in fruit size between irrigated and non-irrigated blackberry plants grown under two different light conditions.




**Picture 1** - Differences in fruit size and shape between irrigated and non-irrigated blackberry Lochness cultivar grown under two different light conditions.

Under LL+LW conditions the fruit weight decreased in Thornfree (about 20%) while it increased in Lochness (about 35%). Under irrigation, Thornfree showed higher values than Lochness, mainly in LL conditions (Fig. 3). Soluble solids content (SSC) contribute to fruit flavour. A high content in sugars and acids characterizes a good berry flavour. Under irrigation, SSC values were higher in Lochness than in Thornfree, mainly in HL conditions. Under water stress SSC did not change in plants exposed to HL but it decreased slightly in both cultivars when plants were grown under LL conditions (Fig. 4).




**Picture 2** - Differences in fruit size and shape between irrigated and non-irrigated blackberry Thornfree cultivar grown under two different light conditions.

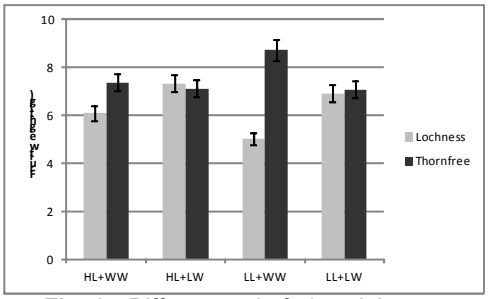



**Fig. 3** - Differences in fruit weight between irrigated and non-irrigated blackberry plants grown under two different light conditions.

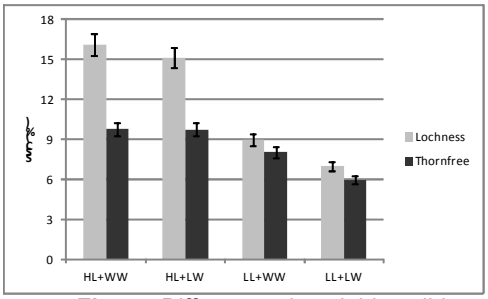



**Fig. 4** - Differences in soluble solids content of fruits between irrigated and non-irrigated blackberry plants grown under two different light conditions.

Soluble sugars content was significantly influenced by light conditions. Well watered plants showed high values under HL conditions. As compared with Thornfree, Lochness had a larger amount of soluble sugars. This might be due to the conversion of starch to soluble sugars which caused also an increase in SSC. Water deficit decreased the amount of sugars in LL conditions only in Thornfree (Fig. 5).

The titrable acidity (TA) is an important determinant of fruit taste. High concentrations of organic acids help to stabilize ascorbic acid and anthocyanins. High light intensity decreased TA in both cultivars. The highest values were found in Lochness plants maintained under irrigation in LL conditions. In both cultivars non-irrigated plants showed lower values than well-watered plants (Fig. 6).

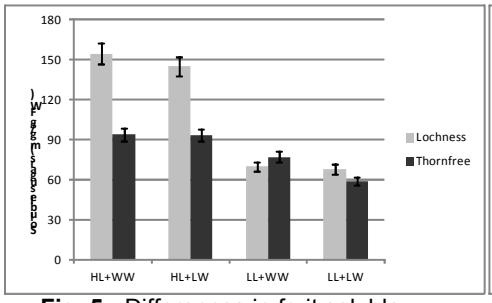



**Fig. 5** - Differences in fruit soluble sugars content between irrigated and non-irrigated blackberry plants grown under two different light conditions.

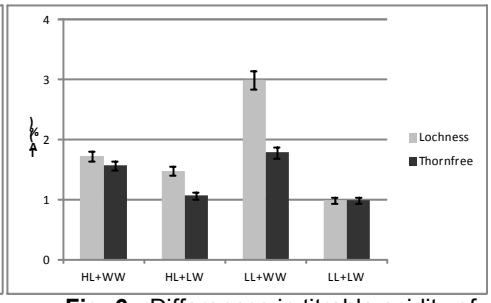



**Fig. 6** - Differences in titrable acidity of fruits between irrigated and non-irrigated blackberry plants grown under two different light conditions.

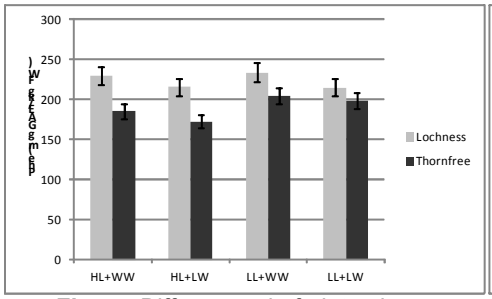



**Fig. 7** - Differences in fruit total phenolics content (Phe) between irrigated and non-irrigated blackberry plants grown under two different light conditions.

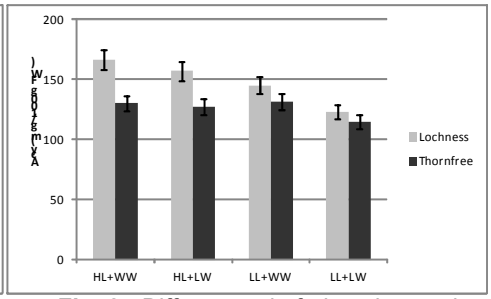



**Fig. 8** - Differences in fruit anthocyanins content (Acy) between irrigated and non-irrigated blackberry plants grown under two different light conditions.

Light and water treatment did not affect the amount of total phenolics (Phe), but in Lochness the Phe contents were higher than in Thornfree mainly in plants grown under HL+WW conditions (Fig.7). Similarly, anthocyanins (Acy) were higher in Lochness than in Thornfree but water deficit decreased Acy in both cultivars when plants were grown under LL conditions (Fig. 8).

## CONCLUSIONS

Based on the results of our study, a combination of high light intensity and irrigation increases the fruit yield and soluble sugars content but decreases the accumulation of organic acids. Fruit yield is higher in Thornfree than Lochness while fruit quality attributes (SSC, soluble sugars, Acy) are better in Lochness than in Thornfree. Lochness cultivar has higher adaptation capability to insufficient water and/or lower light intensities and can be recommended to growers as a commercial crop in similar conditions.

***Acknowledgement****: The present contribution was supported by the EU-funding grant POSCCE-A2-O2.1.2-2009-2, I.D. 524, cod SMIS-CSNR 11986.*

## REFERENCES


1. **Finn C.E., Hancock J.F.**, **2008** - *Raspberries*. In: J.F. Hancock (ed.), *Temperate Fruit Crop Breeding*, Springer Science+Business Media B.V. p. 359-392.
2. **Giusti M., Wrolstad R. E.**, **2001** - *Characterization and Measurement of Anthocyanins by UV-Visible Spectroscopy*. In R. E. Wrolstad (Ed.), Current Protocols in Food Analytical Chemistry, New York, Wiley.
3. **Heinonen I. M., Meyer A. S., Frankel E. N.**, **1998** - *Antioxidant activity of berry phenolics on human low-density lipoprotein and liposome oxidation*. J. Agric. Food Chem., 46, p. 4107-4112.
4. **Kavi Kishor P.B., Sangam S., Amrutha M.N., Sri Laksmi P., Naidu K.R., Rao K.R.S.S., Rao S., Reddy K.J., Theriappan P., Screenivasulu N.**, **2005** - *Regulation of proline biosynthesis, degradation, uptake and transport in higher plants: Its implication in plant growth and abiotic stress tolerance*. Current Sci., 88, p. 424-438.
5. **Singleton V.L., Orthofer R., Lamuela-Raventos R.M.**, **1999** - *Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin–Ciocalteu reagent*. Methods in Enzymology, 299, p. 152–178.
6. **Steinberg D.**, **1991** - *Antioxidants and atherosclerosis: a current assessment*. Circulation, 84, p. 1420-1425.
7. **Wang H., Cao G., Prior R. L.**, **1996** - *Total antioxidant capacity of fruits*. J. Agric. Food Chem., 44, p. 701-705.