THE DYNAMICS OF THE CARBOHYDRATES ACCUMULATION IN SOLANACEE LEAVES CULTIVATED IN DIFFERENT TECHNOLOGICAL SYSTEMS

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Abstract: Our research about cultivated plants from protected spaces(greenhouse and solariums) observed the variation of the carbohydrates parameters in different technological systems(ecologic and conventional). It were studied species from the Solanaceae Family such as: *Lycopersicon esculentum* Mill (tomato), *Capsicum annum* L.(sweet pepper) and *Solanum melongena* L. (eggplant). Sugars metabolism was evaluated through analysis of the mono-, di and polysaccharides at the different phenophases: flowering, ripening and maturity. It was made a comparison between the sugars accumulation in leaves depending of the fertilizing technology (chemical or organic). The sugar parameters have a more accelerated dynamics in conventional culture systems than in ecologic one. In this technological system (classic), carbohydrates have a decreasing dynamics from flowering until ripening, meanwhile the accumulation of the carbohydrates in leaves of plant from ecologic systems have an increasing curve. Disaccharides were well represented in studied plant, in all phenophases, indifferent of type of the protected spaces (solarium or greenhouse).

INTRODUCTION

Increasing world population and demanding for fresh vegetables during all the seasons led to the need for improving technology of cultivation in protected spaces (greenhouse and solariums). Thus, besides crop technology in classic systems was required the organic culture in solariums as part as ecologic agriculture.

Vegetable crop in ecologic system require providing technological conditions for culture succession, schedule plantation, organic fertilization, soil mulching, control of microclimatic factors and drop irrigation. Varieties cultivated in protected spaces have mostly, a luxuriant and rapid growth (with height of 2-3 m) with flowers at apex level and also, cluster fruits, in different stage of ripening, at the middle and basis of the plant. The transport of photoassimilates has an immense importance in controlling crop yield. The balance between organ source(mature leaves, roots) and organ sink(young leaves, apex, fruits) during the vegetation would improve the technology of the cultivated plant.

MATERIAL AND METHODS

It was analyzed some varieties of tomato from two stations studied: Cristal variety from Bacău solarium and respectively, Cherry variety and Risoca variety from Bârlad greenhouse. Analyzed varieties of sweet pepper were following: Milica F1 from Bacau station and Baltasar from Barlad greenhouse. Eggplant varieties were Black Pearl variety (Bacau solariums) and Aragon variety (Bârlad greenhouse). The vegetables cultivated in these protected systems are selected hybrids. Solanacee cultivated in Bârlad greenhouse have the conventional technology(chemical treatment) and varieties from Bacău are cultivated in ecologic systems since 12 years ago. Crop plants cultivated in protected spaces have generally, indeterminate growth.

Analyzing of the sugars metabolism concerning monosaccharides, disaccharides and polysaccharides was performed by the method Bertrand modified and completed by Borel, 1953. The results were expressed in g of glucose’s per cent (g %) from dry leaf matter. It was sampled the photosynthetically active leaves. Photosynthesis was determined with LCi analyzing portable system (ADC Bioscientific, U.K) at fifth leaf from the top of plant.

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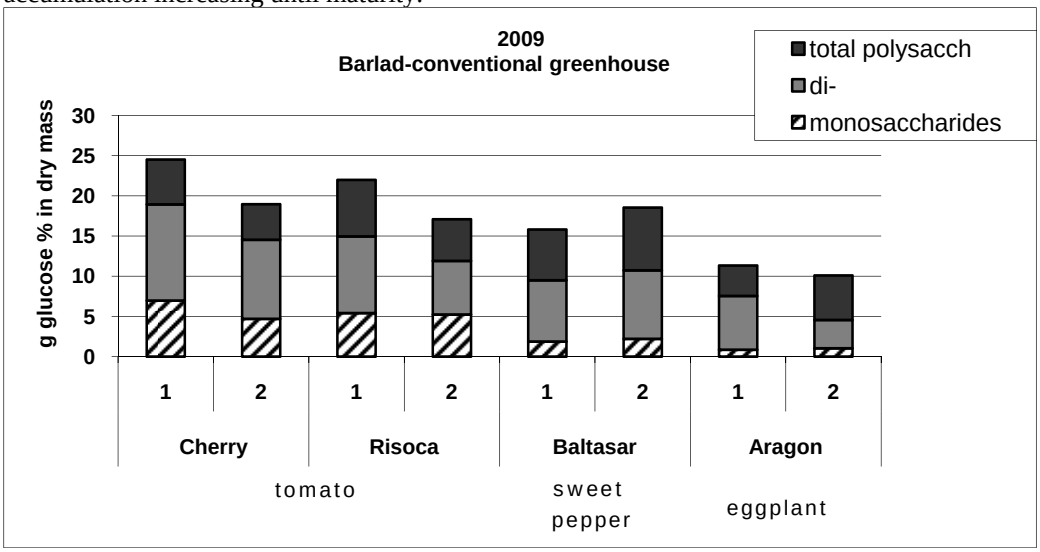
RESULTS AND DISCUSSIONS

This study followed the variation of some physiological aspects in species cultivated in protected spaces (solariums and greenhouse) under different cultivation systems(ecologic and conventional). The purpose of this paper is to observe if the type of the cultivation systems had the influence upon the assimilation of carbohydrates processes in some varieties of tomato, sweet pepper and eggplant.

In Bârlad greenhouse, the distribution of the sugars indicators(mono-, di- and polysaccharides) had a decreasing dynamics from the flowering stage until ripening phenophasis. In fig. 1, it could be observed in flowering stage the highest values of analyzed carbohydrates in all variety of tomato and also in eggplant, which had the closer date of transplantation in greenhouse. The sweet pepper were transplanted the latest of all varieties of solanacee in greenhouse and maybe because of that the curve of carbohydrates accumulation is ascendent in that moment of observation.

In Bacau solariums, the dynamics is ascendant from the flowering until ripening stage. The biggest values were registered at maturity stage as it could be observed in fig. 2.

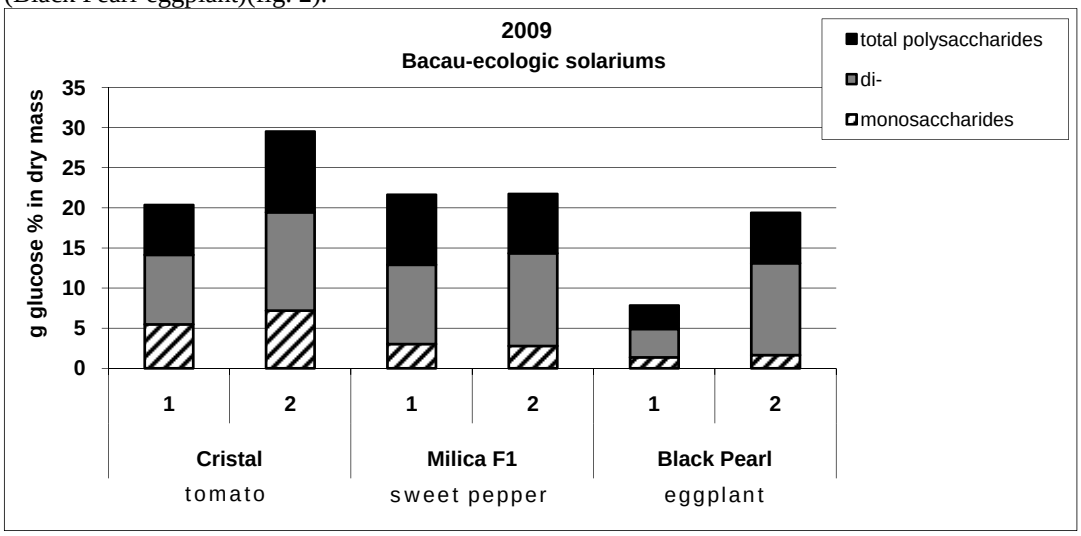
The first observation which have to verify is that ”strategy” of carbohydrates accumulation varied according with the type of technological system applied in greenhouse; in conventional greenhouse the dynamics of leaf sugars is higher after flowering, meanwhile in solariums the accumulation increasing until maturity.



Legend: 1-plants in flowering phenophase (May); 2-plants in full ripening (maturity) phenophse (July)

Fig. 1 Accumulation of leaf carbohydrates in some species at flowering and ripening stage in conventional greenhouse of Barlad

In flowering stage, in studied varieties from Bârlad greenhouse, the total sugars reached value of 24.5 g % (Cherry-tomato) and 22 g % (Risoca,-tomato). The value of 16 g % registered in Baltasar-sweet pepper and respectively, the value of 11.32 g % in Aragon-eggplant (fig. 1). In the same phenophase(flowering) in varieties studied of Bacău solarium, total sugars of leaf registered the value of 22 g % (Cristal-tomato and also, in Milica F1-sweet pepper) and 7.84 g % (Black Pearl-eggplant)(fig. 2).



Legend: 1-plants in flowering phenophase (June); 2-plants in full ripening (maturity) phenophase (July)

Fig. 2 Accumulation of leaf carbohydrates in some species at flowering and ripening stage in organic solariums of Bacau

In ripening stage, in varieties of Bârlad, total sugars of leaf registered in tomatoes 19 g % (Cherry) and respectively, 17 g % (Risoca). The value of 18.53 g % of total sugars was registered in sweet pepper (Baltasar) and respectively, in eggplant (Aragon) a value of 10.09 g % (fig 1). In the same phenophase of ripening fruit, varieties of Bacău, the total sugars of leaf registered 29.5 g % in tomato (Cristal), 21.72 g % in sweet pepper (Milica) and 19.38 g % in eggplant (Black Pearl)(fig. 2).

Mono- and polysaccharides in tomato leaves of Bârlad, decreased meanwhile the disaccharides increased from flowering stage until ripening and maturity stages. In sweet pepper-Baltasar from classic greenhouse (Bârlad), because of the delay of the vegetation were observed an increasing of all sugars compounds, mono, di-and polysaccharides until maturity stage(fig.1). As regarding the eggplant-Aragon, despite of increasing of the mono and polysaccharides amount, the disaccharides content decreased from flowering until maturity stage which made the total sugars content to be finally decreased in comparison with previous stage (fig.1). In all analyzed varieties of solanacee from Bacău the quantity of carbohydrates increased from flowering until maturity stages (fig.2). Disaccharides represented a large amount in sugars proportion in all solanacee leaves cultivated in protected spaces. Disaccharides proportion varied

between 40-60 % of total sugars content in varieties of Bârlad greenhouse and also in varieties of Bacău.

During vegetation period of studied crop plant a comparison was made between variation of photosynthesis and sugars accumulation in leaves. The results are presented in the table below.

Table 1-The Dynamics of sugars leaf in correlation with photosynthesis in solanacee variety in protected spaces

Station	Specie and Variety	Phenophase	A (µmol m^{-2} s^{-1})	Total sugars (g % glucose in dry mass)
Bârlad	*Cherry-tomato*	**1**	**13.74±1.10**	**24.51**
		2	2.83±0.33	18.96
	Risoca- tomato	**1**	**14.71±1.2**	**21.98**
		2	5.6±0.71	17.08
	Baltasar-sweet pepper	**1**	**9.26±0.76**	15.81
		2	3.635±0.24	18.53
	Aragon-eggplant	**1**	**8±0.91**	**11.32**
		2	10.19±0.35	10.09
Bacau	*Cristal- tomato*	1	6.05±0.83	20.35
		2	**13±0.15**	**29.50**
	Milica F1- sweet pepper	1	7.59±3.10	21.62
		2	**8±2.77**	**21.72**
	Black Pearl- eggplant	1	2.26± 0.3	7.84
		2	**12.8±1.7**	**19.38**

Legend: 1-plants in flowering phenophase; 2-plants in full ripening maturity phenophse.
A- rate of photosynthesis, Mean ± standard error.

From the table above it was observed that species cultivated in conventional greenhouse of Bârlad, the photosynthesis and the parameters of sugars metabolism (total sugars compounds. in table) have had the greatest values at flowering stage in comparison with following stage, such as ripening and full maturity of fruits when the values of analyzed parameters decreased. In this case we have an exception in sweet pepper-Baltasar which has still increasing values of photosynthesis. From the table 1, it can observe that photosynthesis and sugars accumulation in leaf are positive correlated.

In solanacee at ecological solarium from Bacău, photosynthesis and total sugars compounds in leaves had the ascendant curve, maximum of values registered in maturity stage of fruit at the ending of the vegetation period (table1).

From the previous work about greenhouse tomato, the higher values of total sugars are observed in tomato varieties in Bacău solarium with all sugars compounds (mono-. di- and polysaccharides) that are well represented (Acatrinei. 2009). It was discussed the increasing of the disaccharides content in all leaves of tomato varieties. The amount of disaccharides registered the values over 70 % of total sugars in tomato varieties (Cherry and Risoca) in Bârlad greenhouse and respectively, 50 % in Baldwin and Buran leaves (Bacău). The values registered in this year,

2009 confirmed the last year observations 2008 were the higher values of total leaf carbohydrates are observed in tomato varieties in Bacău solarium with ecologic technology of cultivation.

Plants are dependent upon the uptake of nutrients(N, P, K) from soil solution. The good functioning of the photosynthesis and respectively, the accumulation of the carbohydrates are demand the nutrients supply(Baker et al., 1992). By applying mineral fertilizer increased the availability to the plant in a form which used directly through roots and can be taken up quickly via xylem(Le Bot et al., 1992). On the other hand, organic fertilizer used in ecologic agriculture made the nutrients available to the plant during time of decomposing them. Classic agriculture with periodic fertilizer supply increased the rate of them absorption and incorporate into metabolism and finally finished with fast growth plant, meanwhile the ecologic or organic fertilization assured the availability of the nutrients in a small quantity during entire the crop development. The plant requirement for the nutrients on growth and for the photoassimilate transport is well known. Sucrose plays a central role in carbon allocation. Because of the sugars accumulation in fruit this process is linked with sucrose circulation from the photosynthetically active leaves through phloem sieve to the sink organs (Heuvelink et al., 2005). Beginning with shoot and leaves growth until fruit ripening the circulation of the sucrose(transport carbohydrate) increased and still remained that until plant senescence(Forbes, 1994). That explained why the disaccharides amount had a great proportion of total sugars compounds in all crop analyzed plants (40-60 %). Increasing of the sucrose amount is not necessarily linked with higher photosynthesis or with higher rate of assimilation, liked it was observed in solanacee leaves from Bârlad greenhouse. Increasing of the sucrose could show a higher consumption of sugars for the growth, respiration or other process. The quantity of light, nutrient availability, water supply, plant variety and some other practice technology(mulching) led the difference between crop plant cultivated in ecologic/organic and other cultivated in classic systems technology.

CONCLUSIONS

The dynamics of the carbohydrates had greatest values in leaves of plant from conventional greenhouse after flowering, meanwhile in ecologic solariums the accumulation increasing until maturity. The dependency with the type of technology is linked to rate of decomposition of the nutrient from soil and to the entering into metabolism(photosynthesis and carbon assimilation); in this way the synthetic fertilizers are available quickly while the organic nutrients are released slowly during vegetation duration.

Monosaccharides and polysaccharides distribution increased after plant transplantation until flowering stage and then monosaccharides have a slowly accumulation until maturity and plant senescence. During vegetation period the leaf disaccharides increased reaching to 40-60 % of total sugars analyzed because of their role(sucrose) in phloem transport and fruit growth.

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