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Study the Effect of Photoperiod Duration on Dynamic Carbohydrates Composition and Enzymes Activity in Soybean Leaves

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Abstract: This study was conducted to investigate the correlation and dynamics of carbohydrate content over diurnal photoperiodic cycle and sucrose-phosphate synthase activity, amylase and invertase in leaves isogenics at EE genes short day and photoperiodically neutral lines of soybean in view of paces of development over different duration period of the day. In short-day photoperiodic cycle disposition of dynamics of sugar and starch content over a day-light period, their runoff over a moon-light period and also activity of enzymes of photoperiodically neutral lines change similar to it of short-day lines. At short day neutral lines more intensively accumulate monosugar and sucrose. At long day, amylose is accumulated in content of starch comparing to short-day lines. Runoff tenseness over night period of short-day photoperiodic cycle in both groups is higher than over the same period of long-day cycle. Capability of photoperiodically neutral lines to change disposition of carbohydrate exchange over a short-day period similar to its disposition of short-day lines is one of the considerable factors in favor of the fact that under the given conditions process of growth and development, this is provided with sufficient amount of substance and energy. As a result morphogenetic processes run at the same speed over both short-day and long-day periods. It allows photoperiodically neutral lines to transit to blooming at the same term over different duration period of the day.

Key words: Soybean [*Glicine max* (L) Merr.], photoperiodism, short-day and long-day photoperiodically neutral lines, sugars, polysaccharides, ferments of carbohydrate exchange

INTRODUCTION

The mechanisms study of metabolic signals transduction is a number of primary directions in the research of regulation of development rates of plants and their ecological prevalence (Kordum, 2003). One of fundamental and universal mechanisms of control of growth processes and genesis development of plants is metabolic regulation of gene expression. Carbohydrates function of plants is not limited only to their transporting, energetic and plastic function take part in expression of row of genes, including those which determinate processes of growth and development of plants (Smeekens, 2000; Siwash *et al*., 2001; Bernie *et al*., 2002; Mahachkova and Krekule, 2002; Sakalo, 2006).

Photoperiodic reaction of plants which shows up in the change of speed of their transition to flowering under act of different duration of photoperiod, is a central object in research of mechanisms of regulation of plants development rates in hormonal (Chailackhian, 1988; Chulafich, 1999), trophic (Tsibul'ko, 1998; Tsibul'ko *et al*., 2000), genetic (Makhachkova and Krekyle, 2002) and other directions (Bernie *et al*., 2002).

It has been shown that accumulation and outflow of carbohydrates determine the rates of development of long-day and short-day plants at different duration of photoperiod (Tsibulko, 1998). Carbohydrates determinate the flowering revocation process at apical meristemes of long-day plants at change of photoperiod duration (Havelange *et al*., 2000; Bernie *et al*., 2002). In long-day and short-day plants at favorable for development photoperiodic conditions content of carbohydrates and albumen increases in apical meristemes, intensity of cell division arises (Milyava *et al*., 1996; Tsibulko, 1998; Tsibulko *et al*., 2000) and transition of plants to flowering is accelerated (Havelange *et al*., 2000; Bernie *et al*., 2002). Under the influence of photoperiodic conditions in long-day and short-day plants activity of some enzymes of

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carbohydrate exchange changes (Zhmurko, 1990; Tsibulko, 1998). Carbohydrates exchange is considered to have substantial part in regulation of rates of development of long-day and short-day plants at different photoperiodic conditions (Tsibulko, 1998; Havelange *et al*., 2000; Bernie *et al*., 2002) and in transduction of photoperiodic signal and evocating of flowering (Milyava, Nikiforova, 1999). Practically all information that is in literature about the role of carbohydrates exchange in regulation of plants development rates at different duration of photoperiod is obtained in experiments with long-day and short-day plants.

Theoretical and practical value of the results obtained. The results obtained substantially complement existent idea about the role of carbohydrates exchange in photoperiodic reaction of plants. In particular, photoperiodically neutral of soybean plants increase of intensity of accumulation and outflow of carbohydrates and activity of enzymes of carbohydrate exchange at a short day is one of the main factors of optimum rates of their development in these conditions. Possibly, change of character of palnt carbohydrates exchange „adequately" related to some photoperiodic conditions, it is one of ponder- able mechanisms of development rates regulation. Results can be used for the grounding ways of existing methods and development of new methods of identification of soybean primary stock for creation with weak or neutral reaction on day duration.

MATERIALS AND METHODS

Soybean has served as material for studies (Glycine max (L.) Merr.). Collection standards: short-day – Fiskeby Tur XX, Morsoybean, Monsoybean SS 2220, VIR 1746, VIR 1779, 073-12; photoperiodically neutral – Bulduri, 073-2, Bravella, NSC 90-86-75. Isogenous by EE lines of soybean (sorts of Clark and Harosoybean): short-days lines of Clark with genotypes $E_1E_2E_3$, $E_1E_2e_3$, $E_1e_2e_3$ and Harosoybean with genotype $E_1e_2e_3$; photoperiodically neutral lines of Clark with genotypes $e_1e_2e_3$, $e_1A_2e_3$, $e_1e_2E_3$ and Harosoybean with genotypes $e_1e_2e_3$, $e_1e_2E_3$. Genes EE in dominant state (EE) determine short-day reaction and in recessive (ee)-photoperiodically neutral (Davydenko *et al*., 2004). The lines are available for study exchange carbohydrates, because they were created in gene background of the same sort and differ only by the genes of EE and also belong the same species (Glycine max (L.) Merr.) which considerably reduces possibility of "masking" of differences processes by sort and species specificity of metabolism.

The plants have been reared in field's conditions at the experimental area of department of physiology and biochemistry of plants KhNU at a natural long (16 hours) and short (9-10 hours) day. The last was created, darkening plants by light-tightness chambers from 17 hours to 8 hours. Some experiments have been conducted consonantly with Institute of plant-growing of V. A. Yuriev of UÀS. The biochemical analysis of leaves from the plants apex has been used.

Water-soluble sugars (monosaccharides and sucrose) have been determined using micromethod which is based on reduction of ferricyanide potassium to ferricyanide by reducing sugars in alkaline medium (Ermakov, 1987). Starch has been determined by the method of Yastrembovich and Kalinin (1962), after its extraction by salcilylic acid with following determination of solution absorbency at 610 nm, after coloring by iodine. Content of hemicelluloses has been determined by the method of Pochinok (1976) after cleaning of material from starch by 80% solution of $Ca(NO_3)_2$ and from water-soluble sucrose by hot distilled water. In hydrolysis content of reducing sugars has been determined by micromethod (Ermakov, 1987). Content of amylose and amylopectin has been determined after McCready (1950). Sugar has been eliminated from the material by triple extraction by 80% ethanol. Starch was extracted by 1H $HClO_4$. In the extract amylose has been determined in presence of amylopectin at 660 nm. Its content has been calculated by calibration curve made by amylose. Starch content has been determined by glucose after hydrolysis with the use of scaler coefficient 0,90. Amylopectin content has been calculated by the difference of starch content and amylose content.

Total activity of amylases (α-amylase, K.F.3.2.1.1; β-amylase K.F.3.2.1.2; glucoamylase K.F.3.2.1.3) has been determined by method by Smit and Roy (Ermakov, 1987). A method is based on determination of hydrolyzed starch amount for period of incubation. Activity has been expressed in mg of hydrolyzed starch on 1 g of raw mass of leaf in an hour. Activity of Sucrose-phosphate Synthase (SFS) (UDF-Glucose: D- fructose-2-α-glucoseltranspherase, K.F.2.4.1.14) has been determined by amount of synthesized sucrose and activity of sour invertase (β-D-fructofuranozid-fructohydrolyze, K.F.3.2.1.26) - by amount of hydrolyzed sucrose (by reaction with resorcinol) and expressed in micromole on 1 g of raw mass of leaf (Pavlinova *et al*., 2002). In all analyses absorbency of solutions has been determined on Photoelectrocolorimeter KFK-2MP. Biochemical analysis has been executed in double, triple analytical repeat. 7-10 experiments with every photoperiodic group of plants have been conducted. Results are analyzed statistically by the method of pair comparison of variants, validity of averages difference (Dospehov, 1972).

RESULTS AND DISCUSSION

Correlation between carbohydrates synthesis and photoperiodically time in leaves of soybean. Long-day

and short-day plants differ by fractional composition of carbohydrates in leaves- in first water-soluble sugars prevail (to 60%) and in last polysaccharides-hemicelluloses and starch (to 60-70%). This results in outflow of carbohydrates in long-day plants mainly at daily hours (about 60%), simultaneously with photosynthesis and in short-day in nightly hours (to 70%) after breaking up of polysaccharides. Fractional composition of carbohydrates determines the period of day, in which the outflow of carbohydrates from leaves to apical meristem prevails and also its intensity in long-day and short-day plants that is one of main factors of regulation of their development rates in different photoperiodic conditions (Tsibulko, 1998). Fractional composition of carbohydrates in photoperiodically neutral plants has not been studied, although, taking into account written higher, its study has great significance for deepening of ideas about role of carbohydrates in regulation of development rates of this photoperiodic group of plants.

The results of determination of correlation of water-soluble sugars and polysaccharides in the conditions of a natural long day in leaves of short-day and photoperiodically neutral collection standards of soybean have shown that in the sum of carbohydrates the part of water-soluble sugars is 28-38%, starch-12-17% and hemicelluloses -48-50% (Table 1). In leaves of studied standards of soybean hemicelluloses amounts almost a half in the sum of carbonhydratess. As known (Goodwin, Merser, 1986), these polysaccharides are structural components of cellular walls of plants. That is why they can be attracted in carbohydrate exchange only in “critical” periods and in stressing conditions, when photosynthesis does not provide vital functions of plants by a necessary amount of metabolically active sugars and starch (Lyaskovsky, 1993). There were not such conditions in our experiments, so we have concentrated our attention to the study of metabolically active carbohydrates-water-soluble sugars and starch.

Determination of their correlation (without taking into account content of hemicelluloses) in leaves of short-day and photoperiodically neutral collection standards (Table 1) and isogenous lines of soybean (Table 2) has showed, that in this case the part of water-soluble sugars in average amounts over 70 % and starch-over 30% in their sum. To our opinion, such correlation of these carbohydrates largely correspond to their functions in vital functions of plants.

At different duration of photoperiod correlation of water-soluble sugars and starch in leaves of different photoperiodic groups of plants has not been studied before. It is considered that at a short day in long night period the hydrolysis of polysaccharides increases in short-day plants that results in growth of carbohydrates outflow (Tsibulko, 1998). Possibly, as a result correlation of water-soluble sugars and starch in short-day and photoperiodically neutral lines of soybean studied by us may change.

The results showed that in the conditions of a short day correlation of water-soluble sugars and starch in leaves of short-day and photoperiodically neutral lines of soybean of Clark remains practically the same, as well as in the conditions of a long day (Table 3). However their content under the influence of a short day decreases at both photoperiodic groups of lines.

Thus, collection standards and isogenous lines of soybean with different reaction on day duration do not differ practically by correlation of water-soluble sugars and polysaccharides in leaves in different photoperiodic conditions. A short day reduces content of water-soluble sugars and starch in leaves of both photoperiodic groups of soybean.

Dynamics of carbohydrates content in the day photoperiodic cycle. Short-day and photoperiodically neutral lines of soybean are similar by correlation of water-soluble sugars and starch. Possibly, they may differ by accumulation and outflow of carbohydrates at

Table 1: Correlation of water-soluble sugars and polysaccharides in leaves of short-day and photoperiodically neutral collection standards of soybean in the conditions of a natural long day

		Correlation of carbohydrates, %	
Short-day collection standard VIR 1746		Total sum	Sugars and Starch
Water-soluble sugars	76.0±1.4	33.0	77.0
Starch	23.0±1.5	10.0	23.0
Hemicelluloses	132.0±1.2	57.0	-
Sum	231.0	100	100
Photoperiodically neutral collection standard Bravella			
Water-soluble sugars	82.0±5.3	31.0	65.0
Starch	44.0±2.2	17.0	35.0
Hemicelluloses	136.0±7.3	52.0	-
Sum	262.0	100	100

Table 2: Correlation of water-soluble sugars and starch in leaves of short-day and photoperiodically neutral isogenous lines of soybean in the conditions of a natural day

Content, mg/g of dry mass			Correlation, % from a sum	
Water-soluble sugars	Starch	Sum	Sugars	Starch
Short-day isogenous line of Clark, genotype $E_1E_2E_3$				
69.1±1.2	34.5±0.8	103.6	66.7	33.3
Photoperiodically neutral isogenous line of Clark, genotype $e_2e_2e_3$				
68.8±1.4	42.3±2.0	110.9	61.9	38.1

Table 3: Influence of day duration on content and correlation of water-soluble sugars and starch in leaves of short-day and photoperiodically neutral isogenous lines of soybean

	Content of carbohydrates, mg/g of dry mass			Correlation, % from a sum	
	Sugars	Starch	Sum	Sugars	Starch
Short-day isogenous line of sort Clark, genotype $E_1E_2E_3$					
16	69.1±1.2	34.5±1.0	103.6	66.7	33.3
9	49.2±1.0	27.2±0.9	76.4	64.4	35.6
Photoperiodically neutral line of sort Clark, genotype $e_2e_2e_3$					
16	68.8±1.4	42.3±2.0	110.9	61.9	38.1
9	51.3±0.9	37.6±0.9	88.9	57.7	42.3

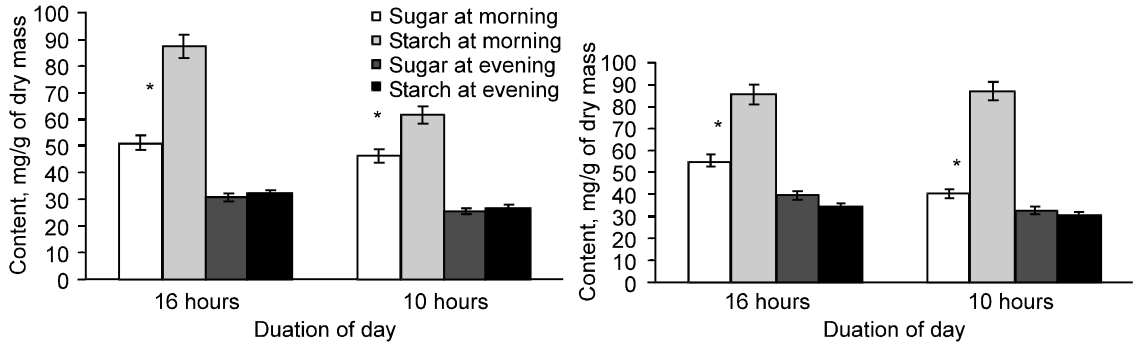

Fig. 1(a-b): Accumulation of sugars (monosaccharides and sucrose) and starch for light period in short-day and photoperiodically neutral lines of soybean in the conditions of different duration of photoperiod. Note: *difference by indexes at a long and short day is substantial at $p \leq 05$
(a) Short-day line of Clark, genotype $E_1E_2E_3$
(b) Photoperiodically neutral line of Clark, genotype $e_1e_2e_3$

different duration of photoperiod. This induced us to study these processes in the day photoperiodic cycle.

Determination of carbohydrates accumulation for light period has been conducted by difference of their content in leaves at its beginning (morning) and in the end (evening). At morning hours in both photoperiodic groups of lines in the conditions of a short day content of water-soluble sugars and starch is less, than in the conditions of a long day but for light period content of sugars increases in them. However, in short-day lines it mostly rises at a long day and in photoperiodically neutral-at a short day (Fig. 1). Starch content for light period in short-day lines practically does not change depending on duration of day and in photoperiodically neutral lines it decreases at a long and short day (Fig. 1).

Possibly, greater accumulation of water-soluble sugars in leaves of photoperiodically neutral lines at short photoperiod may be connected with their ability, unlike short-day, to promote intensity of their synthesis in these conditions. Possibly also, that sugars level increases as a result of strengthening of hydrolysis of starch, as its content during a light period in photoperiodically neutral lines decreases.

Daily dynamics of water-soluble sugars content. Total accumulation of carbohydrates, to our opinion, insufficiently fully represents the features of dynamics of their content during a light period, because it may be "masking" as a result of mid-day depression of photosynthesis. So we studied daily dynamics of accumulation of monosaccharides, sucrose and starch, determining their content at 8, 13 and 18 o'clock.

The results have shown (Fig. 2) that in short-day and neutral lines at morning hours (8:00) in the conditions of

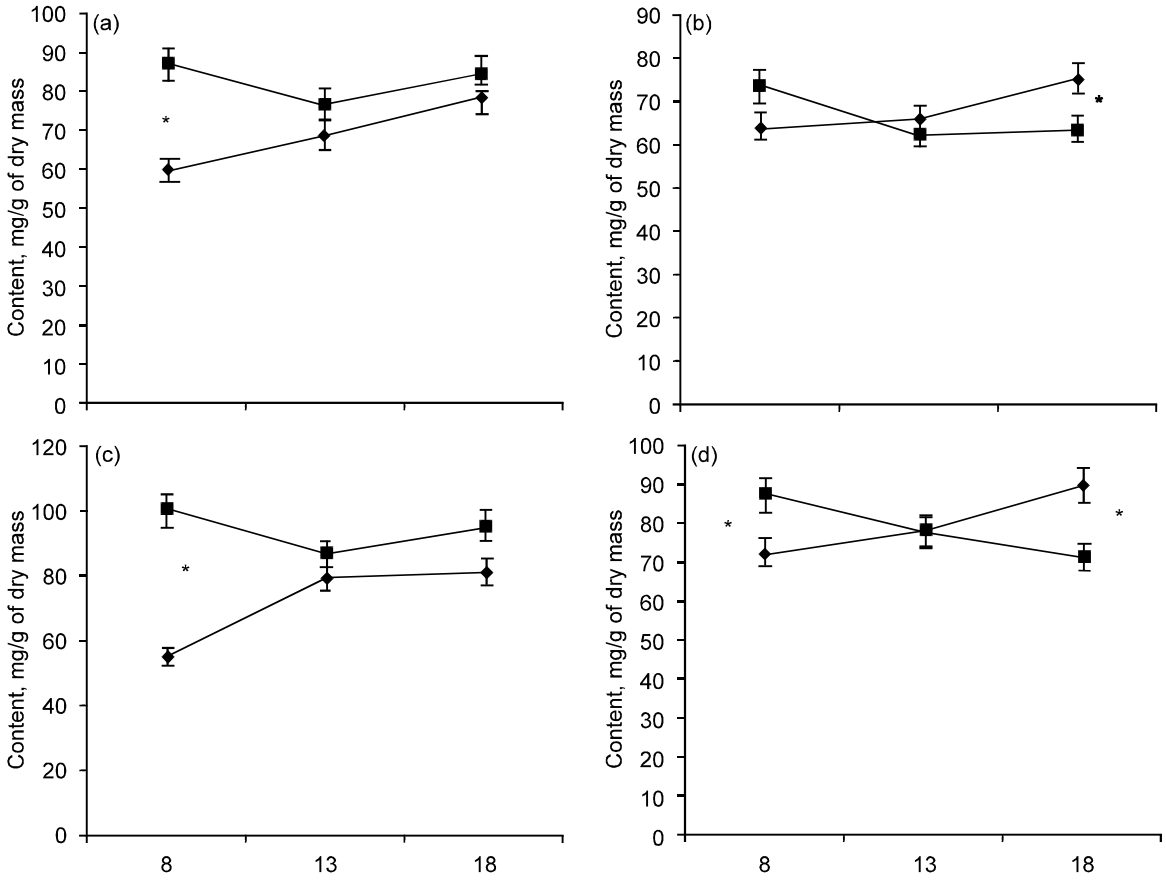

Fig. 2(a-d): Daily dynamics of water-soluble sugars content in leaves of short-day and photoperiodically neutral lines in the conditions of a long-(16 hours) and a short-(10 hours) day.
Note: * difference by indexes on a long and short day is substantial at $p \leq 05$

a short day content of water-soluble sugars is less than in the conditions of a long day. This is connected with greater consumption of water-soluble sugars in metabolic processes and outflow from leaves during long night in the conditions of a short day.

In short-day lines in the conditions of a long day from 8 to 13 o'clock accumulation of monosaccharides and sucrose did not take place and from 13 till 18 it increased. At a short day in them monosaccharides accumulated during all light period and sucrose-mainly in the first its half. In photoperiodically neutral lines in the conditions of a long day from 8 to 13 o'clock accumulation of both monosaccharides and sucrose decreased gradually (Fig. 2), that possibly is connected with intensification of its outflow from leaves. In the conditions of short photoperiod in leaves of these lines there is intensive accumulation of monosaccharides and sucrose. At 13 o'clock it becomes the same, as well as in the conditions of a long day and till 18 o'clock substantially exceeds it (Fig. 2). Possibly, more intensive accumulation of sugars in photoperiodically neutral lines at a short day allows "compensate" decrease of their common amount as a result of duration reduction of photosynthesis period.

Daily dynamics of starch content in leaves of short-day and photoperiodically neutral lines is unidirectional (Fig. 3). The difference between lines by character of starch accumulation consists in that after 13 o'clock photoperiodically neutral lines have a tendency to its decrease which at a short day is expressed in a greater degree, than at a long day (Fig. 3).

Practically similar character of starch accumulation in studied groups of plants may tells that photoperiodically neutral lines at a short photoperiod accumulate it in such amount, that sufficient for providing of vital functions processes with carbohydrates at a short duration of photosynthesis.

It is known that assimilatory starch is main reserve polysaccharide of leaves that is formed in the process of photosynthesis (Goodvin, Merser, 1986). It is involved in exchange mainly after a night hydrolysis by amylases, from products of which monomers are formed which are

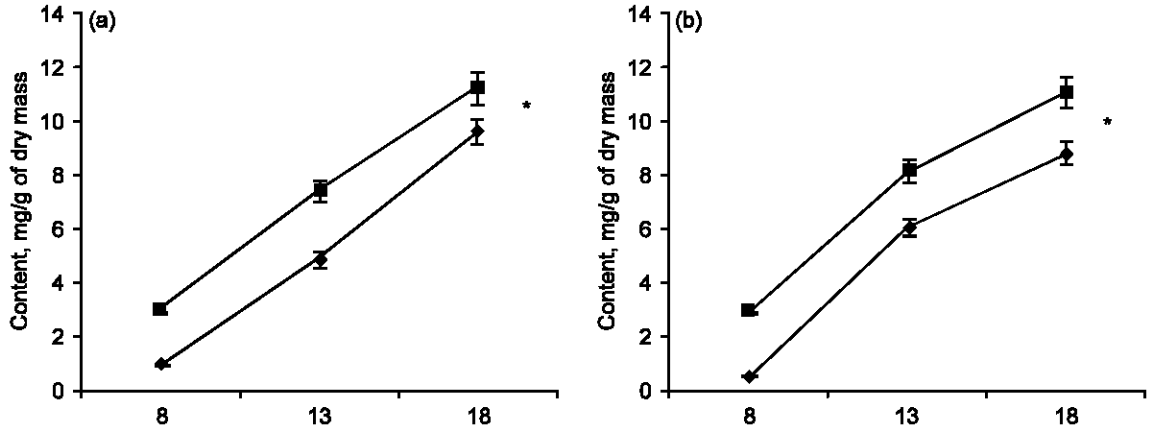

Fig. 3(a-b): Daily dynamics of starch content in leaves of short-day and photoperiodically neutral lines in the conditions of a long-(16 hours) and a short-(10 hours) day. Note: *difference by indexes on a long and short day is substantial at p≤05

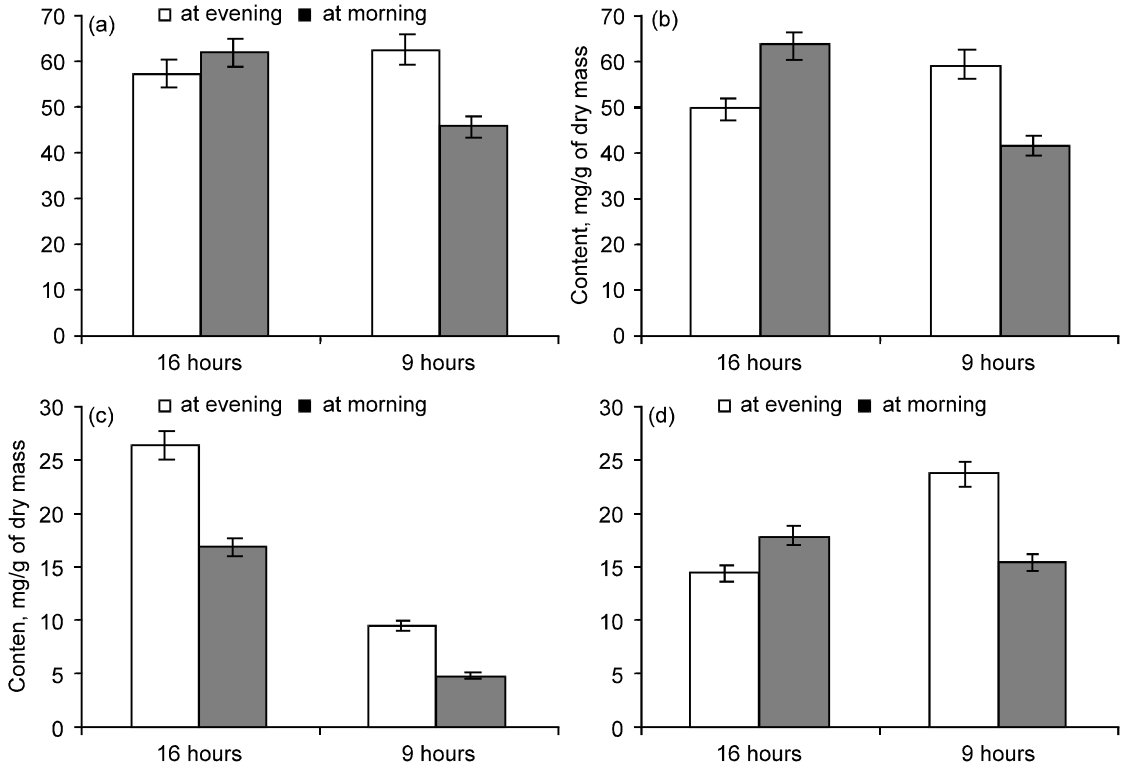

Fig. 4(a-d): Change of water-soluble sugars content during night period in leaves of short-day and photoperiodically neutral lines of soybean in the conditions of a long and short photoperiod. Note: *difference by indexes on a long and short day is substantial at p≤05

used in biosynthesis and for formation of sucrose from triosephosphates and consequently for providing of carbohydrates outflow from leaves to meristem, where morphogenetic processes are carried out and to the stocking organs.

Study of nightly sugar outflow has shown (Fig. 4) that in leaves of short-day lines during night in the conditions of a long-day photoperiodic cycle content of monosaccharides increases and content of sucrose decreases substantively. At the same time in the conditions of a short-day photoperiodic cycle content of both monosaccharides and sucrose decrease and considerably more intensive, than during night of a long-day cycle. In leaves of photoperiodically neutral lines

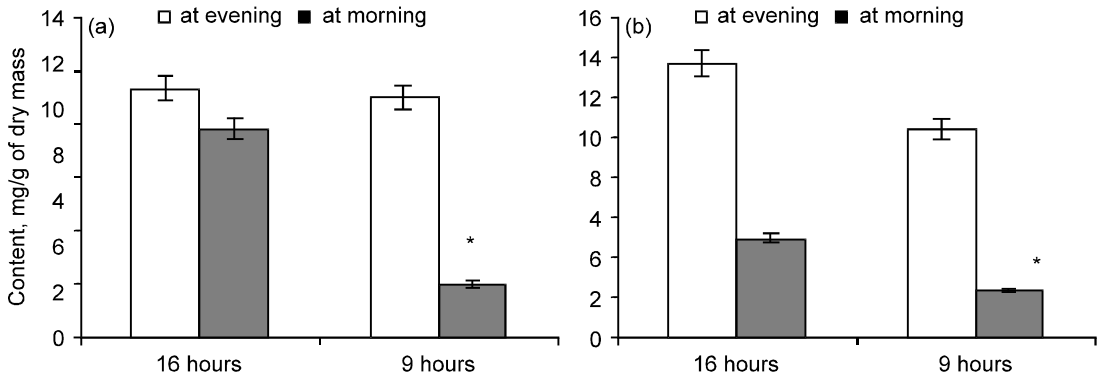

Fig. 5(a-b): Change of starch content during night period in leaves of short-day and photoperiodically neutral lines of soybean in the conditions of a long and short photoperiod. Note: *difference by indexes on a long and short day is substantial at $p \leq 05$

(Fig. 4) during night period of a long-day photoperiodic cycle content of sugars in leaves of neutral lines does not change substantively and during night period of a short-day cycle it decreases substantively in them, that tells about intensification of sugar outflow.

The study of change of starch content during night at different day duration has showed that in both groups of lines in the conditions of a long day starch content both at the end of light period (evening) and at the end of darken period (morning) is higher, than in the conditions of a short day (Fig. 5).

In leaves of short-day lines during night period of a long-day photoperiodic cycle starch content decreases insignificantly and of a short-day -decreased almost in 5 times, that indicates intensive hydrolysis of starch. In leaves of photoperiodically neutral lines, unlike short-day, substantial decrease of starch content during night period takes place both in the conditions of a long-day and in the conditions of a short-day photoperiodic cycle. But during night at a short day it is almost in three times greater, than during night at a long day.

So, in the studied lines of both photoperiodic groups day reduction (lengthening of darkness period), possibly, result in intensification of starch hydrolysis, in comparison with its intensity in darken period at a long day. However, in photoperiodically neutral lines during darken period in the conditions of a long day starch is hydrolyzed more intensive, than in short-day lines.

The products of starch hydrolysis may be included in exchange and also, transforming into triosephosphates, be used in the synthesis of sucrose which is the main transporting form of carbohydrates in plants. That is, hydrolysis of starch in night period can provide outflow of assimilates from leaves.

Thus, dynamics of carbohydrates content in short-day photoperiodic cycle in studied short-day and photoperiodically neutral lines of soybean by intensity and character is similar. Possibly, in photoperiodically neutral lines, as well as in short-day at a short photoperiodic, this may be the ponderable factor of sufficient providing of growth and development processes by carbohydrates and consequently of optimum rates of morphogenetic processes, that shows up in ability of neutral lines not to change terms of transition to flowering in these conditions.

Amylose and amylopectin content in leaves of soybean in the conditions of different day duration. Amylose and amylopectin are different by molecules structures complexity that results in different speed of their formation and hydrolysis (Goodvin, Merser, 1986). Their correlation in the molecule of starch may determine speed and efficiency of its use for providing of vital functions of plants by assimilates. This position was determining for the study of amylose and amylopectin content in starch of leaves of the studied photoperiodic groups of soybean lines.

During light period in the conditions of a long and short day in short-day and photoperiodically neutral lines decrease of amylopectin content takes place and in neutral lines it is expressed more substantially than in short-day lines (Fig. 6). Amylose content in both groups of lines increased both in the conditions of a long day and in the conditions of a short day but largely at a long day. Lines differed by amylose content in starch – in photoperiodically neutral lines it varied in the conditions of a long day within the limits of 8-15% and in short-day -4-9%. To our opinion, this favours that photoperiodically neutral lines in the conditions of a long day can more quickly include into exchange more simple component of starch – amylose. Amylopectin content in starch of photoperiodically neutral lines in the conditions of a long day for 4-5% is less than in short-day. Possibly this allows them more “effectively” use starch in metabolic processes, because amylose is hydrolyzed more quickly and consequently is included in metabolism.

Activity of amylases, SFS and invertase in leaves of soybean in the conditions of different day duration. We studied activity of basic enzymes of synthesis and

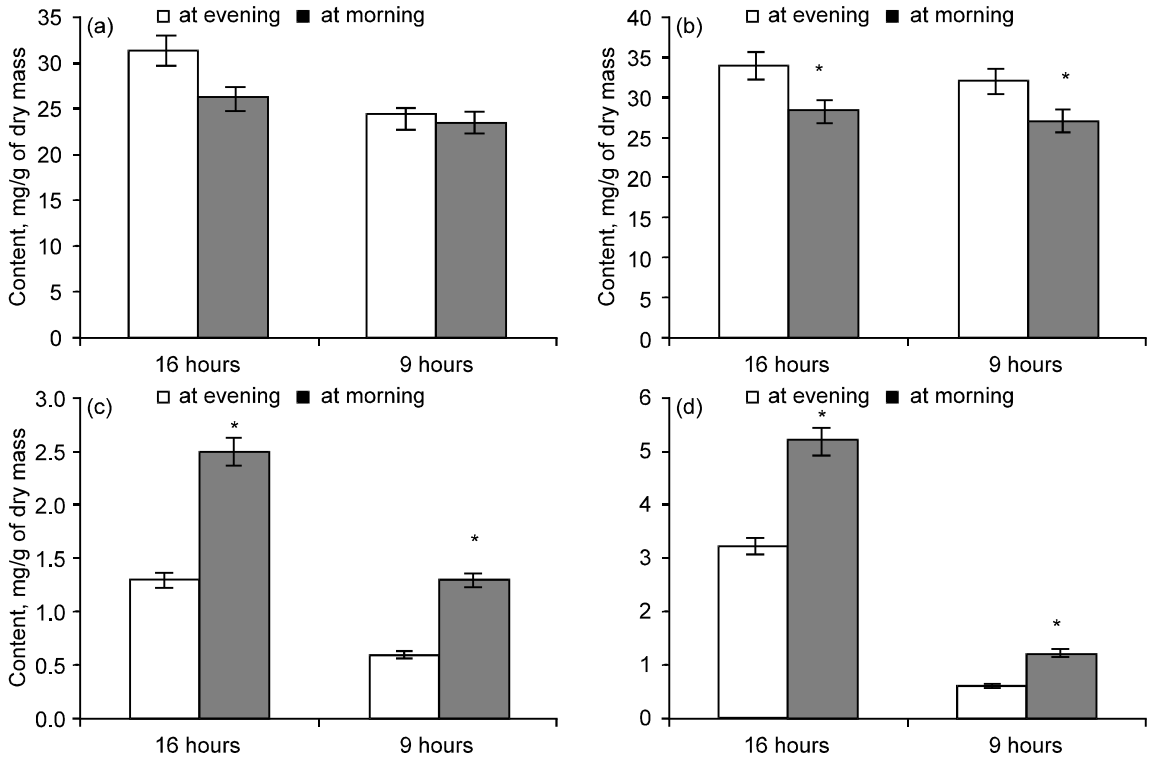

Fig. 6(a-d): Amylopectin and amylose content in starch of leaves of short-day and photoperiodically neutral lines of soybean in the conditions of different duration of photoperiod. Note: *difference by indexes on a long and short day is substantial at $p \leq 05$

breaking up of carbohydrates, coming from the next reasonings. Amylases hydrolyze starch of chloroplasts to D-glucose which through a number of transformations in carbohydrates exchange provides metabolism and synthesis of sucrose for a distant transport with necessary products. SFS is a key enzyme of synthesis of sucrose from triosephosphates which can be formed not only in the process of photosynthesis but also from the products of starch hydrolysis. Sour invertase, hydrolyzing sucrose, plays substantial role in its including to metabolic processes (Goodvin, Merser, 1986). Consequently, these enzymes are functionally connected. By their participation in plants leaves carbohydrates accumulation and outflow takes place, that plays great role for providing of growth and development processes by assimilates.

The results of determination of enzymes activity have showed that under the influence of a short photoperiod activity of amylases, SFS and sour invertase increased both in short-day and at photoperiodically neutral lines (Fig. 7). We note that at daily hours (15:00) activity of enzymes was higher than in morning (9:00) in both photoperiodic groups of plants, regardless of photoperiod duration. Possibly, this is connected with intensification of carbohydrates formation-substratum of these enzymes-in the process of photosynthesis.

Higher activity of amylases, SFS and sour invertase at a short day in short-day and photoperiodically neutral lines of soybean, to our opinion, is one of necessary conditions of enhanced intensity of accumulation and outflow of water-soluble sugars and including of starch in metabolism, that has been discovered in experiments in these conditions. Possibly, this results in that photoperiodically neutral lines of soybean at a short photoperiod are able to support the necessary level of assimilates supply for realization of normal rates of growth and development.

Thus, results of the research show that in short-day and photoperiodically neutral collection standards and isogenous lines of soybean at growing in the conditions of a short photoperiod changes in accumulation and outflow of sucrose and starch and also activity of carbohydrates exchange enzymes are unidirectional by character and intensity. For short-day plants of other species increase of intensity of carbohydrates accumulation and outflow is one of main factors of accelerated transition to flowering at a short day (Tsibulko, 1998). By our data under enhanced intensity of carbohydrates exchange at a short day short-day isogenous lines of soybean accelerate transition to flowering and photoperiodically neutral lines blossom simultaneously at a long and short day. Possibly,

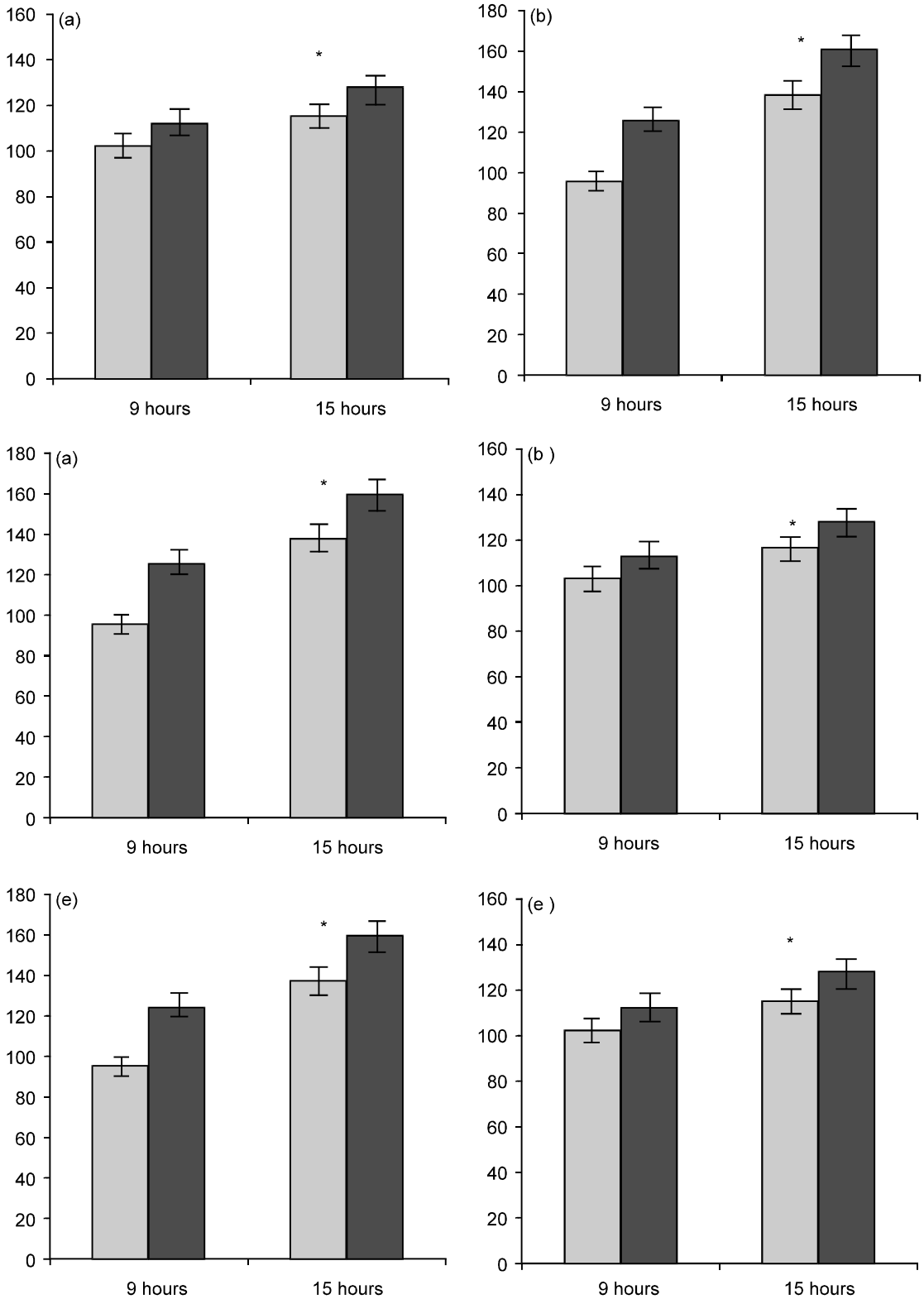

Fig. 7(a-e): Activity of amylases, SFS and invertase in leaves of short-day (A, line of Clark, genotype $E_1E_2E_3$) and photoperiodically neutral (B, line of Clark, genotype $e_1e_2e_3$) lines of soybean on a long and short photoperiod. Note: *difference by indexes on a long and short day is substantial for $p \leq 05$

intensification of carbohydrates exchange at a short day in photoperiodically neutral lines of soybean is a ponderable factor which allows them not to change the rates of development. High intensity of carbohydrates exchange stipulates the sufficient supply of carbohydrates for morphogenetic processes realization which shows up in ability of photoperiodically neutral lines of soybean not to detain transition to flowering in the conditions of a short photoperiod.

Conclusions: By correlation of water-soluble sugars and polysaccharides in leaves short-day standards and isogenous lines of soybean in different photoperiodic conditions practically do not differ from photoperiodically neutral ones. Reduction of photoperiod duration causes decrease of sucrose and starch content in them but does not change their correlation.

Constancy of correlation of these forms of carbohydrates in leaves at different photoperiod duration tells that this is one of important factors of providing by assimilates of growth and development processes of the studied photoperiodic groups of soybean in the conditions of different duration of day.

Accumulation of water-soluble sugars in leaves of short-day and photoperiodically neutral standards and lines for a light period at a long day is higher and of starch is less, than at a short day. In short-day lines starch content in the conditions of a short day during a light period increases insignificantly and in neutral decreases.

The studied lines differ by intensity of daily dynamics of monosaccharide and sucrose content in leaves in different photoperiodic conditions. Under the influence of a short day in leaves of short-day lines their accumulation decreases and in leaves of neutral ones, oppositely, increases, in comparison with accumulation at a long day. Character of daily dynamics of starch content in different photoperiodic conditions in leaves of the studied groups of lines is similar.

Outflow of water-soluble sugars from leaves of short-day and photoperiodically neutral lines and also hydrolysis of starch during night of a short-day photoperiodic cycle are more intensive, than during night of a long-day cycle. Increase of intensity of carbohydrates accumulation and outflow in photoperiodically neutral lines at a short-day cycle is one of ponderable factors that allows them to support the sufficient level of providing of optimum rates of growth and development by assimilates in these conditions.

Short-day and photoperiodically neutral lines differ by amylose and amylopectin content in starch of leaves. In photoperiodically neutral lines at a long day amylose content is almost in 2 times and amylopectin -5-10% higher, than in short-day lines.

Activity of amylases, SFS and invertase in leaves of short-day and photoperiodically neutral lines of soybean at a short day is higher, than at a long day. Possibly, this is one of ponderable factors of increase of carbohydrates exchange intensity under the influence of a short photoperiod in plants of studied photoperiodic groups of soybean which is set in experiments.

By character and intensity of dynamics of water-soluble sugars and starch content and by level of carbohydrates exchange enzymes activity at a short-day photoperiodic cycle the studied short-day and photoperiodically neutral lines of soybean do not differ practically. Increase of intensity of carbohydrates exchange in photoperiodically neutral lines at a short day may be one of important factors of the sufficient providing of morphogenetic processes by carbohydrates, that allows them not to retard development rates and, in the end, not to detain transition to flowering in these conditions.

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