DIFFERENTIAL EFFECT OF RED AND BLUE LIGHT ON THE ACCUMULATION OF CARBOHYDRATES AND NITROGEN COMPOUNDS

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Introduction

There are contradictory data in literature concerning the problem whether a change in the spectral composition of light has any effect on the rate of accumulation of carbohydrates and nitrogen compounds. Cayle and Emerson (1957), Moyse et al. (1959), as well Bergmann and Balz (1966) stated, that there is no difference in carbohydrate and nitrogen content under red and blue illumination if the CO_2 fixation, resp. the increase of dry matter was kept on the same level. Similar data had been reported earlier by us (Szász, 1966). In some contradiction with that others (Kowallik, 1962; Hauschild et al., 1964; Voskresenskaya and Nechaeva, 1967) demonstrated, that the blue and red light affected the accumulation of carbohydrates and nitrogen compounds differently even if the dry matter production was the same.

Material and methods

Plants of soybean (*Glicine soya* cult. Rábakecöli fekete) were grown, simultaneously at three different light intensites (3.000, 8.000 and 12.500 ergs. $cm^{-2}sec^{-1}$), under controlled conditions, for a five week period. The illumination was presented by blue and red fluorescent lamps. In our climate chambers (Horváth, 1964) temperature varied between 15—25° C, humidity between 40—70 percent, in a daily rhythm. The plants were grown in pots of sand and Pryanisnikov's nutrient solution was used for irrigation.

The experiment has been repeated three times, and our data refer to 100—120 plants.

The plants were dried and determinations have been carried out from the dry material as follows: soluble carbohydrates, starch, soluble nitrogen and TCA precipitated protein fractions (Dubois et al., 1956; Kelley et al., 1946).

Results

The increase of dry weight of plants grown in blue and red lights is shown in Table I.

In the case of an identical dry weight accumulation, the carbohydrate and nitrogen contents in the leaves were significantly different in blue and red lights (Figs. 1 and 2). In roots and stems, there could not be demonstrated any differences.

Table I. Dry weight (mg) of soybean plants

light intensity ($ergs.cm^{-2}sec^{-1}$)	root		stem		leaf		whole plant	
	blue	red	blue	red	blue	red	bule	red
3.10^3	12,0	12,2	51,8	57,2	19,2	16,2	83,0	85,6
8.10^3	14,0	10,3	69,0	82,0	51,0	56,7	134,0	149,0
$12,5.10^3$	26,5	27,0	90,8	114,7	83,5	77,8	200,8	219,5
L.S.D. at 5 per cent level	4,7		8,7		9,7		22,6	

According to the figures the soluble carbohydrate and starch contents were higher in red light, and the soluble and protein nitrogen contents in blue one. Depending upon the dry matter accumulation, the red light increased the soluble carbohydrate content by about 27—48 per cent, and the starch content by 36—55 per cent. On the other hand, the blue light brought about an increase of the soluble nitrogen fraction of 31—62 per cent, and of the protein fraction of 25—33 per cent.

Figures show also the increase of the carbohydrate content and decrease of the soluble nitrogen content as a function of the dry matter accumulation.

Discussion

The demonstration of the stimulatory effect of blue light on the accumulation of nitrogen compounds is in good accordance with data of several authors, published on the synthesis of amino acids, resp. proteins (Ohlenroth and Mohr, 1964; Das and Raju, 1965; Christel and Bergmann, 1967).

On the basis of the data obtained we suppose that the spectral composition of light may have an immediate influence on the synthesis of carbohydrates and nitrogen compounds, and the differences which occur are not exclusively due to the changes of the dry matter accumulation.

The fact that the differences could have been shown only in the leaves refers to a connection with photosynthesis. We had earlier tried to correlate the formation of the determined carbohydrate and nitrogen

fractions from the Calvin cycle (Horváth and Szász, 1965). On the other hand, the effect manifested in the starch and protein contents, is showing that the change in the spectral composition of light exerts its influence not only via the photosynthetic reactions but other metabolic pathways may be effected as well.

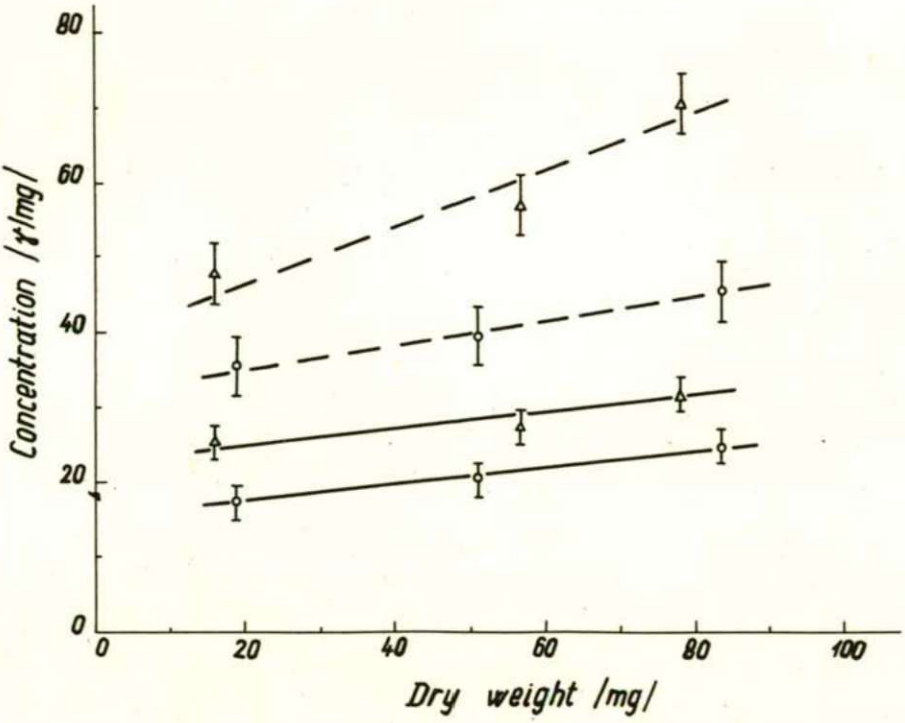

Fig. 1 Change of the soluble carbohydrate and starch contents in soybean leaves as a function of the dry weight accumulation. ———, soluble carbohydrates; — — —, starch; o, blue light; △, red light.

Summary

We investigated the effect of the spectral composition of light on the accumulation of carbohydrates and nitrogen compounds in soybean plants grown under controlled conditions. The examinations indicate:

1) In the case of an identical dry weight accumulation, in leaves, the soluble carbohydrate and starch contents were higher in red light, the soluble and protein nitrogen contents, however, in blue one.

2) In roots and stems no difference could be detected.

Authors suppose that the spectral composition of light has an immediate influence on the synthesis of carbohydrate and nitrogen compounds.

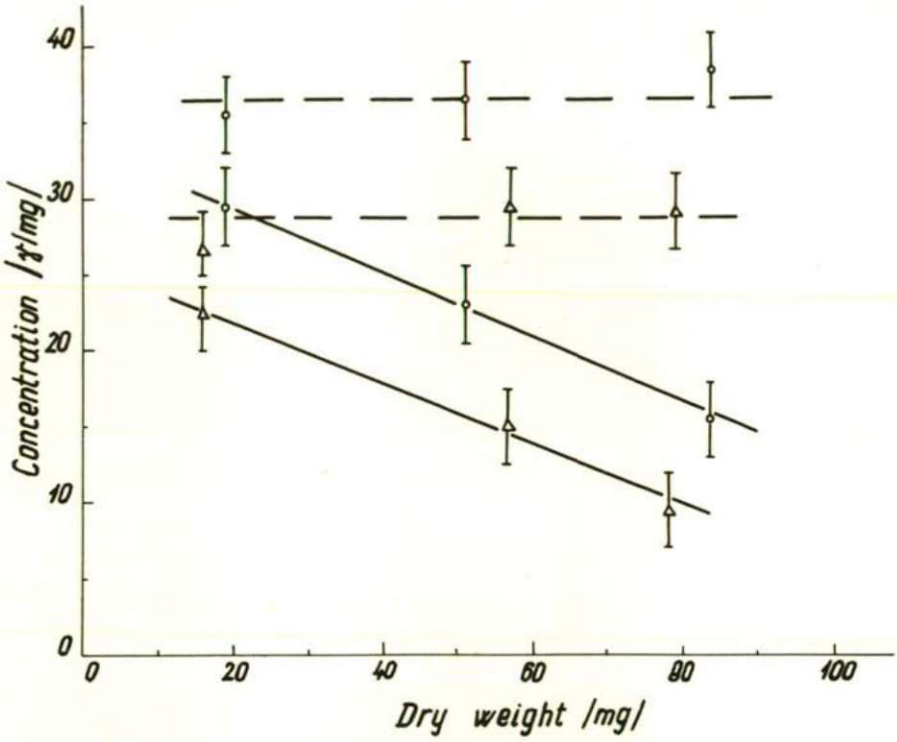

Fig. 2 Change of the soluble nitrogen and protein contents in soybean leaves as a function of the dry weight accumulation. ———, soluble-N; — — —, protein-N; o, blue light; △, red light.

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