Using the products of photosynthesis in the production process of plants

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We investigated $^{14}CO_2$ assimilation, ^{14}C distribution among the labeled product of photosynthesis and their transport from leave to acceptor under changing conditions for flax, wheat and potato plant. The data showing, that photosynthesis is carried out in accordance with the established at this time environmental conditions and activity of organs-acceptors are presented. A sudden increase in the number of photosynthetic products (increased concentration CO_2) leads to repressing the assimilate efflux from leaves and strengthening the photorespiration and nonreducing PGA metabolism. Conversely, reducing the assimilate amount (reducing illumination) enhances the carbohydrate direction of photosynthesis and stimulates efflux from leaves. The energy assimilated in photosynthesis, is largely spent on sugar loading in the phloem. It is about 40% at saturating illumination. It was shown when illumination was reduced from 400 to 100 W/m^2 for growing potatoes, the energy for consumption of per unit of biomass formation was reduced 2 times, while the productivity (weight of the formed tubers per unit of leaves mass) decreased only by 34%.

The analysis of the distribution of ^{14}C -products of photosynthesis among plant organs showed that there were three mechanisms of assimilate transport at the same time: 1) active energy-dependent phloem transport in a downward direction from the leaf, 2) diffusive symplast transport in all directions, 3) high-speed stream of assimilates, that came from the phloem to the apoplast, with transpiration water upward.

The diffusion component of transport is the least energy-consuming and its contribution increases with the decrease of illumination. The upstream assimilates moving with transpiration water, causes the growth of aboveground mass of plants. There is an optimal combination of these three components of transport for economic plant productivity. The apoplast invertase plays an important role in the sucrose transport, the increase activity of which enhances the transport diffusion component of photosynthetic product. This conclusion was confirmed by introducing an additional gene of cell wall invertase in the DNA of plants. The data the possibility of controlling the invertase activity are given.