STUDIES ON PHLOEM EXUDATION FROM YUCCA FLACCIDA HAW.

VI. THE FORMATION OF EXUDATE-SUCROSE FROM SUPPLIED HEXOSES IN EXCISED INFLORESCENCE PARTS

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SUMMARY

Excised parts of the stalk of young inflorescences of *Yucca flaccida* Haw. were placed with one end in a solution of either fructose-^{14}C(U) or glucose-^{14}C(U).

The phloem exudate collected from the opposite ends of the stalk parts always contained sucrose as the major ^{14}C-labelled component, while ^{14}C-hexoses could not be detected in it.

1. INTRODUCTION

The observed exudation of phloem sap from excised parts of young inflorescences of *Yucca* (VAN DIE & TAMMES 1966) has made it possible to use these parts for studies on translocation. Although in general only small amounts of exudate are obtained from them (compared with the large volumes collected from the inflorescence part that remains attached to the plant) they are much more suited for laboratory experiments, especially when radioactive tracers are involved.

Using whole plants it was found (VAN DIE & TAMMES 1964) that the application of $^{14}CO_2$ to a photosynthesizing leaf resulted in the exudation of ^{14}C-labelled sucrose, while labelled hexoses were hardly detectable.

It seemed of interest to know whether the sucrose that is present in the small amounts of exudate from isolated inflorescence parts, finds its origin in the sucrose that is already stored in the inflorescence tissues, or whether it is synthesized during the exudation process from hexoses also present in them.

This paper describes some experiments which clearly show that excised inflorescence parts are able to use externally supplied fructose and glucose for the synthesis of the sucrose present in the phloem exudate. The results are briefly discussed.

2. METHODS

Stalks of young inflorescences, 30–60 cm long, were harvested in the month of June. They were divided in two parts – the more basal part and the top one. From the latter the apical 0.5 cm was cut off.

Both inflorescence parts were placed with one end in a small beaker containing a 1% solution of fructose – ^{14}C (U) or glucose – ^{14}C (U) with an activity of 5 μc/ml. From the opposite end exudate was collected.

The position of the inflorescence part in the beaker was of no importance. Whether the proximal or distal end of the inflorescence part was in contact with the solution did not have any detectable influence on exudation rate, exudate composition or on the results obtained in these experiments.

The exudate collected from the upper end of the stalk part was analyzed for its sugar composition by one dimensional descending paper chromatography, using the solvent system of SERMANNI (1956). From the resulting chromatograms autoradiograms were prepared by means of "Kodak-no-screen" X-ray films.

As controls the labelled sugars were dissolved in inactive exudate obtained from other experiments.

The ^{14}C-sugars used were obtained from the Radiochemical Centre, Amersham, Great Britain.

3. RESULTS

After placing an inflorescence part about 20 cm long into a labelled hexose solution active exudate could be collected from the top end after about 2 1/2 hours.

When ^{14}C-fructose was supplied almost exclusively ^{14}C-sucrose was collected in the exudate. ^{14}C-fructose was completely absent. The only other active component in the exudate was a substance with an R_f value slightly higher than glucose. In the autoradiogram it appeared as a very faint spot.

Acid-hydrolysis of the exudate-sucrose eluted from the sucrose regions of the paper chromatograms revealed that about 88 per cent of the carbon–14 was present in the fructose part, and about 12 per cent in the glucose part of the sucrose molecule.

The ^{14}C-glucose used was slightly contaminated with various unknown components, probably caused by some radiochemical breakdown during its storage for several years in the laboratory's freezer. Control autoradiograms showed several faint spots at various places, besides the main glucose spot. In the exudate ^{14}C-sucrose was again the main component. In addition two faint spots were present in the glucose area, probably none of it being identical with glucose. Moreover some of the contaminant spots shown by the control autoradiogram were also found on the exudate chromatogram.

A mixture of labelled glucose and fructose supplied to stalk parts yielded an exudate with an activity pattern similar to that found after the supply of labelled glucose alone.

4. DISCUSSION

It is generally accepted that the influx of sucrose from surrounding cells into the sieve tubes has a secretion process as its driving force. The experimental

evidence for this view comes from various kinds of investigations (e.g. ROECKL 1949, PAVLINOVA 1955) but it is of an indirect nature. The present results directly prove the selective secretion of sucrose into the sieve tubes. They also show that this secretion is not restricted to phloem regions in carbohydrate synthesizing centres, but also occurs in carbohydrate-utilizing organs, at least under experimental conditions. The severance of the rapidly developing inflorescence is followed by the secretion of sucrose previously imported from the green parts of the plant (VAN DIE & TAMMES 1966) or as in the present work, synthesized from externally supplied hexose given through the xylem vessels.

Apparently the sequence of reactions underlying these phenomena is easily reversible:

$$\frac{\text{uptake from}}{\text{secretion into}} \text{ the sieve tubes} \longleftrightarrow \frac{\text{conversion of sucrose to hexoses}}{\text{synthesis of sucrose from hexoses}} \longleftrightarrow \frac{\text{accumulation}}{\text{mobilization}}$$

of hexoses.

It is tempting to suggest as an explanation for the results obtained so far that (1) the concentration of sucrose in the sieve tubes and in the surrounding nucleate phloem cells determines the direction of the sucrose movement between them, and with that the direction of the associated reactions, and that (2) the direction of the flow of assimilates in intact plants is essentially determined by the resultant of the secretion/absorption balance of all the individual nucleate phloem cells along the whole sieve tube system.

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