**Short Communication**

**Translocation of Sucrose by Squash Plants**

JOHN E. HENDRIX  
Department of Botany and Plant Pathology, Colorado State University, Fort Collins, Colorado 80521

Received for publication June 19, 1973

**ABSTRACT**

Sucrose-14C was fed to the leaf blades of squash plants (Cucurbita pepo L. var. melopepo torticallis Bailey) for 30 or 60 minutes. Petioles of treated plants were cut into sections and extracted. The majority of the 14C within the petiole was in sucrose rather than stachyose, the sugar that is transported by the squash plants when 14CO2 is supplied. This indicates that the phloem loading system of squash plants is not the system that specifies which sugar is transported.

Sucrose is translocated in the phloem of most plants that have been studied; however, some plants transport other nonreducing sugars and sugar alcohols (2, 9, 11). Squash plants, as well as several other species, transport stachyose (3, 4, 6, 8–10). The selection of the nonreducing sugar that is translocated by a given species could be under the control of the phloem loading system. Alternatively, the selection might be dependent on which nonreducing sugar is supplied to that system.

Webb and Gorham (8) reported that export from young squash leaves did not start until these leaves started producing stachyose, even though they produced large amounts of sucrose earlier in their development. This suggests that the transport system of squash does not load sucrose. Trip et al. (7) attempted to study the selectivity of the white ash transport system by supplying several 14C-labeled sugar and sugars alcohol to the leaves. They harvested the plants 24 hr after the labeled compounds were introduced. With such a long elapsed time, it is very likely that the patterns they saw resulted from differential rates of metabolism, and from (as they said) "... differential rates of accumulation rather than translocation." In the studies reported here, squash plants were harvested 30 and 60 min after introduction of 14C-sucrose. The results indicate that sucrose is readily transported by squash plants.

**MATERIALS AND METHODS**

**Plant Material.** Seeds of Cucurbita pepo L. var melopepo torticallis Bailey were germinated in vermiculite in the greenhouse. After the seedlings had emerged, they were transferred to modified Meyer's solution (6). When the second true leaf was fully expanded, the plants were transferred from the greenhouse to a hood where 1000 ft-c was supplied by 300-w reflector flood incandescent lamps. The light was filtered through water. The day before the 14C-sucrose was supplied, all leaves greater than one-fifth expanded, except the youngest fully expanded leaf, were removed. This procedure of removing all other transpiration sinks ensured a strong flow through the xylem into the treated leaf, thereby ensuring that the supplied sugar would not be drawn into the petiole by a reverse flow in the xylem. To ensure that these precautions were effective, a preliminary experiment was done using 14C-glucose. The pattern of labeled compounds found in the petiole was similar to that found when sucrose was used. If the sugars had been drawn into the petiole by reverse flow through the xylem, the proportion of the label in glucose should have been very high. This indicates that reverse flow was not occurring.

**Extraction and Purification.** Each petiole section was extracted with 80% ethanol in a microsoxhlet for 24 hr. The extracts were chromatographed on Whatman No. 1 filter paper using a 5:3:2 v/v/v 1-butanol-ethanol-water solvent. The chromatograms were autoradiographed. Each radioactive spot was counted by liquid scintillation. The spots on the film were compared with chromatographic standard side strips.

**RESULTS AND DISCUSSION**

Labeled sucrose was supplied to the plants for times varying from 30 to 60 min. Data from the two extremes are presented in Figures 1 and 2. It is obvious that most of the 14C is accounted for in sucrose and stachyose. In fact, in the three petiole sections adjacent to the stem in the 30-min experiment, all of the extracted 14C is accounted for as sucrose and stachyose. In all other sections, additional label was found in some or all of the following compounds or chromatographic positions on each chromatogram: origin, verbascose, raffinose, hexoses, and three unidentified compounds, one of which migrated between stachyose and raffinose and the other two between raffinose and sucrose.

The percentages indicated for the 60-min experiment are from totals of 4.5 to 6.1 × 105 cpm for each 1-cm section up to 14 cm from the blade. At a greater distance there was a drop to 3.4 × 104 cpm per section. Obviously, this does not include the front of radioactivity. The variability in count is attributed to the fact that the sections were rapidly hand cut with a razor blade, with speed being of prime importance. This variability

---

1 This work was supported in part by Colorado State University Faculty Improvement Committee Grant 867.
should also apply to the 30-min experiment; in spite of that, there was a general decreasing trend in activity within that petiole from $3.4 \times 10^6$ cpm in the 4-cm section adjacent to the blade to $0.5 \times 10^6$ cpm in the section adjacent to the stem.

It is apparent from Figures 1 and 2 that the major portion of the $^{14}$C was in sucrose, and that its proportion increases with increasing distance from the blade. Figure 3 gives a clear picture of the ratio of $^{14}$C-sucrose to $^{14}$C-stachyose with distance from the blade. This is quite different from the results when $^{14}$CO$_2$ was supplied to the blade (6). Under those conditions, 60% to 80% of the $^{14}$C in the petiole was in stachyose and only about 20% in sucrose. In addition, the ratio of stachyose to sucrose did not change with distance when $^{14}$CO$_2$ was supplied to the blade.

It becomes apparent from the data reported here and those previously presented for $^{14}$CO$_2$ labeling (5, 6) that the changing ratios of $^{14}$C in these two compounds (Fig. 3) do not represent metabolic interconversions within the transport system, but rather a history of conditions within the blade. The materials which traveled the greatest distance in the shortest time left the blade first. In the section of the petiole adjacent to the stem in the 30-min experiment, very little $^{14}$C was detected, indicating the "front" of $^{14}$C had just passed. At this point, nearly all of the $^{14}$C was in sucrose, and $^{14}$C was detected in only sucrose and stachyose. In the 60-min experiment, there were only small changes in the ratios of these two compounds, but the trend was the same.

These data indicate that sucrose was loaded into the transport system of these squash plants, and that the changing ratios represent incorporation of $^{14}$C-sucrose into stachyose in the blade, thereby changing the ratios of the $^{14}$C in these sugars available to the phloem loading system. This implies that the phloem loading system is not the point at which the specific sugar is selected for transport, but that the loading system will use whatever nonreducing sugar is supplied to it. Undoubtedly, there are some restrictions on this, yet to be determined. However, we must look elsewhere apparently for the final control determining which sugars are normally transported from leaves.

Acknowledgments—I wish to thank C. Ross, P. Hanchey, and M. Nabors for reviewing the manuscript for this paper.

LITERATURE CITED