CORNELL CHRONICLE
JULY 27, 1989
P. 7
20(38):7
VOL. 20
No. 38

Physiologist's monitor shows how plants store food

A new system that uses computerized radioactive labelling to eavesdrop on plants could reveal how food produced by photosynthesis reaches agriculturally important parts of crops.

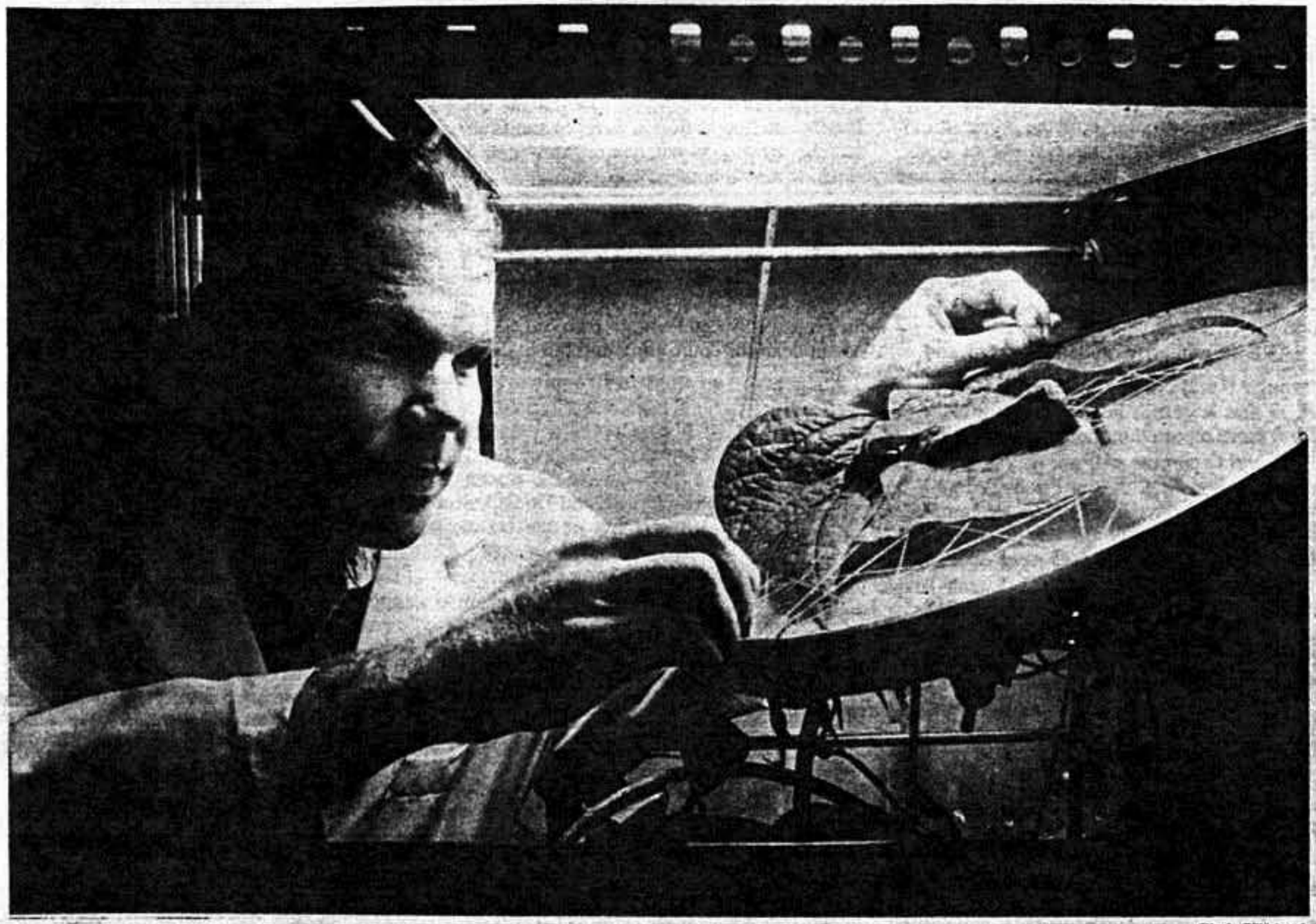
Cornell plant physiologist Erle C. Ellis will describe the system, called "steady-state labelling for photosynthate transport," on Aug. 1 at the Toronto meeting of the American Society of Plant Physiologists.

The technique will not only provide a deeper scientific insight into how plants function, it also could allow plant breeders, agronomists and other agricultural researchers to determine the limiting factors on crop yield, including the effects of pollutants and increased ultraviolet radiation, said Ellis, a graduate student in plant physiology.

Steady-state labelling, as developed by the Cornell plant physiologist, puts plants in a glass and aluminum assimilation chamber where sensing instruments monitor composition of air as well as chemicals in parts of the plant such as the seeds. A computer controls the release of the radioactive tracer element carbon-14 in carbon dioxide and maintains the rate of photosynthesis.

"The effects on plants of the so-called greenhouse effect and the thinning of the ozone layer could also be examined with steady-state labelling."

— Erle Ellis



Chris Hildreth

Plant physiologist Erle Ellis inserts a bean leaf in the assimilation chamber of his steady-state radioactive labeling system.

In the plant leaves, radioactive carbon becomes part of the sugars and amino acids that are transported throughout the plant until they reach storage "sinks" such as seeds and roots. A variety of sampling techniques are used to measure radioactive carbon levels in sink tissues.

The steady-state technique reveals the details of one of the most important processes in the life of plants — the "partitioning" of foods, explained Ellis, who has been studying the process since 1983. "Partitioning is one of the key physiological factors in crop yield. "The higher-yield crops tend to partition more food to the harvested part of the plant. It's not just a matter of larger plants producing higher yields; the higher-yield wheat varieties, in fact, are smaller plants.

"Of course, we can always determine partitioning by chopping up the plant at the end of the growing season," Ellis continued. "But we'd like to know ahead of time where the food is going, how it gets there and where it comes from. With this system we can follow the path of foods to the storage place in plants in 24 hours."

Ellis's latest procedure is an improvement on an earlier plant monitoring technique, pulse labelling. That technique calls for radioactive carbon in carbon dioxide to be manually injected through a plastic bag into the air around a leaf. Steady-state labeling was originally developed by Donald R. Geiger, a biologist at the University of Dayton. The Cornell facility, one of only about a half dozen in the world, features automated photosynthesis measurement and can be easily adapted to a wide range of plant studies.

The Cornell system consists a glass chamber, approximately the size and shape of a medium pizza, which is sealed around one or more leaves on a living plant that is inside a larger, artificially lighted chamber. A computer-controlled mixture of gases is pumped through the inner chamber, surrounding the leaves. Radioactive gases that are not assimilated by the plant are removed for proper disposal.

"The advantage of steady-state labelling is that it lets us observe plant processes moment by moment for several hours at a time," the Cornell scientist said. "We can set up experiments the night before and let the plant adjust to the stresses. And we can use carbon-14 rather than carbon-11, which is very expensive to produce."

Ellis has been using his new system to study the process of "phloem unloading" in kidney beans. Sugars produced in plant leaves travel conduit-like phloem tissue and reach plant seeds in minutes, he noted. "Phloem transport has been very hard to study because it is the most sensitive system in the plant; it will shut down in response to cutting or even touching a stem."

Steady-state labelling may also be used to study the way pollutants in the air and soil affect partitioning, Ellis speculated. "The effects on plants of the so-called greenhouse effect and the thinning of the ozone layer could also be examined with steady-state labelling. We know, for example, that more carbon dioxide in the atmosphere increases photosynthesis — at least over short periods of time. The question now is how plants will adapt to these changes in their environment."

"Ultimately, if we can figure out the physiology of phloem unloading, we may not need radioactive labelling," Ellis said. "We will be able to screen plants for efficient partitioning to the seed and predict which ones will have the highest yields."

— Roger Segelken