Scientist probes light effect on plants

BELTSVILLE, Md. — At precisely 8 a.m., plant physiologist Steven Britz opened the door of the growth chamber, a large metal box somewhat smaller than a walk-in freezer, and switched on the lights.

Then he opened wooden boxes inside the chamber. In the pots inside the boxes, grass grew 14 inches high.

Within an hour, Britz began harvesting Pangola grass, a forage crop grown in warm climates worldwide. This is part of his research work at the Beltsville Research Center of the U.S. Department of Agriculture.

Britz wanted to find out how each grass plant handled the internal distribution of soluble sugars and starch, the food plants manufactured by photosynthesis, using energy from sunlight. To do this, Britz measured the size of each plant's leaves and then the amount of starch stored in each leaf.

A plant stores some of the products of photosynthesis as starch in the leaves and moves some, as sugar, into other parts of the plant. Britz knew that the length of daylight controls the amount of starch stored in leaves — in other words, that starch storage is photoperiodic. Many changes in plants, such as flowering, are controlled by the length of daylight.

But the USDA Agricultural Research Service scientist wanted to know:

"Is there a particular day length that affects the plant's starch-storage machinery?"

Britz had chosen to seek the answer in Pangola grass because that plant has the same rate of photosynthesis no matter what the day length. The amount of starch which is stored in leaves, however, would depend on the length of the previous day.

The scientist had exposed several pots of the grass to seven hours of light the previous day, some to 16 hours, and others to varying times in between.

Now, as the time came to harvest the grass and measure its starch content, he removed the first potted plant and placed it on a table. It was 9:03 a.m. Carefully, he selected just the youngest mature leaves, then picked them off by hand and piled them neatly beside a small box which measured the exact surface area of each leaf.

"I'm sorry, but I won't be talking for awhile," Britz interrupted his concentration to explain. "In experiments, there usually are concentrated bursts of activity like this."

As two research assistants fed the individual leaves past a photoelectric cell in the measuring device, a digital dial on the box blinked out the informaiton that the first plant's leaf surface totaled 215.19 square centimeters. Another registered 242.24 square centimeters, still another 163.69.

Seldom have grass clippings been handled with such care. None it seemed, could be mislaid before or after their measurement and storage in a nearby container of liquid nitrogen. A few days after the harvest and freezing, the starch content of the leaves would be determined.

Perhaps realizing that such are with grass clippings might seem unreasonable to an observer, Britz said: "If there is one thing that makes me unhappy, it is fuzzy data — numbers that don't provide a clear cut result."

By 10:24 a.m., half of the grass had been picked, measured and frozen. The other half would be harvested in the afternoon, beginning precisely at 2 p.m. Britz then could calculate the rate of starch storage in its leaves for the intervening five hours.

For now, there was time for Britz to take a coffee break and discuss his career.

Curiosity about the effect of light on plants had burned inside him for more than half of his 32 years. Striving to find nuggets or truth about the relationship of light to plants began for the scientist with a high school science experiment in Cherry Hill, N.J.

"After that," he recalled, "I considered medical research, but plants held my interest. Their dependence on light and the many different ways they react to light fascinated me."

The plant kingdom unfolded many of its secrets to him.

Plants, as Britz came to know them, are not simply room ornaments or something to eat but are complicated organisms with electrons shuttling back and forth between molecules; enzymes digesting some compounds and creating others, and live "plumbing" which carries plant food manufactured in the leaves to all parts of the plant, such as roots and seeds. They are organisms of boundless complexity and challenge.

Back in his office, Britz was pleased to find a letter from friends in Germany, where he had studied for a year. Also, he put aside some newly arrived scientific journals for browsing later.

"Keeping up on experimentation around the world is an important part of the job," he said. Later that day, he would be briefing a Japanese colleague on his experiments.

Before beginning another experiment that day, the sixth he would be conducting simultaneously, Britz explained his current goals.

"I want to know more about partitioning, that is, how plants decide where to send the products of photosynthesis," he said.

Such curiosity, he believes, will benefit people in the years ahead as he and other plant investigators uncover important secrets of nature which will lead to more and better food.

Extensive experiments in partitioning in potatoes were conducted at the University of Wisconsin, where a famous type of laboratory called a biotron provides a controlled environment for experiments for both plants and animals. In North Carolina, phytotrons (a "biotron" for plants only) provide controlled environments for other experiments, such as the effect of variable light periods and temperatures on potatoes. The phytotrons are located at North Carolina State University and Duke University.

If a food producer knew the secrets of partitioning, Britz believes, he or she could cultivate plants in such a way, say, that ears of corn would become bigger, or cassava roots (a major source of good in developing countries) would grow larger, or forage grasses such as Pangola grass would grow more nutritious leaves.

A half million acres of Pangola grass are grown in the southeastern United States alone. Anything that improves Pangola grass could affect beef supplies worldwide.

In other words, the energy of the sun and the seemingly endless raw materials of ordinary air could be targeted to those parts of plants which humanity finds most useful.

Already, Britz has found that if day length is increased by two hours, the storage of starch in leaves is reduced by one-half.

"The more starch plants retain in the leaves, the less there is to transport to other parts of the plant," said Britz. "That may be beneficial in a crop where the leaves are eaten but disadvantageous in a crop where some other part is harvested."

Britz wants to find those parts of the plant — those photoereceptors — which act as switches in the partitioning process under the influence of light and darkness. Light, as we generally see it, is a combination of colors ranging from red to violet. Each kind of photoreceptor in a plant responds to a particular color of light.

"Knowing which colors of light activate which processes, such as starch storage, helps us understand the chemical make-up of receptors and how they work," said Britz as he turned to a separate experiment on the effect of light on pea plants.

Once again, as the interviewer left, Britz was absorbed in his world of plants and light.