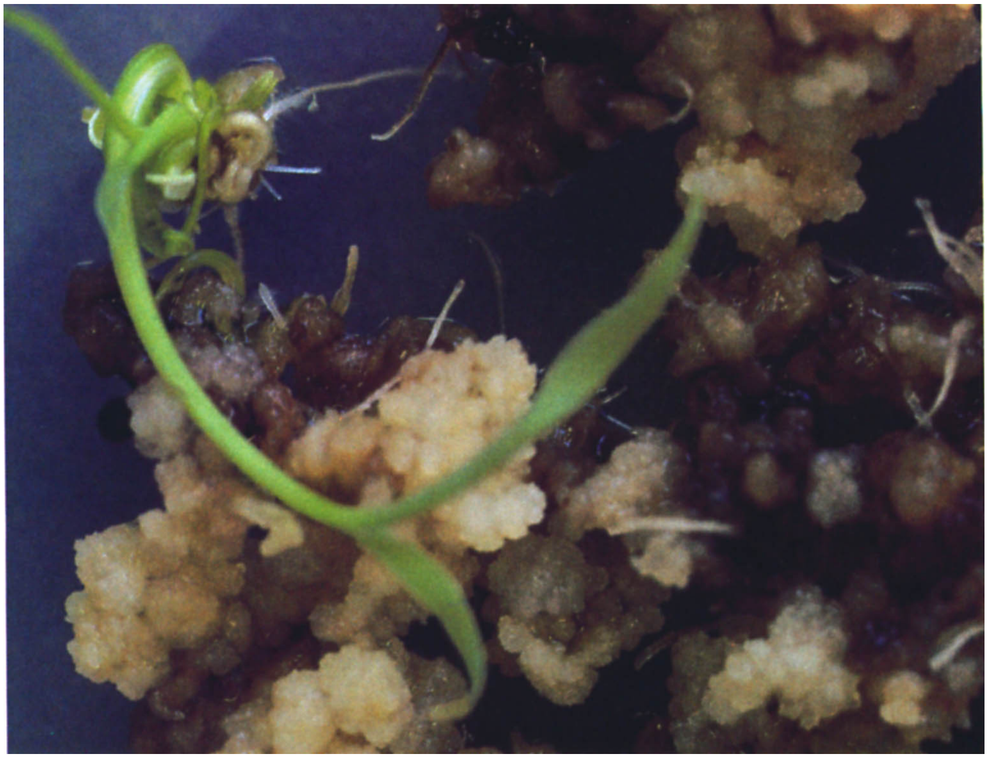


Cell culture techniques are utilized to measure energy expended by plants to adjust to salt stress. Here, leaves and roots have formed on plantlets of rice generated from callus tissue growing on a salinized culture medium.

Metabolic energy cost for plant cells exposed to salinity

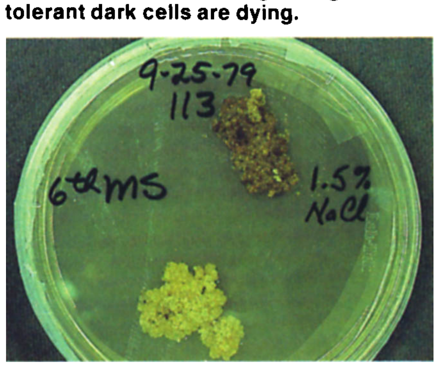
D. William Rains

A biological system under stress probably uses more energy than the same system in the absence of stress. When a plant is exposed to high levels of salt, extra metabolic energy is likely to be consumed in processes related to osmotic adjustment within the cells. Without this adjustment, the plant would lose water to the surrounding saline environment, dehydrate, and die.

Consuming energy to adjust osmotically to salt stress could reduce the energy available for growth and thus influence productivity. To researchers developing plants tolerant to salinity, a basic question is whether a plant grown under salt stress will be inherently less productive than one grown without stress. If the answer is yes, then growing plants under saline stress may not provide optimum economic yield or use of resources.

Cell culture techniques provide a means of directly evaluating the amount of metabolic energy expended by a plant exposed to salt stress. In the laboratory at UC Davis, we have selected a salt-tolerant alfalfa cell line by these techniques (*California Agriculture*, August 1982). The energy consumption of this cell line can be compared with that of a nontolerant line when the two are exposed to salt stress. Alfalfa cells grown in culture are supplied with all of their mineral nutrient requirements, plus sugars as a source of energy. By determining the amount of sugar consumed during the production of a certain weight of plant cells, we can calculate the energy efficiency of the system. Efficiency is expressed as follows:

Subjected to increasing salinity, rice plant cells selected for salt tolerance (white clumps) are healthy and growing. Nontolerant dark cells are dying.



$$\%\ \text{energy efficiency} = \frac{\text{increase in dry weight of plant cells}}{\text{1 unit weight of sugar consumed}} \times 100$$

Plants usually have energy efficiencies of 0.3 to 0.4, or if expressed as a percentage, 30 to 40 percent. That is, they convert 30 to 40 percent of the sugar energy to living tissue.

In a test of energy efficiency, a salt-tolerant and a nontolerant line of alfalfa cells in culture media were subjected to increasing salinity levels. As the salt level went from 0 to 0.50 to 1.00 percent weight/volume, the tolerant cells continued to convert glucose to dry matter at 30 percent energy efficiency, and their growth was not suppressed significantly. In contrast, the nontolerant cells progressively dropped in energy conversion efficiency from 30 to 18 to 0 percent (cells dead) as the salt level rose, with a parallel decrease in growth.

These observations suggest that a plant with a greater efficiency in converting energy to biomass when exposed to stress not only survives but can be productive and maintain greater yields. This productivity must be accomplished along with the diversion of energy to processes required in adjusting to salt stress. The less efficient plant, while allocating energy to processes related to tolerance of a saline environment, may become energy deficient and unable to maintain productivity. At higher salt levels, the plant may die.

Some plants apparently have the potential to adapt to stress by maintaining biological efficiency and reasonable productivity. The next step is to develop techniques at the whole-plant level that will permit evaluation of the relationship between salt tolerance, metabolic energy efficiency, and productivity.

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