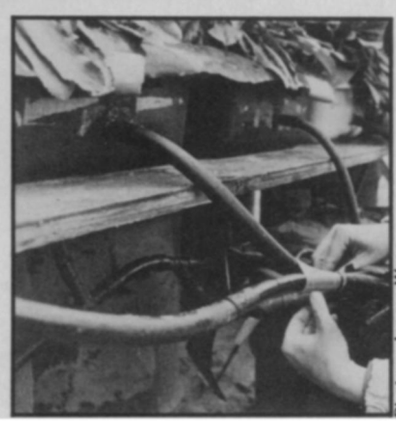
Growing Plants With Seawater

A geneticist is trying to develop plants that can be irrigated with salt water

by Sheila Moramarco



Radlow with plant grown in 100 percent seawater and (left) seedlings in 10 percent seawater. Right, checking the irrigation system.

Photos: Jenny Wren

Imagine a world overpopulated, overpolluted and underfed. According to population experts Joseph L. Fisher and Neal Potter, the population of the world will be about 110 percent larger in the year 2000 than it was in 1960. It will take about a 320 percent increase in food output to feed the seven billion human beings who will populate the earth by the end of the 20th century. Where can we begin to look for a solution to the food crisis which is already an intimate fact of life for "between 1 and 2 billion malnourished or undernourished" inhabitants of the earth (SN: 5/11/74, p. 306)?

Anne Radlow, a plant geneticist at the Scripps Institution of Oceanography in La Jolla, Calif., is working on a series of experiments designed to create new crops that can be irrigated with seawater so that some of the estimated 12 million acres of land in the world not now usable for agriculture may be made arable. Her work is funded by the Foundation for Ocean Research.

If Radlow succeeds in isolating the pair of genes responsible for creating salt tolerance (the ability of plants to germinate, grow, reproduce and fruit in solutions of seawater) in plants, she and other scientists will then be able to develop a greater variety of plants that can thrive under varying degrees of salt stress. Once she is successful in locating the controlling genes, she then will be able to alter the genetic makeup of plants in order to render them salt tolerant.

The first step in Radlow's project involves the collection and study of halophytes (plants that grow in saline conditions). At present, she is working with wild plants that grow only in the salt marshes of California. Although these plants are tolerant, they have, in themselves, no crop value. After all of these plants are collected, the ultimate goal is to cross them with close relatives that grow in nonsaline habitats to see if salt tolerance can be transferred. This process of crossing plants is very lengthy, as generations and generations of plants are involved in order to observe this expression of salt tolerance from parent plants to their progeny. A plant is considered salt tolerant only if it can germinate, grow and fruit in saline solutions.

Such observations can provide information as to whether the row of ploidy (number of chromosomes) or simple Mendelian laws of inheritance (numbers of genes) is the underlying system for the expression of salt tolerance. Only in wild plant material whose genetic constitution has not been tampered with through decades of plant breeding can the full expression of plants' responses to salt stress be seen. Knowledge based on these observations would then be applied to various crops

One step: Crossing a salt-sensitive Grindelia flower with a salt-tolerant one.

with food value whose genetic constitutions have been constantly rearranged throughout the course of domestication of that crop.

Radlow begins her genetic experiments with two wild populations, one of which she knows is tolerant because it is found growing in a salt marsh. The second population will be gathered from an area such as a flood plain or vernal pool in which salinities are known to be quite low. Tolerance is represented genetically by TT; sensitivity by tt. The geneticist then makes two different types of crosses. In the first case, the homozygous plants TT and tt are crossed, producing an F_1 population with the heterozygous composition of Tt. At that point, she performs two additional kinds of cross, creating an F_2 population. In *selfing*, a cross is made between Tt and Tt, producing offspring, if one pair of genes is involved, in a ratio of three tolerant plants to one sensitive plant—indicating that tolerance to salt is dominant in expression over salt sensitiveness. Next the geneticist conducts a *back cross* of the F_1 plants to the sensitive parent (Tt x tt). If the progeny of this cross are found to be in a 2:1 ratio of tolerant plants to sensitive plants, it can be assumed that tolerance is controlled by one gene as well as being dominant to sensitiveness.

What do salt tolerant plants look like and how do they differ from sensitive plants? To determine these differences, Radlow has germinated 10,000 seeds in different concentrations of salt and observed their physical characteristics such as height (growth), number of flowers and buds, and number of seeds produced by the plants as they grow in the seawater. She also measures their physiological characteristics—amounts of chloride and sodium taken up by plant tissues. "If we find statistically significant differences between the tolerant and sensitive plants in any of the above characteristics, and can trace this difference through the series of crosses—i.e., chloride uptake varies in a 2 : 1 ratio in a back cross—we would then assume that this aspect of salt tolerance is controlled genetically by one pair of genes," says Radlow. "If the results of the back cross support the results (ratio) of the selfing of the F_1, then we feel doubly assured that we have delineated a one-gene effect."

Success in isolating the genes for salt tolerance will be of immense importance to Israel, India and other countries of similar climate and topography. In an age of exploding world population, work such as Anne Radlow's may eventually provide at least a partial answer to the planet's ever-increasing need for food. □