Using Arid Lands

A. FERTIG

Dr. James R. Simpson, grad student Margaret Livingston and Dr. Greg McPherson.

Xeriscape or Zeroscape

Keeping a single, water-guzzling tree alive during the summer in Southern Arizona can cost three dollars a week, so some homeowners have begun simplifying their landscaping. Some have carried water conservation to the extreme with zeroscapes, which eliminate nearly all plants around homes; in the process they increase air conditioning costs. Our research compared two kinds of water-conserving landscapes with a high water-use landscape to determine their relative contributions to cooling energy efficiency.

To measure the cooling and water impacts of different landscapes, we built three identical one-quarter scale houses using conventional building practices and cooled them with room air conditioners. Each house was surrounded by landscape: a seeded bermudagrass lawn, a xeriscape using three- to five-foot shrubs and a two-inch layer of decomposed granite around the house, and a zeroscape using a two-inch layer of granite with no vegetation.

The grass was watered nightly with an automatic sprinkler system and the shrubs were drip irrigated each day. Air conditioner electricity use and water consumption were measured for each house in late summer, when temperatures exceeded the mid-nineties.

Not surprisingly, the model with the zeroscape used the most air conditioning energy, but the difference was unexpectedly large: 20 to 30 percent more than the houses with turf or shrubs. The others had similar cooling loads, but for different reasons. The shrubs cooled by shading and the turf by evapotranspiration, which lowered air temperatures around the house.

The granitescape used no water. Based on a normal application rate, the shrubs grew on about 23 gallons per day while the turf needed about 340 gallons per day during the study period. The water costs of turf outweighed their cooling benefits, but the addition of shrubs to a granitescape increased projected water costs by less than a dollar. The cost was more than offset by the $1.62 savings in air conditioning. The measured energy savings seem small because the models were small; the savings for a real house would be many times larger.

Landscaping can affect cooling costs by as much as 30 percent without using large amounts of water. Adding low-water-use trees and shrubs to shade the east and west sides of a house presently surrounded by zeroscape and installing an efficient drip irrigation system can achieve a net savings of over $150 a year. Because older homes with less insulation heat up more in the summer than well- insulated houses, xeriscapes surrounding them may result in greater savings since the resulting cooling effects of vegetation will be more significant.

E. Gregory McPherson, Ph.D.
Landscape Architecture Program
James R. Simpson, Ph.D.
Soil and Water Science

About one third of the world's total land area has been designated as semiarid or arid.

Directory of Research Institutions

An indispensable reference about arid lands research became available last August. The greatly expanded third edition of *Arid Lands Research Institutions, A World Directory,* produced by the University of Arizona's Office of Arid Lands Studies and published by the Allerton Press in New York, is a reference source about the institutions and arid lands research projects underway around the world.

The latest 290-page edition lists nearly twice as many entries as its predecessors (1967 and 1977 from the University of Arizona Press). The new book is the result of a survey of six hundred leading institutions worldwide that are concerned with the diverse scientific, technical, socioeconomic, and interdiscplinary areas of research that are vital to understanding, managing, and reclaiming the world's arid and semiarid lands.

The new version lists 278 major institutions in sixty-four countries that are actively involved in arid lands research. Almost twice as many countries are represented as were in the 1977 edition, and over one hundred entries are provided for the first time. Each entry includes a description of the institution's scope of interest, its research program, internal organization, facilities, publications, and history. There is a twelve-page index of institutions and a four-page subject index.

Linda Smith
Arid Lands Studies

Desertification Bibliography

Desertification is the process by which productive land is degraded and becomes desert. Desertification is linked today to such areas of concern as drought forecasting and famine early warning systems, both of which are related to global climatic change. Desertification is accelerated by drought, overpopulation, and poor land management. The UA Office of Arid Lands Studies provides worldwide information services through its Arid Lands Information Center. Its mission includes helping arid lands scientists and research institutions exchange information about desertification.

In 1988 3,500 references on desertification were compiled into a single work entitled the *World Desertification Bibliography.* Funded and published by the United Nations Environment Programme, the publication will be distributed by the United Nations Sales Section.

The bibliography cumulates and updates previous bibliographies: *Desertification: A World Bibliography* (1976), and *Desertification: World Bibliography Update 1976–1980,* (1980). Fifteen-hundred new references have been added. Citations are listed on such topics as remote sensing, sand stabilization, reclamation, and reforestation. The information represents research conducted by scientists throughout the world.

Carla Casler, M.L.S.
Arid Lands Studies

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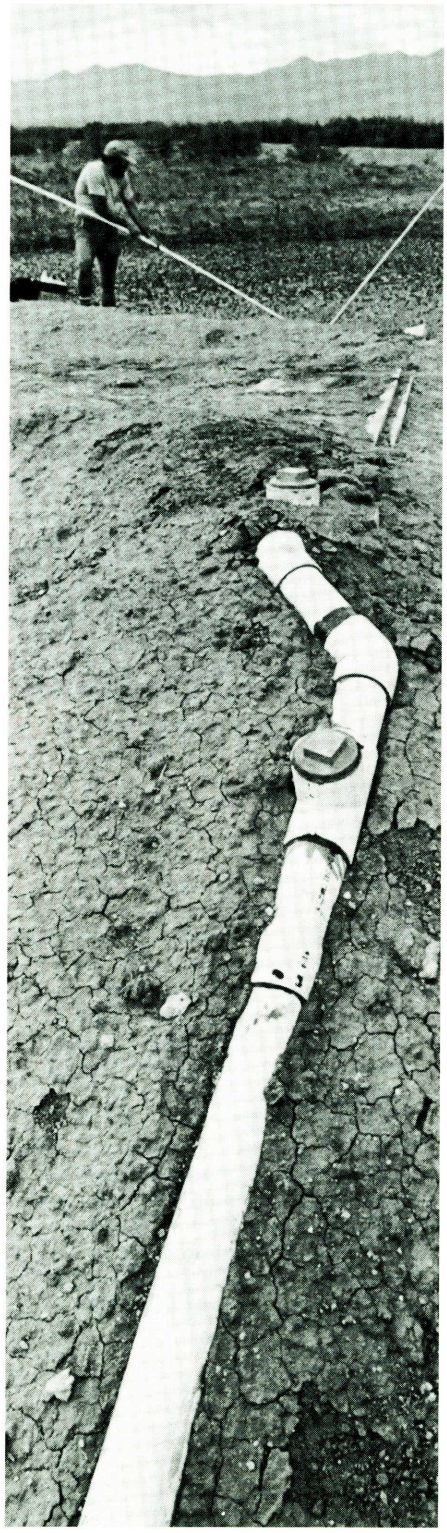

I.G. KETCHUM

Plant Genes That Respond to Salinity

Plants face many environmental stresses that ultimately limit their distribution and, in crop plants, determine productivity. One such stress, high salinity of groundwater or surface water used for irrigation, is rapidly becoming a major problem for agriculture. Farmers and a growing urban population are in competition for water with low levels of salt. In addition, a still-increasing world population requires that marginal lands and water resources be developed. One modifier on the demand for low-salt water is the development of alternative or adapted crops that perform well under conditions of drought and high salinity.

We have been able to use the common ice plant and salt grass to correlate physiological and biochemical adaptations to the stress of salinity. Several biochemical pathways, notably those of carbon metabolism and amino acid biosynthesis, undergo change. We have isolated several genes, some that code for proteins involved in those biochemical pathways. Some gene activity is regulated by the stresses of high salt and drought, either related to the passage of time or due to a tissue-reaction.

Our results will aid in understanding why some plants can tolerate salt and drought. We will attempt to transfer into crop plants the biochemical competence that will allow them to deal with such stresses better than the presently used varieties. Gene transfer experiments utilizing some of the isolated genes and their control regions are underway.

Hans J. Bohnert, Ph.D.
Biochemistry

Drip irrigation systems are used to facilitate salinity research as well as to irrigate crops in the desert.

Salt-tolerant Plants of the World

The use of salt-tolerant plants, or halophytes, may become the most feasible approach to crop production under saline conditions near the sea and inland in salt-affected regions.

HALOPH: *A Data Base of Salt Tolerant Plants of the World*, is an information source for people interested in growing halophytes. A computerized listing that focuses on the economic uses of the plants, it contains more than 1,560 species in 550 genera and 117 families. ***HALOPH*** is organized alphabetically by botanical family; within each family, listings are by genus and species. Categories include: life form, plant type (which refers to the primary habitat in which a family or order is normally found in nature), geographic distribution, maximum reported salinity tolerance, photosynthetic pathway, economic uses, and pertinent references. Its index lists plants alphabetically by family, genus, and species.

Compiled and edited by James A. Aronson, of the Rudolf and Rhoda Boyko Institute for Agriculture and Applied Biology at the Ben Gurion University of the Negev, Israel, and published by the UA Office of Arid Lands Studies, ***HALOPH*** is the most extensive reference listing of halophytic plants available to date. The publication directs readers to the plants most relevant to their particular problems and indicates at least a starting place in the available literature.

Emily Whitehead
Arid Lands Studies

Increasing Salt Tolerance

Achieving genetic improvement in the salt tolerance of major arid-region crops using traditional plant breeding methods could take decades because the number of available breeders is small and traits must be selected in each crop separately. If genes that confer salt tolerance were to be identified and isolated, progress could occur more rapidly using recombinant DNA technology.

We are investigating how plants accumulate amino acids in response to a broad range of environmental stresses, including salt stress. We use the plant *Arabidopsis thaliana*, which is easily grown in the laboratory and has a relatively simple genetic structure. With some specimens we are altering the plants' specific amino acid content by externally supplying an amino acid. With others we are using a more complicated approach—selecting for a genetic mutation that affects how the plants form specific amino acids. The salt tolerance of both groups of plants is then assessed.

We have determined that *Arabidopsis* seeds treated with the amino acids proline and asparagine are more salt tolerant during seedling establishment than are untreated seeds. We have also isolated mutants in *Arabidopsis* that contain more proline than normal due, we believe, to a single gene mutation. A few of those mutants are also significantly more salt tolerant than normal. Currently we are working to isolate and characterize the gene responsible for the increased salt tolerance. Such a gene would be of great value if it confers increased salt tolerance in plants other than *Arabidopsis*.

Fredric R. Lehle, Ph.D.
Plant Sciences

New Germination of Salt-tolerant Alfalfa

Throughout the world excessive salinity represents one of the most serious factors limiting crops produced using irrigation. Crops with the ability to remain productive under saline conditions would complement soil and water management programs implemented to address the problem.

Using a straightforward plant breeding strategy, our research team has developed what may be the most salt-tolerant alfalfa in the world. Over the past ten years we have focused on the identification of individual alfalfa plants that could germinate at extremely high salt concentrations. When our work began in 1978, only 2 percent of the seeds of Mesa-Sirsa, a popular Arizona alfalfa variety, could germinate at salt concentrations close to half that of sea water. We cross-bred the hardiest selections each year for the next ten years, each time at higher levels of salinity. Now nearly 90 percent of our seeds can germinate at the level of salinity that only 2 percent of Mesa-Sirsa formerly germinated. Our work has led to the public release of an improved population (named 'AZ-GERM-SALT-II') for use in further research and breeding.

Now we are applying our findings from our early research on salt tolerance at germination to improvement of salt tolerance in alfalfa at all stages of growth; we are hoping for an improved population within the next five years. Our research also provides much information about the basic physiological and genetic mechanisms controlling salinity tolerance in plants and about the most efficient plant breeding strategies that might be used to improve that desirable characteristic.

Albert K. Dobrenz, Ph.D. and Steven E. Smith, Ph.D.
Plant Sciences

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