Water Currents

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Dear Reader:

Since this issue marks two full years of publication for **Water Currents** we would like for you to tell us how we are doing.

Have we interested you in new areas of water research?

Have our cover photographs caught your attention?

Have we given you the information you need to make decisions on water issues facing Texas now and in the future?

Have we chosen topics of importance to you?

Past issues have reported water-related research conducted by the Texas Water Resources institute and The Texas Agricultural Experiment Station on drought preparedness, plant improvement, urban lawn water conservation, stream quality, aquaculture, groundwater, and rice water management. This issue of **Water Currents** presents research on salt tolerance and on management practices to alleviate salt impacts in agriculture.

We are honored to have you as a reader. Please take a couple of minutes to fill out and mail one of the enclosed survey cards. Leave the second card for another reader if you share your copy of **Water Currents.**

Your answers are very important to us. They will help us plan future issues of the publication as well as help us update our mailing list.

Lou Ellen Ruesink
Editor
Water Currents

Water Currents reports quarterly on water research conducted by the Texas Water Resources institute, Wayne R. Jordan, director, and The Texas Agricultural Experiment Station, Neville P. Clarke, director.

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In Spite of Salt

Farming in low rainfall areas even when fresh water is available for irrigation challenges the best of agricultural producers. But raising an economic crop when only saline water is available - now that is a real art.

Salinity is one of agriculture's most complex production problems. Excessive salts from irrigation water or high water tables can severely limit crop production. Years of saline water irrigation on poorly drained soils can eventually make economic crop production impossible.

Researchers associated with The Texas Agricultural Experiment Station (TAES) say salt problems do indeed reduce both agricultural yields and cultivated acreage in the state. They estimate that salt limits production on at least one-half million acres of irrigated land in Texas.

By far the largest number of acres where saline soils and water limit production are in the Trans Pecos Region. TAES researchers say that 30 years of irrigation with saline water affects most of the 250,000 acres in the Trans Pecos. Rainfall in the area is too low to move the salt through the soil profile.

Salt problems also limit production in the Rio Grande Valley. A large number of acres there - about 150,000 - suffer from saline groundwater rising into the root zone. Other major salt-related problem areas in the state are in North Central Texas, the El Paso area, and some parts of the Gulf Coast.

Texans can blame nature for most of their saline water. Water, a solvent, dissolves the salts and minerals from rocks and soils with which it comes in contact. Naturally occurring salinity in surface waters is particularly severe in the upper reaches of the Red, Colorado, Brazos, and Pecos river basins. Natural pollution of primarily sodium chloride (table salt) comes from salt springs and salt flats in the drainage areas of these rivers.

Groundwater also picks up salt from soils and rocks; and saline groundwater underlies millions of acres of the state. Salt related problems have increased in recent years in Texas due to the following:

- Oil and gas exploration and production activities have worsened natural pollution in some areas of the state.
- Overpumping of aquifers in coastal areas has allowed saltwater encroachment into once freshwater aquifers.
- Irrigation has exhausted freshwater supplies in many areas, leaving only saline water.

- Years of irrigating with saline water have left accumulated salts in the soil profile.
- Saline groundwater, often increased by irrigation, rises into root zones in some areas.

The Texas Agricultural Experiment Station has conducted research for many years to help Texas irrigators make the most of whatever quality water is available to them. The following projects are examples of research to alleviate harmful effects of irrigating with saline water.

TRANS PECOS

TAES researcher Jaroy Moore currently studies traditional Trans Pecos irrigation methods to find ways to reduce saline water's impact on the soil. Moore, the superintendent of the TAES research station near Pecos, says that with only 10 inches annual rainfall, farmers there must irrigate to produce a crop. The only water available to most of them, he explains, is groundwater containing salts.

The traditional method of irrigating around Pecos is to flood water down each furrow. The method, according to Moore, is labor intensive, distributes water unevenly through the field, and on most farms requires a tailwater recovery system to recycle water flowing out the end of the furrows.

Mechanical systems such as center pivot sprinkler systems offer labor savings and control of application rates, but require additional energy, lose more water to evaporation, and cause foliar burn when plants are young or exceptionally sensitive to salts.

Many wells in the Trans Pecos area would be classified as too saline for sprinkler irrigation, says Moore, but he has developed methods which alleviate some of the negative impacts of sprinkler irrigation with saline water. For instance, he found that sprinkler irrigation of saline water is less harmful at night when less evaporation means less salt concentration. By using good salt management techniques, he says, cotton can be grown under sprinkler irrigation with saline water.

For several years Moore has evaluated applying saline water with an overhead sprinkler system. He generally uses a typical saline water for the area of 2,500 ppm (parts of salt per one million parts of water) on cotton in the TAES research fields. Surprisingly, Moore also grows cotton with water containing salt as high as 6,000 ppm in the TAES research fields.

He applies this water with a center pivot system modified to apply water near ground level at pressures of less than 10 pounds per square inch. The modified center pivot, designed by TAES researcher Bill Lyle, applies water below the leaf canopy so salt damage to leaves is not the problem it is with other sprinkler systems.

Moore tests the soil in the research fields at least three times a year and analyzes salt buildup in the soil down to four feet below the surface.

MIDDLE RIO GRANDE REGION

Seiichi Miyamoto, a soil and water scientist stationed at the TAES research center at El Paso, evaluates potential remedies for salinity problems in pecan orchards.

During the past twenty years, says Miyamoto, increasing numbers of acres in the Middle Rio Grande Basin have been developed into pecan orchards. In the El Paso area, for instance, pecans have surpassed the traditional cotton crop in cash value.

Many of the pecan orchards were planted with little regard for the large water requirements or the salt buildup.

An orchard with mature trees needs nearly twice the irrigation water of a cotton field, according to Miyamoto. Large trees consume a great deal more water than small trees; consequently, salt accumulation becomes a greater problem as trees mature and consume more water.

In 1981, Miyamoto purposely salted a portion of an orchard of 10-year-old pecan trees. He used local well water containing 3,000 parts per million of dissolved salts. During the first year, he found no significant differences between trees in the salted area and those in other parts of the orchard. But in the second year after he applied the saline well water, the TAES researcher found the growth rates of trunks, shoots, and leaf areas declined by about 20 percent from those in the unsalted area of the orchard. He also observed that the trees in the salted area showed earlier browning and defoliation in the fall. Miyamoto expects further slow-down of the trees in the salted area of the orchard in subsequent years.

In another salt-related project, the TAES researcher evaluated management procedures for minimizing salt accumulation in pecan orchards. He found measures such as land leveling, irrigation borders set according to soil type, and improved irrigation scheduling to be effective in reducing salt accumulation. Improved irrigation practices, he says, will greatly reduce the salinity hazard in pecan orchards.

As part of his TAES research, Miyamoto also developed a model for scheduling pecan orchard irrigation with microcomputers. The model takes into consideration environmental factors such as weather and soil in the orchard as well as crop data such as tree trunk diameter and planting density.

Miyamoto tested the model on 640 acres in two commercial pecan orchards in the Middle Rio Grande Basin and found that it can help orchard managers determine the water needs of the trees. The model can also predict the amount of water needed to alleviate salt buildup in the soil.

WICHITA VALLEY

A project conducted by Cleveland Gerard, soil physicist with the TAES Chillicothe-Vernon research center, provides another example of TAES research to alleviate salt impacts on agricultural production. He studied the effects of different amounts of saline water and different application methods of irrigation with saline water on the production of sweet corn.

Farmers in the Wichita Valley have irrigated their crops with highly saline water - 2,000 to 4,000 parts salt per million parts water - for over 50 years. They know that their crops depend upon the rainfall, the soil, and the quality of irrigation water as well as their management techniques. Even though the area averages 29.5 inches of annual rainfall, there is not enough rainfall every year to adequately leach the salt from the root zone.

Gerard designed his research to determine if the amount of saline water applied affected either the crop response or the amount of salt remaining in the root zone. Using a drip irrigation system, he applied saline irrigation water through a hose stretched on the ground between rows of corn. The hose had emitters spaced at two-foot intervals. Gerard evaluated soil salinity and its effect on growth, ear size, and total yields in 12 test plots of sweet corn grown in the Wichita Valley west of Wichita Falls.

He concluded that applying saline water with drip irrigation would require periodic leaching to alleviate salt buildup in the soil. Leaching means washing the salt down through the soil past the root zone and is the only way to remove salt in the root zone. Rainfall leaches well-drained soils in areas with adequate precipitation, but extra water applied with every irrigation or heavy irrigation applied before planting is often needed to move salt down below the root zone.

Reclamation of salted fields involves modifying them in some way so that effective leaching can take place. Different types of reclamation include soil modification to increase infiltration, mechanical movement of soils such as chiseling or deep plowing, and installation of tile drains below the root zone to carry away water and salt.

Gerard's research, and the research projects conducted by Moore and Miyamoto, are but a few of the many efforts of TAES researchers to alleviate - maybe even eliminate - some of the salt problems which plague Texas crop producers.

TAES research identifying irrigation practices and other management techniques to reduce salt effects could mean that Texas producers could again grow crops on now fallow fields or on land considered marginal for crop production.

Selecting for Salt Tolerance

Researchers with The Texas Agricultural Experiment Station (TAES) have found that plant species vary tremendously in their ability to tolerate saline conditions. "Why is it," they ask, "that some plants thrive in salt water while others suffer from even a slight amount of salt in the soil or water?"

While their research environments and plant materials differ, these TAES scientists share a common research objective. Each scientist tests plant response to varying concentrations of salt in irrigation water.

Their research is part of a major TAES research emphasis to identify and breed varieties of plants able to tolerate the salt found in so much of Texas' water and soil.

The mechanisms and factors involved in salt tolerance are many and are not yet well understood. But salt tolerant characteristics appear to be related to either one or both of two conditions: (1) the ability of the plant to restrict the entrance of salts into its roots or (2) the ability to tolerate or adjust to salts after they are taken in by the plant.

The effects of salts on plants generally show in both rate of growth and in total plant size. Excess salinity also shows up in spotty or skippy stands because plants generally are more susceptible to salt damage during seed germination and seedling establishment. Another visible symptom of salinity is a lack of response to applied fertilizers. Since most inorganic nitrogen and potassium fertilizers are soluble salts, the application of fertilizers often adds to the problem of excess salts more than it benefits the plant. Some organic fertilizers such as fresh manure also contain soluble salts which aggravate a salinity situation.

TAES research will continue to ask questions related to salt limiting agricultural production and urban plant growth. And if current projects are any indication, TAES researchers will continue to answer those questions concerning the plant varieties and management techniques to best use whatever water and land is available.

Jaroy Moore carefully watches cotton plants in nine 12-foot square test plots at the TAES research station west of Pecos.

Moore's test cotton plots receive three concentrations of salt water. All three are from wells on the research center. The concentration ranges from 1,200 ppm (parts of salt per one million parts of water) to 6,000 ppm. The lower concentration is commonly considered a good enough quality for drinking water in West Texas, whereas the 6,000 ppm water is generally considered too concentrated for even the most salt tolerant crops.

Moore has found differences in establishment and yield among the four varieties of cotton tested in each plot. A casual observer, in fact, can see differences between cotton varieties in the different plots irrigated with different amounts of salt. The obvious differences are the number of plants which have survived, the size of the plants, and the amount of cotton on the plants. Moore explains that a difference he has found is in how close the branches of a cotton plant grow on the stalk. Saline water tends to cause cotton plants to grow shorter and more compact.

Moore works with TAES research associate John Schoenemann at Pecos and with TAES cotton breeder John Gannaway at Lubbock.

Leonard Pike grows cucumber plants in stainless steel containers resembling those used in cafeteria steam tables. He conducts his research in a building out in the TAMU research fields.

Pike and two graduate students in the TAMU Department of Horticultural Sciences have screened over 600 genotypes of cucumbers to find strains more resistant to salt than varieties now available commercially. They have also developed methods to better identify these salt tolerant strains.

Cucumber plants susceptible to salt grow visibly smaller leaves as they are watered with high concentrations of salts. Leaves of the more tolerant types do not show a size difference as they are irrigated with increasingly higher concentrations of salt.

Pike has found significant differences in the varieties' responses to the amount of salt in irrigation water. He feels that his research methods will allow plant breeders to more efficiently select for salt tolerance of many types of plants in their breeding programs. Eventually this could mean vegetable production on land now considered too salty or in areas where water available for irrigation is considered too salty for vegetables.

Stephen Kresovich weighs tiny pieces of sugarcane and sorghum leaves as they grow in test tubes at the TAES research laboratory in Weslaco.

Keith McCree places sorghum plants, pot and all, in a glass box where a computer monitors the amount of carbon dioxide entering and exiting the carefully controlled environment. His lab is on the third floor of a modern research building on the new West Campus of Texas A&M University (TAMU).

McCree and Kresovich seek answers to the basic question of why some plants adapt to saline water while others wither and die.

McCree measures the amount of carbon dioxide emitted by a plant's respiratory system, to determine "how hard" the plant is working. In other words, McCree can measure how many calories a plant burns at a given time by measuring the carbon dioxide emitted by the plant.

Currently, he compares the carbon dioxide lost daily by sorghum plants as they are subjected to various levels of salt. When a plant copes with salt, says McCree, it uses energy which could be channeled toward growth and reproduction.

Stephen Kresovich, a former student of McCree's and now a scientist with the TAES research center in Weslaco, also studies the cellular mechanisms by which a plant adjusts to saline conditions.

He places cultured tissues of sugarcane and sorghum leaves into liquid containing various concentrations of sugar and salt. As the plant cells grow, Kresovich can determine how much sugar (energy) has been consumed by measuring the sugar in the plant tissue as well as the sugar remaining in the liquid.

By analyzing the precise amount of energy the cells consume and comparing their growth in various concentrations of salt, he can better explain the plant's energy use when subjected to salt stress. By using this laboratory procedure, Kresovich may also quickly screen varieties of sugarcane and sorghum for salt tolerance.

Later research will field test the plants grown from the cultured tissues Kresovich identifies in his laboratory work as the varieties most able to adjust to salt.

Ripples & Waves

Horticultural scientist Ed McWilliams says salt problems affect not only crop producers, but cause major problems for nursery growers, landscape managers, and urban gardeners. Often poor plant performance is blamed on diseases, insects, weeds, or weather, when in fact salinity has weakened the plant.

McWilliams has found many plants popular with urban gardeners especially susceptible to salts in municipal water supplies. He has also found major differences in the salt tolerance of popular house plants.

Damage from excess salt is not always due to high salt concentrations in the water supply. McWilliams says both indoor and outdoor home gardeners tend to overfertilize which can cause salt buildup. They also tend to irrigate with Iight, frequent applications instead of deep irrigations which would leach salts below the root zone.

C. J. Gerard, a soil physicist stationed at the Chillicothe-Vernon research center, studies the effectiveness of tile drains in reclaiming saline seeps. A saline seep is an area where subsurface water and salts accumulate in the root zone because of poorly drained soil layers below. After three years of research, Gerard has concluded that installation of tiles to drain subsurface water and reclaim saline seeps is effective in the Rolling Plains of Texas.

Agricultural use of saline water is a continuing research emphasis of The Texas Agricultural Experiment Station. Researchers work throughout the state on projects to alleviate the impact of salt on agricultural production as well as on urban landscapes.

Many of the state's municipal water supplies contain high enough concentrations of salt to harm grasses. Garald Horst, researcher at the TAES center in El Paso, hopes to determine characteristics of salt toIerant grasses in order to breed them into turf grass varieties suitable for Texas cities.

TAES agricultural economists David Laughlin, Ronald Lacewell, and Donald Moore evaluated the agricultural benefits of a proposed project to control salt in the Red River

Basin. They also estimated the benefits of the project to cities and industries using the water from Lake Kemp.