Water Conservation in Field Crops in Southwest Texas

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Lack of water during key periods of crop growth is in most cases a variable which limits yields in crop production throughout the state of Texas, and is a severe and frequent problem in the southwestern region of the state. It is not necessarily deficit annual rainfall that causes the onset of crop yield limiting stress, but the distribution of precipitation within the year. Additionally, the ability of the soil to absorb and hold water within the root zone of the crop in question and the great demand for water associated with high temperatures, wind, and intense sunlight are also contributing factors. For example, long term annual precipitation averages range from about 20 inches in the western part of southwest to about 34 inches on the east. Considering that corn yields are not generally limited by water when approximately 24 inches are available during the growing season, it becomes apparent that the amount of rainfall is less likely to restrict crop yields in this region than is the distribution. Having fields prepared in a manner to absorb and store water can have a profound impact on the level of stress experienced by the crop. Success in dryland agriculture greatly depends on those management activities that enhance infiltration, store rainfall, and reduce evaporation and transpiration.

Central and southwest Texas are known for sporadic rainfall patterns often consisting of a series of droughts connected by intermittent floods. Long-term annual average rainfall figures do not depict the sporadic nature of this precipitation. Figures 1 and 2 depict weekly averages and the probability of receiving at least 0.5 inch of rainfall during a one week interval at Uvalde. A careful evaluation of this data reveals that November through late March are the driest months, with probabilities of receiving 0.5 inch of rainfall or more in any week during this period being less than ten percent from November 1 to March 22. Average precipitation falling over this 21 week period, or 0.48 inch per week. The weeks beginning July 26, August 9, and 16 are notably dry weeks during the somewhat wetter spring and summer months. The weeks beginning on April 26, May 17, June 25, August 30, and October 4 are the most likely to be wet. These weeks have at a 19 to 21 percent probability of 0.5 inch or more of rain. The average rainfall for these weeks is .079, 0.89, 0.87, 0.57, and 0.79 inches, respectively for a 71-year period.

The use of long term weather data such as these can help in the planning of crop planting dates as well as variety and maturity selections. While such planning will not take into account variations in weather from year to year, they will well serve the farmer in the long run.

Many practices may be employed by the farmer to conserve water. These include:

Water harvest techniques including furrow diking, land pitting, mulches, mini-bench terracing, and high residue farming.

Much of the annual rainfall in southwest and central Texas comes in heavy showers which tend to have significant runoff. Any land preparation activity which can reduce the impact of the raindrop on the soil

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surface, slow the rate of water crossing the soil surface or that captures and retains runoff water can increase infiltration and percolation of water. The increased storage results in available water for the crop that otherwise would have left the field as runoff. In many cases this runoff can lead to reduced environmental quality, lower long-term soil productivity and decreased water holding capacity.

Furrow diking is a fairly low cost form of mechanical soil management. It can be accomplished simultaneously with other field activities such as cultivation. Furrow diking catches and holds potential runoff water close to the proximity in which it falls. It also can be useful in preventing runoff of irrigation water. A potential risk of furrow diking is the possible injury to the crop from flooding on nearly level clay soils that are subjected to heavy, repeated rains. If flooding is a real possibility, alternate row furrow diking can reduce this threat and still capture and store significant quantities of water. Also, furrow dikes may be constructed only in those times of the year when there is lower probability of torrential rainfall or during the fallow period between crops..

Land pitting is a soil management activity that can be used on pasture lands and with some modification, small grain fields. It works in a manner similar to furrow diking to capture water near where it falls. Land pitting usually involves heavy equipment pulling a chain modified to create many small reservoirs on the soil surface to catch and hold precipitation.

Mini-bench terraces require a somewhat higher cost in land shaping and are used only in gently sloping land. This leaves the field in a series of gently sloping bench terraces which harvest and store water for dryland crops.

Utilizing crop residue to intercept raindrops and slow runoff is probably the least expensive approach to water harvesting. Cropping with large amounts of residue on the surface results in storage of more soil water than does clean tillage. It also reduces runoff, and prevents water losses associated with plowing and primary tillage.

Technologies to reduce water loss include high residue farming (no-till, conservation tillage), narrow row planting, early planting of warm-season annuals, late planting of cool-season annuals, use of early maturing varieties or hybrids and careful weed control.

Narrow row planting works as a water conservation technique by reducing evaporation. In the narrow row systems, as the crop canopy intercepts solar energy and shades and cools the micro-environment by transpiration. Cooler crop canopy temperatures reduce evaporative demand from the soil surface, the transpiration gradient from the leaf surface and reduces stress in the crop. Excessively high planting rates can reduce the water savings associated with narrow rows by increasing transpiration and reducing partitioning efficiency.

Early planting is a drought avoidance mechanism. Temperatures tend to be cooler and evaporative demand less during the early part of the growing season, allowing the crop to mature before evapotranspiration (ET) demands become greater later in the season. Most south Texas farmers are aware of this technique to reduce water loss. If planting is too early, cool temperatures and damp conditions coupled with pathogens can damage a root system, thereby reducing late season water-use efficiency.

In cool season crops such as winter wheat, late planting serves to minimize water in much the same manner as does early planting in summer annuals. This technique simply avoids the warmer temperatures of early fall and the high ET demands, typical of September and October. The growing season and associated water demands are shortened as well. One study in the High Plains indicated that winter wheat planted in late August used about 5 inches more of water in the fall and winter than did wheat planted in the first week of October. Care should be taken in selecting excessively late planting dates, as wheat planted too late (December) forms shallow root systems that cannot extract water stored deep in the soil profile. Spring wheats also tend to have a more shallow root system than do timely planted winter wheats.

Early maturing varieties and hybrids also are planted to limit exposure to high ET demands in the late season, and to shorten the overall period of water-use. Careful selection of early maturing crops must be exercised, as many of the breeding programs for early maturity hybrids are centered in the northern U.S. where heat and drought stress are not major considerations in crop selection.

Technologies to enhance use of stored water include: detection and destruction of tillage pans, deep banded fertilizer, use of systemic seed treatment fungicides, timely planting and selection of deep rooted crops.

High density soil horizons, often created with tillage equipment, wheel traffic or in some cases by grazing of wet fields can severely restrict root development and water percolation. These plow, traffic or hoof pans need to be identified and to be broken up by tillage activities as early in the fallow season as is feasible. Steps to reduce wheeled traffic and to control the amount of the land surface exposed to wheels should be implemented. Use a penetrometer, shovel or other tool to identify tillage pans.

Phosphorus-deficient crops often have weak, spindly root systems that do not expand sufficiently to allow extraction of the available water stored in the soil profile. Surface P application followed by shallow incorporation results in stratification, or an accumulation of P near the surface and lower concentrations deeper in the soil profile. With infrequent rainfall or limited irrigation, the soil surface dries rapidly. Roots cannot actively take up nutrients concentrated in the dry soil near the surface. In this situation, moisture may be available deeper in the soil profile, but P uptake is limited. Deep banding of P with chisels greatly expands the time available for a crop to uptake P, resulting in larger and more efficient root systems with increased water-use efficiency.

Crop rotation and seed treatment fungicides can also profoundly affect the health of the plant root system. Where injury from seedling diseases such as fusarium and pythium occurs, water-use efficiency can be greatly reduced.

Crop selection greatly impacts water-use efficiency. Deep-rooted, stress-tolerant crops tend to be much more efficient at water capture and utilization than do other selections. For example under conditions of limited moisture, cotton, sorghum and wheat are more efficient in water use than are corn or soybean. Winter annual crops, primarily grown in conditions of lower ET are frequently in the field longer than summer annuals, and water use does not match annual rainfall patterns as well as do summer annuals.

Technologies to reduce fallow season evaporation: crop residue cover, dust mulch and weed management through residual and postemergence herbicides.

The fallow period, or period between crops, should be a time for water harvest and storage for the following crop. Field operations which leave large amounts of crop residue on the surface during the fallow period are water conserving. Clean till land preparation results in the loss of 2- to 3-inches of stored soil moisture, and is less efficient in water capture than is a high residue surface.

If primary tillage is necessary, it should be completed early, and weed and crop volunteer management accomplished with stalk pullers, sweep tillage or chemical fallow.

Technologies to reduce water-use in irrigation include: use of efficient irrigation equipment and the use of water efficient delivery systems.

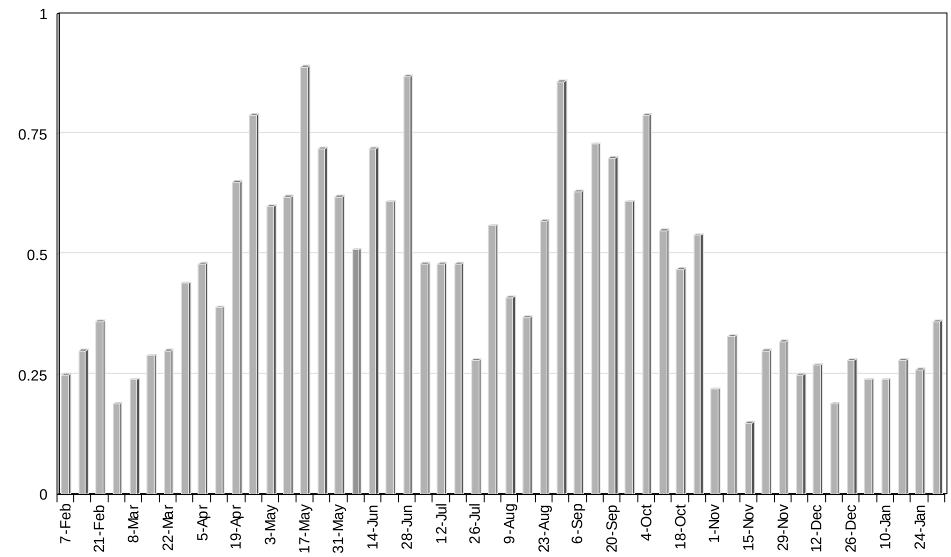
In addition to fine tuning the efficiency of irrigation systems farmers should use a systems approach to conserve water in dryland situations, including narrow row spacing, crop residue, furrow diking, early maturing varieties and hybrids, deep-banded fertility, early planting of summer annuals, late planting of winter annuals, carefully planned weed control, etc. Careful irrigation strategies should be employed, based upon water availability and crop needs. These strategies could include scheduling of irrigation based upon a PET (Potential Evapotranspiration) percentage; scheduling based upon moisture content using resistance blocks, tensiometers or neutron probe readings; or scheduling based on crop stress indicators such as canopy temperature measurements, pressure bomb readings, or stem flow gauges. Actual measurements of crop stress are the most precise indicators of irrigation requirement, rather than remote or model generated indicators, but may be beyond the ability of individual farmers to deliver water in a timely manner to prevent stress damage to the crop. Irrigation scheduling based on PET is a relatively easy process and can be very acuracte when using the correct crop coefficiencts (for more information on PET for irrigation scheduling, see the Texas ET Network website: http://texaset.tamu.edu).

In the case of limited water supply, irrigation decisions based upon a knowledge of crop physiology and crop stress tolerance should be employed. For example, major losses can occur in sorghum if significant stress is present at panicle differentiation or bloom, but stress is less harmful in early vegetative growth or between panicle differentiation and bloom. The same is true in most grain crops. Excessive moisture stress when the ear or head is developing reduces head or ear size and the potential number of grains per plant. Stress at and shortly before bloom can result in infertility and reduced seed set. Post-bloom stress reduces potential seed size, but may be less critical than earlier stresses which affect seed number.

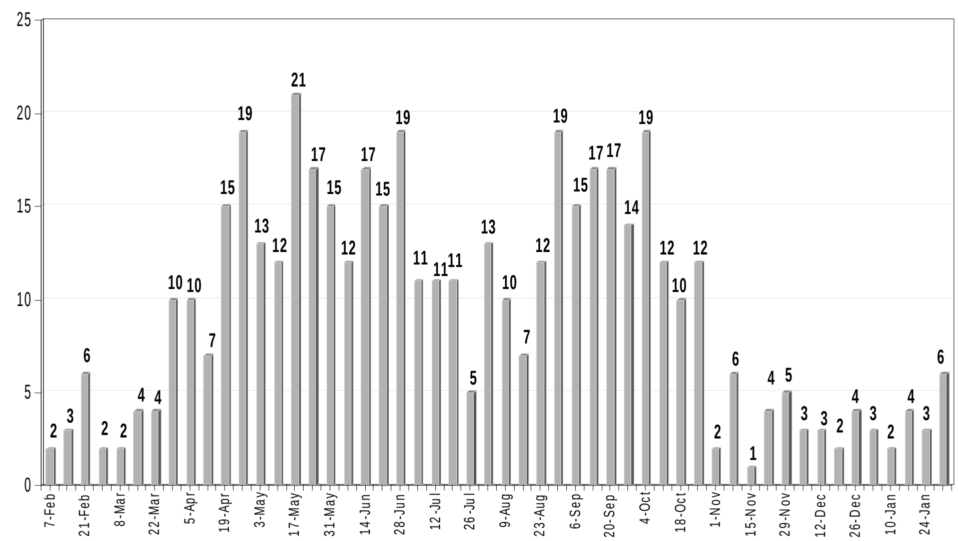
In cotton, primary emphasis should be placed in setting early season fruit set. Use of early varieties, narrow rows and higher plant populations places increased early fruit set and reduces late season water demands.

Most successful farmers throughout Texas already employ many practices to reduce water loss in their production systems. The goal of each producer should be to evaluate their existing production systems, and to add those items that will result in saving water and money, as well as to modify the system to improve efficiencies. Practices that become immediately apparent include: increased usage of no-till or high-residue farming, furrow diking, shorter maturity hybrids and varieties, narrow row planting, and better management of irrigation water and scheduling.

Average Rainfall by Week at Uvalde, TX



Probability of 0.5 Inch or More Rainfall By Week at Uvalde, TX



Additional information and publications can be found on the Web at:
http://taexsoilcrop.tamu.edu

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