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Irrigation Water Management for the Texas High Plains: A Research Summary

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- Full Text

The four main crops produced in the Texas High Plains have been the subject of water management research for several decades by the Texas Agricultural Experiment Station and the USDA/Agricultural Research Service. As expected, experimental results for yield and water use efficiency have varied for these four major crops, but many common principles have likewise emerged from this research. Definite improvements in water use efficiency have been made, and widespread application of these management principles is underway. Limited irrigation is now being widely practiced on drought tolerant crops that take advantage of expected rainfall. A 30-day period of fairly reliable rainfall occurs from mid-May through mid-June which coincides with sorghum and cotton planting and follows typical corn planting.

Sorghum has good ability to adjust to water stress. Sorghum grain requires 13 to 24

inches (330-610 mm) of seasonal water use (evapotranspiration) from precipitation, stored soil moisture and irrigation to achieve 3,000 to 6,700 pounds per acre (3,400-7,500 kg/ha) of grain sorghum yield. Dryland sorghum yields average about 1,600 pounds per acre (1,800 kg/ha), and yields up to 3,000 pounds per acre (3,400 kg/ha) are not uncommon. Peak water use rate is about 0.30 inches per day (7.6 mm/day). Irrigations should be timed to avoid water stress during periods of peak water use--boot, heading and flowering stages--to achieve reasonably good yields and maximum irrigation water use efficiency. Two well-timed seasonal irrigations of 4 inches (100 mm) per irrigation or the equivalent are adequate in normal years for good yields of medium maturity hybrids. Preplant irrigation is often not needed, and the same amount of water may be more efficiently used if applied at later stages of crop growth especially for conventional graded furrow irrigation systems. Conservation tillage can reduce the need for preplant irrigation of sorghum through improved soil moisture storage. Irrigation water use efficiencies may reach 400-500 pounds per acre-inch (1.8-2.2 kg/m3) with limited but well-timed irrigations as compared to about 200-250 pounds per acre-inch (0.88-1.10 kg/m^3) with adequate irrigation. Saving irrigation water by withholding a 4-inch (100 mm) irrigation reduces sorghum grain yields by only about 10 percent during the early 6-8 leaf stage but by almost 50 percent if withheld at the heading and bloom stage. :

Corn is much more sensitive to water stress than sorghum, wheat or cotton. Corn is planted earlier than sorghum which typically allows more efficient use of the May-June wet season than for sorghum. However, early planting dates required for corn increases the need for preplant irrigation for stand establishment. Moisture stress caused by low soil water availability or hot, dry conditions during the flowering (tasseling, silking and pollination) stage can severely restrict corn yield. Preplant irrigation is often necessary, and 3 or 4 seasonal irrigations of 4-inch (100 mm) each are essential for high corn yields in most years in the Texas High Plains. Drought seasons require one or two additional irrigations. Reduced irrigation of corn has generally resulted in significant yield decreases. Irrigation water use efficiency values are usually 250-450 pounds per acre-

inch (1.1-2.0 kg/m^3) with adequate irrigation, although peak IWUE values of 500 pounds per acre-inch (2.2 kg/m^3) or more have been obtained with limited irrigation in good rainfall seasons. Center pivot irrigation allows frequent irrigations of 1 to 1.5 inches (25-38 mm) during peak water use periods on corn. The total seasonal water use (ET) for corn to achieve any grain yield is about 13 inches (330 mm), while seasonal ET's for peak yields are around 28-32 inches per year (710-810 mm). Peak ET rates are 0.3-0.4 inches per day (8-10 mm/day), depending upon weather conditions. Planned water deficits into the stress range are feasible only on soils with moderate to high water storage and during the early vegetative or grain ripening stages. Reduced acreage, rather than reduced irrigation, offers the primary way to adjust corn irrigation to limited water supplies.

Winter wheat is a major drought tolerant crop with a 9-month growing season. Wheat grows vegetatively during the drier fall to early spring period and develops grain during a period of increasing spring rainfall. Wheat is normally planted around October 1 and requires available 8011 moisture for germination and early growth, plus perhaps one late fall irrigation followed by 2 to 3 spring irrigations for good production. About one additional early irrigation (and additional applied fertilizer) is needed for early planted wheat that is grazed and also managed for grain production. Seasonal water use is around 26 to 28 inches (660-710 mm) for wheat (grain only) yielding 4,700-5,800 pounds per acre, or 85-100 bushels per acre (5,270-6,500 kg/ha). The highest yield response to irrigation usually occurs during jointing and boot stages (a relatively low rainfall period), during which irrigation water use efficiency values of about 230 pounds per acre-inch (1.0 kg/m^3) are realized from a 4 inch (100 mm) irrigation. Spring irrigations totaling 4 to 12 inches (100-305 mm) have resulted in good irrigation water use efficiencies above 170 pounds per acre-inch (0.75 kg/m^3). The least efficient irrigation is during grain filling, where IWUE values have been less than 115 pounds per acre-inch (0.51 kg/m^3), and is associated with increased rainfall. Short wheat varieties in recent tests have exhibited 50 percent higher irrigation water use efficiency values than tall wheat varieties in earlier tests. Wheat yields have been increased in some experiments using no-till, limited tillage, or furrow diking as compared to conventional

tillage.

Cotton is a drought-tolerant long-season crop that lends itself to limited irrigation despite a somewhat complicated pattern of water use, deficits, and application. Cotton is the major irrigated crop on the Texas High Plains and is second to Wheat in dryland production acreage. Widespread production under limited irrigation has major impact on water demands and the state's water budget. Production, placement, and retention of fruiting sites are sensitive to soil water status. Early fruit set is important. Under dryland conditions, expected lint yields are in the range of 250 to 300 pounds per acre (280-336 kg/ha). Cotton requires over 13 inches (330 mm) of seasonal water use to produce good yields, and maximum yields occur at about 27 inches (685 mm) of seasonal water use. High water levels can decrease lint yield through excessive vegetative development and fall immaturity. A preplant irrigation of 4-inches (100 mm) is usually advantageous especially if spring rainfall is not excessive, but heavier preplant irrigations are not warranted. Cotton has the ability to overcome moisture stress at most growth stages, but the growing season length may not accomodate late-season regrowth. The most critical period for irrigation is early to mid-bloom. If available, a second irrigation should be applied at peak to late bloom. The irrigation cut off date for cotton is mid- to late August. For irrigated cotton, yield results generally favor narrow-row with high plant populations. Irrigation water use efficiencies for cotton have ranged from as little as 20-30 pounds per acre-inch (0.09-0.13 kg/m^3) for full irrigation to as high as 80-100 pounds per acre-inch (0.35-0.44 kg/m^3) for two well-timed furrow irrigations (preplant and peak bloom) in some experiments. A reasonable target for limited furrow irrigation appears to be 50 pounds per acre-ineh (0.22 kg/m^3). Cotton Irrigated with LEPA Sand drip systems produced around 90 pounds lint per acre-inch (0.40 kg/m^3). Land leveling on slopes of 0.5 percent or greater have increased yields by more than 100 pounds lint per acre (110 kg/m^3) for both furrow irrigated and dryland cotton.

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