CENTER PIVOT IRRIGATION FOR CORN: WATER MANAGEMENT AND SYSTEM DESIGN CONSIDERATIONS

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ABSTRACT

Much of the irrigated corn production acreage in the west has been converted from furrow irritation to higher efficiency pivot sprinkler irrigation. Several reasons have led to the conversion including federal programs, occasionally low snow packs, and a search for power efficiency. Irrigation with a pivot can provide challenging in the arid west when daily evapotranspiration (ET) rates can exceed the application rate of the pivot system especially during the tasseling period which tends to coincide with the highest summer temperatures. Producers can mitigate drought stress situations by paying close attention to several factors including pivot design, soil types, pivot operation, crop water needs, and incorporating additional management practices where applicable.

Key Words: Corn production, pivot irrigation, drought stress, water use efficiency

INTRODUCTION

Pivot sprinkler systems offer producers many advantages, and every year more pivot systems are being installed on farms throughout southern Idaho. Corn can be successfully grown to top yields under a pivot system with careful management and consideration of soil properties and equipment capabilities.

Knowledge of the farm soil is critical. Water holding capacity, depth, current moisture content, and infiltration rate will all affect how much water the soil can absorb per irrigation application and how fast it can absorb it. On the equipment side, pivot capacity, nozzle size, head design, and pivot speed affect how much water is applied per irrigation application. In addition, the operation of the pivot along with proper tillage practices will affect the amount of runoff from the field.

This bulletin describes the water requirements of the corn crop and explains how to manage a center pivot system to deliver sufficient water to the corn crop when it is needed. The bulletin focuses on three significant water-stress factors that reduce crop yield—water stress at critical crop stages, insufficient water to meet evapotranspiration requirements of the crop, and water stress due to inadequate water delivery to the soil (water stress due to surface runoff).

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WATER STRESS AT CRITICAL CROP STAGES

Growth and development of the corn plant has been divided into a number of stages identified by unique crop characteristics (Abendroth et al. 2011) (figure 1). The crop stage approach provides a series of well-defined points useful for ensuring that agricultural chemicals and other management practices are applied at the correct time and provides the time reference for many other management decisions.

Water stress is a major yield-reducing factor. Corn can manage some water stress throughout the growing season as long as that stress doesn't occur during critical stages (Doorenbos and Kassam 1979; Heiniger 2001). Corn has several critical stages where sufficient moisture is necessary for maximum yield: between V5 and V6, from V7 to V12, and VT. The first, between V5 and V6, is when the potential for ear size and kernel number is set (figure 1). From V7 to V12 leaf size is being determined. Smaller leaves reduce photosynthetic capability of the plant and reduce yield. Around V12 final ear size and kernel number are set. If the plant is stressed during these V stages, the yield potential can be permanently reduced.

One management-related possibility for creating water stress during the V5–V6 period is related to the application of glyphosate herbicide. In southern Idaho, as corn approaches the V2–V3 stages, farmers stop irrigating to dry the fields for herbicide application, cultivation, and reservoir tillage. By the time herbicide application is finished and irrigation can resume, corn on initially dry, shallow, or low-water-holding soils may experience water stress. Evidence of water stress at this stage may appear at harvest as a condition called "bottleneck" where the ear may have 18–20 rows at the base that merge into fewer rows midway up the ear.

The third critical stage is VT (vegetative-tasseling), which represents tasseling and the initiation of flowering. At this time the female flowers on the ear are sending silks up to the end of the ear for pollination. Silk develops from the base of the ear first. If a plant is moisture stressed during this time, the female flowers toward the tip of the ear may not be pollinated or they may abort.

Seed VE V2 V4 V8 V12 VT R1 R5

Figure 1. Corn growth stages. Vegetative stages are labeled with a "V" and reproductive states with an "R." The number following the V indicates the number of fully developed leaves. VT indicates the last branch of the tassel is completely visible. (Adapted from Hanway, J. J., and S. W. Ritchie. 1984. How a corn plant develops. Special Report 48. Iowa State University.)

Several abnormalities may appear when the ear reaches maturity including tip dieback, zippered ears, or nubbin ears. The results are the same: less grain and reduced silage quality.

INSUFFICIENT WATER TO MEET ET REQUIREMENTS

The potential for crop water stress during any crop growth stage can be estimated by comparing the estimated need for water to the water available from rainfall, irrigation, and soil water storage at that point in time. Evapotranspiration (ET) is the total amount of water needed to replace water lost through (1) evaporation from the soil surface and the plant leaf surface and (2) transpiration from plant metabolic processes. Because of water losses during irrigation due to evaporation and wind drift and the need for some "extra" water to account for less than perfect application uniformity, about 15% more water must be applied than is required to just replace ET. Yield loss from insufficient water can be the result of either poor irrigation scheduling or insufficient system design capacity to deliver adequate water.

Irrigation scheduling problems

Not applying the right amounts at the right times.

Yield loss from water stress can be the result of a single event or cumulative from several events throughout the growing season. For example, research has shown a 1-inch evapotranspiration (ET) deficit can result in a yield loss of up to 7% during the vegetative stages, up to 22% during flowering, and up to 4% during yield formation after flowering. However, spreading that 1-inch deficit over the entire growing season can result in a yield loss of up to 5% (Doorenbos and Kassam 1979). Although most discussion will be about applying too little water, over application of irrigation water and the resulting surface runoff has its own set of costs such as loss of N and P in surface runoff and potential nutrient movement into surface or groundwater systems.

Not applying water according to seasonal ET pattern.

Water stress may occur because of insufficient water application to meet crop ET. Early in

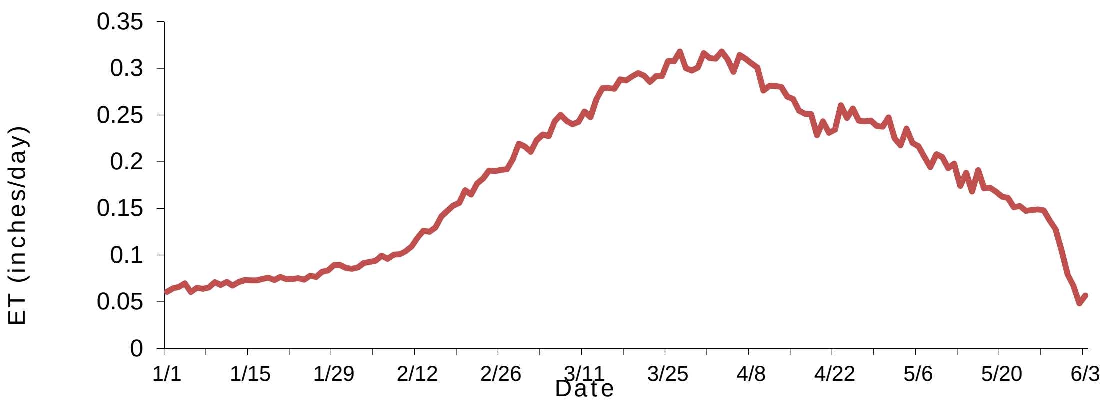

Figure 2. Average 30-year ET requirements for corn in the Magic Valley, estimated by AgriMet.

the season wh... ter requirements. ... As the plant grows and summer heat increases, the ET requirements for the corn crop also increase. In

Idaho's Magic Valley, the corn crop ET requirement begins at germination at 0.07 inch/day, peaks at 0.30–0.32 inch/day for a 2-week period from late July to August, and decreases until the crop is harvested for silage or until it reaches full grain maturity (figure 2).

Most center pivot irrigation systems in southern Idaho are designed to apply 6.5–7.5 gallons/minute/acre, depending on location and soil properties. A system running at 80% efficiency and applying 6.5 gallons/minute/acre has the capacity to deliver 0.28 inch/acre/day. During the early and late parts of the growing season, such a system can keep up with the daily ET requirements of the corn crop. However, during the hottest part of the summer, which coincides with flowering (mid July through early August), such a system cannot meet the daily ET requirements and the potential for moisture stress and yield loss increases. Slowing the system rotation speed or changing nozzles to apply more water will only increase runoff losses.

Not filling the soil profile early.

One of the key management practices with a pivot system is to apply enough water during the early part of the growing season, when ET is low, to fill the soil profile so water is available later in the season when the pivot can't meet crop ET. Figure 3 illustrates this concept for the 2005 growing season in Bliss, Idaho. The spring of 2005 was unusually wet and the soil profile was filled at the beginning of the season. The growing degree days (GDD) between April 20 and October 15 were also 139 GDD below average.

The trend lines for actual ET and maximum irrigation system delivery track very closely with each other, indicating that the irrigation system was capable of very nearly meeting

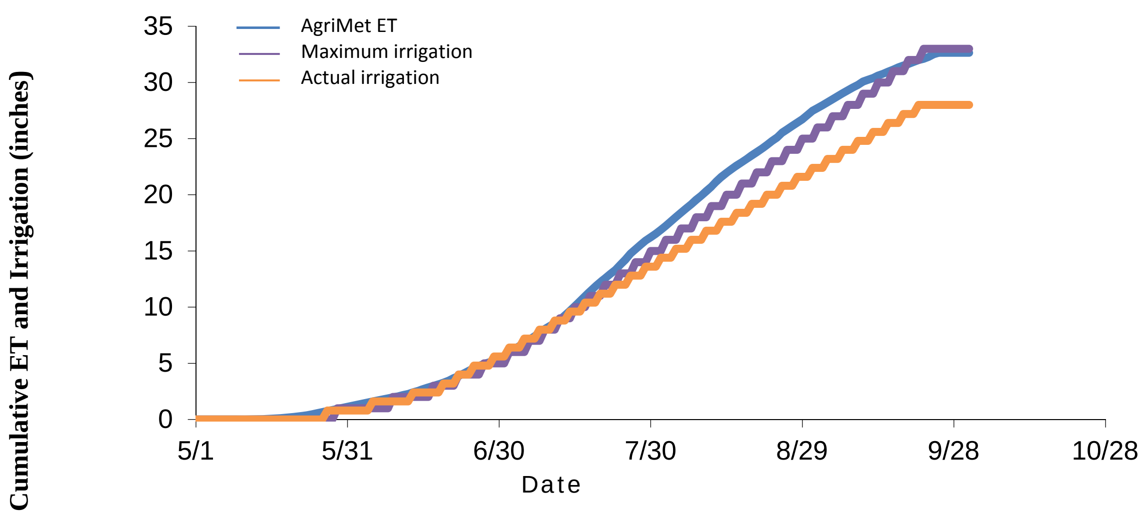

Figure 3. AgriMet-estimated cumulative corn ET, Bliss, ID 2005, and the actual cumulative irrigation applied. The maximum irrigation curve represents net center pivot irrigation system capacity at 7 gpm/acre and 85% application efficiency.

ET for system

It is important to note that actual irrigation began to fall short after the VT stage had been reached. The yield loss in this corn would be a tonnage loss in silage with possibly some grain yield loss. The soil in this field was sandy loam, and the early season moisture stored in the soil profile was able to offset insufficient irrigation through over half of the growing season. These data reinforce the practice of filling the soil profile early in the season when excess water is available.

An analysis of AgriMet corn ET data (30-year average) was conducted at the University of Idaho Kimberly Research and Extension Center to look at corn irrigation under three conditions: irrigating to meet full ET of the corn throughout the season, irrigating at 80% of that necessary to meet full ET, and irrigating at 80% of ET requirements but starting with a full soil profile at the beginning of the season (figure 4). While both deficit irrigation treatments failed to meet 100% ET, the treatment that started the season with a full profile was nearly able to meet full ET and began to show a deficit only late in the growing season, well past flowering and easily into the time frame for silage harvest in southern Idaho.

The treatment meeting 80% ET without filling the profile began to show a deficit a week or two before the corn would have flowered. Not only did this irrigation practice fail to meet ET for the remainder of the year, but also it would have cost the producer in lost silage tonnage and grain quality. These data further reinforce the practice of filling the soil profile early in the season when ET requirements are low and the farm is likely to have excess irrigation water.

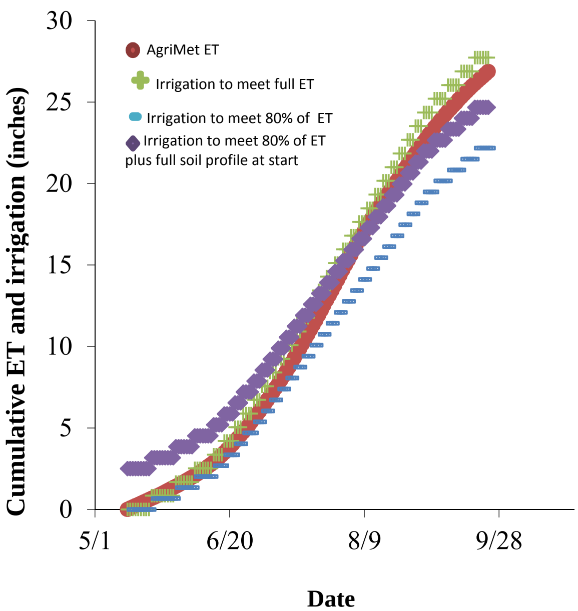

Figure 4. Irrigation system performance relative to AgriMet-estimated, 30-year average corn ET, Kimberly, ID. Assumed center pivot capacity is 0.28 inch/day with net irrigation of 6.5 gpm/acre at 80% application efficiency.

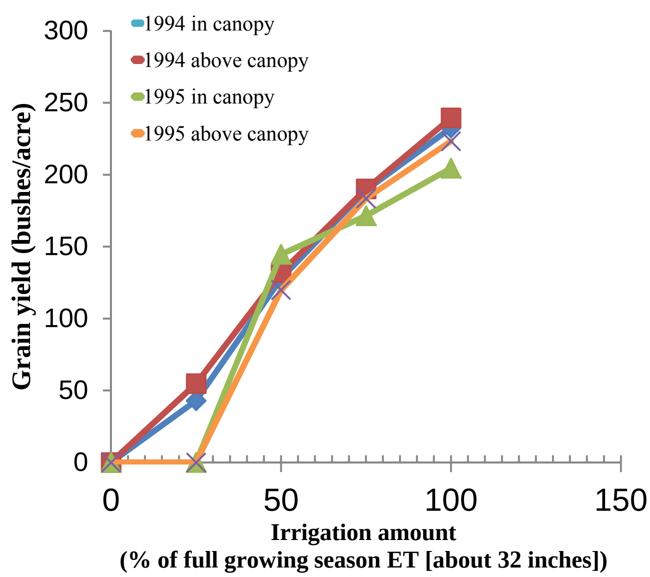

Figure 5. Grain yield response to irrigation treatment, Bushland, TX, 1995 and 1995. (Source: Schneider, A. D., and T. A. Howell. 1998. LEPA and spray irrigation of corn—Southern High Plains. Trans. ASAE 41(5):1391–1396.)

Reducing season-long irrigation (deficit irrigation).

The impact of several levels of irrigation deficit on crop yield was evaluated in a 2-year field study near Bushland, Texas (figure 5). Corn grain production was compared under two pivot irrigation systems with the nozzles on one system placed 1 foot above the ground in-canopy and the second system placed 1 foot above the canopy. One inch of water was applied at each irrigation event. Deficit irrigation treatments received 0, 25, 50, 75, and 100% of the application rate (1 inch).

There was little difference in grain yields whether the nozzles were in-canopy or above-canopy but significant differences in grain yields among the deficit treatments. Averaging the data from both years and both irrigation systems, the results show no crop harvested for 0%, 24 bushels for 25% (0% for 1995 due to heat and drought), 129 bushels for 50%, 181 bushels for 75%, and 221 bushels for 100% irrigation applications. These data clearly demonstrate the need to irrigate to meet crop ET throughout the growing season to achieve maximum yield.

Center pivot design problems

Many center pivot irrigation systems were designed and installed before corn became a major crop in southern Idaho. As a result, the water application rate per acre and the sprinkler nozzle package may not be well suited for corn production. When determining the pivot application package and maximum water application rate, several factors must be considered: location, amount of water available, soil texture, soil depth, and crop water requirements.

Water application rate.

Figures 6 and 7 show ET data from corn crops grown in 2005, 2006, and 2007 at Bliss and Kimberly, Idaho, and pivot system capacity at each site. Bliss is located at 3,200 feet elevation and has sandy loam soils. Kimberly is located at 3,800 feet elevation and has silt loam soils. The pivot systems at these sites have a capacity of 0.33 inches/acre/day or

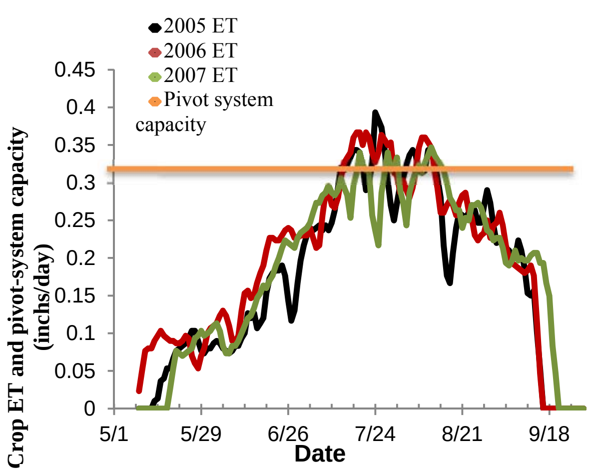

Figure 6. AgriMet-estimated crop water use and pivot system capacity for corn at Kimberly, ID. ET data are plotted as a 3-day moving average to smooth daily fluctuations.

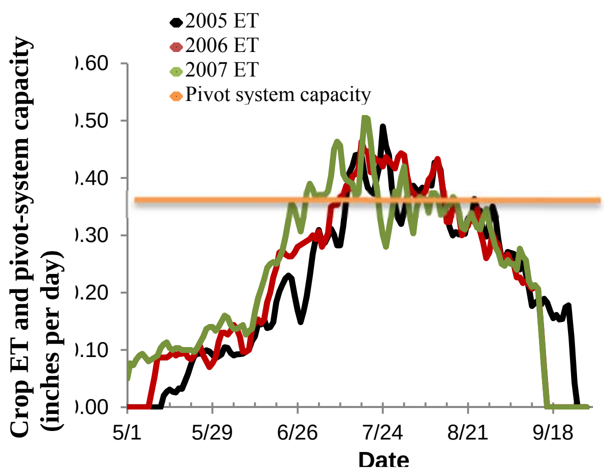

Figure 7. AgriMet-estimated crop water use and pivot system capacity for corn at Bliss, ID. ET data are plotted as a 3-day moving average to smooth daily fluctuations.

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Maximum ET at the Kimberly site was 0.40 inches/day in 2005 and at the Bliss site was over 0.50 inches/day in 2007. At neither site could the irrigation system keep up with ET requirements during the hottest part of the summer. When this occurs, the soil becomes drier as the crop “mines” water from the soil profile to make up the difference between ET and the water applied. In southern Idaho the deficit period occurs during the last 2 weeks of July and the first week of August, just as corn is flowering and ear development is starting.

The year 2006 was a high peak ET year and a high seasonal ET year. In Kimberly, the pivot system could not keep up with ET for about 2½ weeks, but at Bliss the system failed to keep up for about 5½ weeks. The system at the Bliss site, with its sandy soils and stronger winds, would need to have applied 9.0 gpm/acre in order to reduce the water stress to that at the Kimberly site. In southern Idaho a 9.0 gpm system is not practical due to relatively low soil infiltration rates on silt or clay loam soils. Rates this high may have acceptable runoff levels on lighter textured soils with higher intake rates, however.

When the pivot system cannot keep up with corn ET requirements, the water stored in the soil during the early season becomes important to supplement irrigation. It is critical that producers know what soil type they have and the water holding capacity of that soil. Usable water storage per foot is shown in Table 1.

The soil in the Bliss example is sandy loam, and the soil in the Kimberly example is silt loam. Sandy loam soil will store 1.7 inches/foot of water, and silt loam will store 2.4 inches/foot of water. Since management allowable depletion (MAD) for corn is 50% (greater than 50% depletion will cause yield loss) the calculation for usable water per foot of soil is:

Water holding capacity x 0.50
= Usable water per foot of soil

Soil depth in southern Idaho varies, and producers should know soil depths for their own fields, but typically 2 feet is used in calculations as an average depth. The calculation for the

Table 1. Usable soil water in inches (water stored between field capacity and permanent wilting point with Management Allowable Depletion (MAD) =0.5).

Root zone depth, inches	**Sandy loam**	**Light-textured silt loam**	**Heavier-textured silt loam**
12	0.8	1.0	1.2
24	1.6	2.0	2.4
36	2.4	3.0	3.6

sandy loam soil in Bliss is

1.7 in/ft x 0.50 = 0.85 in/ft of usable water
0.85 in/ft of usable water x 2 ft soil depth
= 1.7 inches total available water

The calculation for the silt loam soil in Kimberly is
2.4 in/ft x 0.50 = 1.2 in/ft of usable water

1.2 in/ft of usable water x 2 ft soil depth
= 2.4 inches total available water in the soil

Comparing different pivot system designs at the Bliss and Kimberly sites in 2006 shows how system design and water holding capacity of the soil work together to meet crop ET needs (figures 8 and 9). Each curve in figures 8 and 9 demonstrates the total water deficit in the corn crop over the growing season. The horizontal dashed and solid lines at 1.7 and 2.4 inches of deficit represent the amount of water stored in the soils and available to supplement irrigation to meet crop ET at Bliss and Kimberly, respectively. Any deficit curve that is under one or both of the horizontal lines indicates the total ET requirement of the corn crop would have been met that year. A curve above the horizontal lines represents the total deficit above what the soil would have supplied with the soil profile completely filled.

At the Bliss site, a system delivering 8.5 gpm would have had a total of about 1.7 inches of accumulated deficit, while a system delivering 6.0 gpm would have had a total of about 7.5 inches of accumulated deficit (figure 8). If the soil profile had been full at the start of the deficit period, the 8.5 gpm system would have had 1.7 inches of usable water in storage to supplement irrigation and would have been able to meet 100% of crop ET requirements that year. The 6.0 gpm system would still have had a deficit, but it would have been reduced from 7.5 inches to 5.8 inches due to supplemental water provided by the soil profile. This level of deficit would have reduced crop yield and quality by some amount. All the other systems fall somewhere in between these two extreme examples.

Had the soil at Bliss been a silt loam as at Kimberly, the profile would have provided 2.4 inches of supplemental water. In this case, both the 8.5 gpm and the 8.0 gpm systems

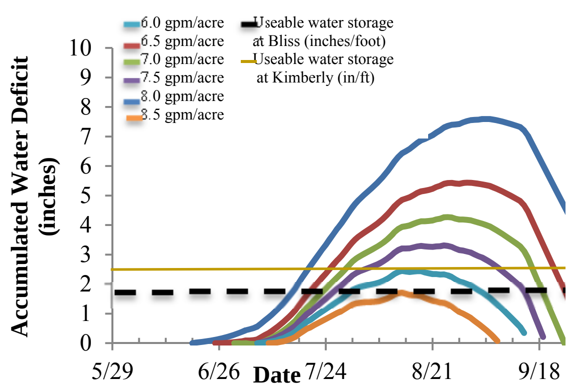

Figure 8. Accumulated water deficit (AgriMet ET - water applied) with center pivot capacities of 6–8.5 gpm/acre, Bliss, ID, 2006.

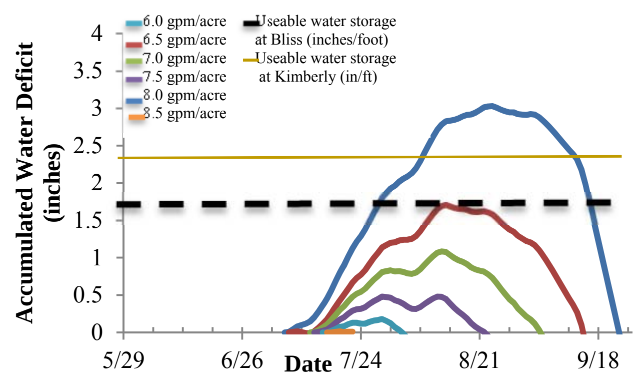

Figure 9. Accumulated water deficit (AgriMet ET - water applied) with center pivot capacities of 6–8.5 gpm/acre, Kimberly, ID, 2006.

had ... crop yield loss (figure 8).

At the Kimberly site, the 8.5 gpm system would have had no water deficit and the deficit for the 6.0 gpm system would have been 3.0 inches (figure 9). If the soil had been full at the start of the deficit period, it would have provided 2.4 inches of water to supplement irrigation. The 8.5 gpm system would have been able to meet 100% crop ET regardless of soil water contribution. The 6.0 gpm system would have had a small deficit of 0.6 inches (3.0 inches−2.4 inches) instead of 3.0 inches.

If the soil in Kimberly were sandy loam, as at Bliss, all systems except the 6.0 gpm system would have met 100% of crop ET requirements, and the 6.0 gpm system would have had a 1.3-inch deficit.

The typical pivot system in southern Idaho is set up to deliver 6.5–7.5 gpm, so some water deficit is expected during the growing season. Knowing this information, the producer can fill the soil profile early in the growing season to supplement irrigation when it is hot and the corn is flowering. Table 2 shows the system capacities required to meet crop ET for the years 2005–2007 at the Bliss and the Kimberly sites. The year 2005 was early and cool, 2006 had above average ET, and 2007 was an average season. Knowing the soil type and depth is critical information for producers to know when planning irrigation systems, crop rotations, and water allocation, especially in water short years.

Low-pressure versus high-pressure pivot systems.

The height of corn grown under pivot systems with drop nozzles in southern Idaho will occasionally rise and fall with location along the pivot lateral. The question has been raised whether drop nozzles can distribute water evenly through the crop canopy.

A small study was conducted on one farm in 2009 and 2010 using a low-pressure pivot with drop nozzles and a high-pressure pivot with impact sprinklers mounted on the pivot lateral. Soil water measurements indicated that both systems would adequately meet crop ET if operated and managed properly. The only problem encountered was when a pivot got stuck and the operator simply reversed it instead of fixing the problem and allowing the system to move forward.

Table 2. Required system capacity, gpm/ac to meet peak ET with 2-ft root zone filled to field capacity before mid-season.

Location	Soil texture	2005 Early cool season	2006 Overall high ET season	2007 "Normal" season
Kimberly	Sandy loam	6.5	6.5	6.5
	Silt loam	6.0	6.2	6.0
Bliss	Sandy loam	8.0	8.5	8.0
	Silt loam	7.5	8.0	7.7

Potential solutions for ensuring adequate water distribution include reducing nozzle drop spacing to about 5 feet and using new water application devices that better spread water within the canopy.

WATER STRESS DUE TO RUNOFF

Infiltration rate.

Soil can absorb water at a certain rate, the infiltration rate. It varies mostly with time and with soil texture, although other factors such as soil moisture content, soil compaction, tillage history, structure, and slope are also important. Some of these factors can be altered by the producer and some are fixed properties of the soil. Generally, infiltration rate is high initially and drops off with time. The decrease is due in part to smaller soil particles on the soil surface reorienting with droplet energy and water movement and packing into the pores between the larger particles. Surface sealing is most pronounced in silt loam soils.

Changes in farming practices throughout southern Idaho have contributed to reduced infiltration rates. The new practices typically produce more compaction because larger equipment is driven on the soil when it is wet and less deep tillage is performed to break up the compacted layer. Heavily loaded manure trucks on wet soils in the spring and winter and corn silage trucks on fields in the fall contribute to compaction.

Water starts to accumulate on the soil surface when the water application rate exceeds the infiltration rate for a sufficiently long period of time. Surface runoff occurs when sufficient water accumulates on the soil surface to overflow shallow depressions and flow over or past surface crop residue.

Surface storage can be increased by maintaining crop residue in the row middles or by using implements such as a dammer/diker, which uses a shank to shatter compacted soil in the row middles and form a series of small ponds or pockets to hold water for subsequent infiltration. “Reservoir tillage” is another term commonly used to describe the use of tillage implements in this fashion.

Center pivot application rates.

The ability of a pivot system to meet ET when crop demand is highest is limited by the amount of water that can be applied to soil without creating runoff. Typical water application devices for center pivots are shown in figure 10.

Figure 10. Typical center pivot water application devices. Top left to right: high-pressure impact sprinkler, flow control spray nozzle with serrated plate, Senninger Wobbler and pressure regulator. Bottom left to right: Nelson Rotator with pressure regulator and Nelson Spinner with pressure regulator.

High-pressure pivot systems with impact sprinklers on top of the span spread the water over a large area up to 100 feet in diameter. Broad distribution allows the water application to more closely match soil infiltration rates.

The conversion to more efficient low-pressure systems initially caused some challenges because the irrigation application devices available at the time applied water over a much smaller area, resulting in excessive application rates and surface runoff. Several design features have been developed to offset this problem. When designing a pivot for corn irrigation plan for an application diameter of 40 to 50 feet or larger.

Figures 11 and 12 illustrate application and infiltration rates of water at Kimberly, Idaho, on Portneuf silt loam soil. The curves on these graphs represent the water application rate as each of three sprinkler types approaches and passes over a point in the field. For small-wetted-diameter devices, the time of application is short and the peak application rate is high. As the water is spread over larger areas, the application time increases and the peak rate decreases to ensure that the area under each curve (total water applied) is the same for all devices.

Because more time is required to travel the path of each successive pivot tower moving out from the pivot point, water application time at a point under the first span is much longer than at a point under the last span. For example, water from a 20-foot-diameter spray nozzle will wet a point under the first span (figure 11) for about 2 hours, while it will wet a point under the last span (figure 12) for about 9 minutes. To apply the same amount of water at both points, the outer span must apply water at a much higher rate than the inner span.

In figure 11, none of the water application curves comes above the infiltration rate curve, indicating that the application rate from each of these head types is sufficiently low to produce no runoff. The curve for the stationary plate head just comes to the black infiltration rate curve, indicating that the maximum water is being applied without causing runoff.

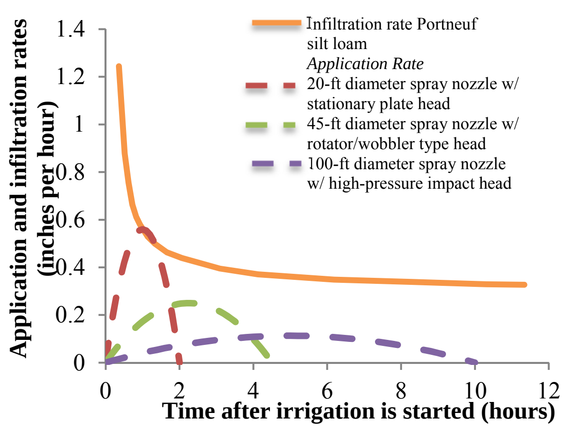

Figure 11. Estimated water application rates from three sprinkler devices under the first pivot span as compared with the infiltration rate for a Portneuf silt loam soil, Kimberly, ID.

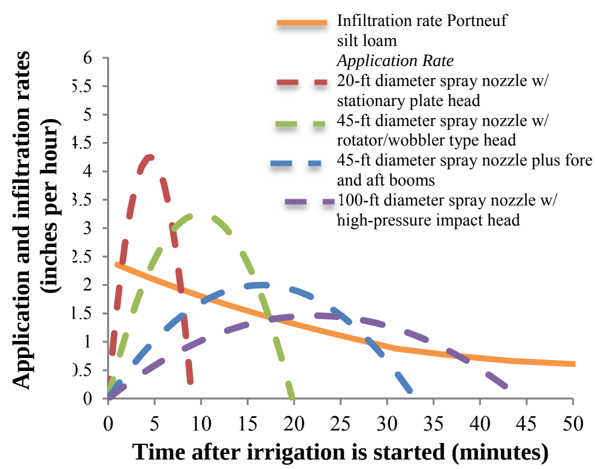

Figure 12. Estimated water application rates from three sprinkler devices under the last (outer) pivot span and from the 45-foot-wetted-diameter device with alternate fore-aft booms as compared with the infiltration rate for a Portneuf silt loam soil, Kimberly, ID.

infiltration rate curve indicating that some runoff

represent the same 45-foot application diameter, but in one the application is split with fore and aft booms to spread the same amount of water over a larger area, thus reducing the application rate.

The peak application rate of the standard 45-foot head is about 3.5 inches/hour. Using the boom system, the peak application rate is reduced to just a little over 2 inches/hour, although the depth of water applied is the same in both cases. The high-pressure system with impacts, while less water efficient, is able to spread the water over a large area. As a result, it creates the least amount of runoff because the peak application rate is less than 2 inches/hour.

Since high-pressure systems are less efficient and more expensive to operate, it is important to use practices that will aide in reducing runoff while taking advantage of the efficiencies of the low-pressure systems. Reservoir tillage will help accomplish this goal. This method uses an implement drawn through the field that creates “mini” pockets in the furrows that can store water until it infiltrates into the soil. The implement is commonly called a dammer/diker (figure 13). The extra storage will depend on the slope of the land with 0–2% slopes storing about 0.75 inch, 2–5% slopes storing 0.50 inch, and slopes greater than 5% storing 0.25 inch of additional water.

Figure 14 shows a sugarbeet field in southern Idaho where a dammer/diker was used in part of the field. Outside this treated area (inside the red box), was an area of reduced water movement into the soil. The soil was significantly drier than the treated remainder of the field, plants wilted, and leaf area was reduced, leaving places for weeds to get started with less competition.

Figure 13. Dammer Diker equipment for row crops.

Figure 14. Sugarbeets with dammer/diker run above and below boxed area, which was not treated. Soil was moist in the top 6 inches where the equipment was run. Soil water sensors showed water stress where it was not used.

Figure 15 represents the same situation as figure 12, with the addition of a curve showing infiltration rate following reservoir tillage. This adds an additional 0.50 inch of storage to the soil. The application rate curves for both the rotator heads on booms (45 feet + booms) and the high-pressure impact sprinklers (100 feet) are under the new infiltration rate plus surface storage curve and should result in no runoff. While the other two methods still have some runoff, it is reduced by about 0.50 inch. Additional benefits include reducing soil erosion and minimizing pivot track rut depth. Besides the benefits of improving water application efficiency, reducing runoff also helps save money by reducing or eliminating nutrients and soil lost to runoff, and it reduces the depth of pivot track ruts.

When considering runoff on the outer pivot spans it is important to keep in mind that most of the field area is under the outer pivot spans. On a ¼ mile (1,320 foot) pivot, approximately 50% of the field will be under the last 380 feet of the pivot. Runoff on the outer two spans will affect a major portion of the field (figure 16).

The 20-foot diameter curve rises above the infiltration rate curve at about 220 feet. The implication is that the outer 1,100 feet of this system will have some runoff, and the runoff will increase continually to the end of the pivot. The field area curve indicates that approximately 82% of the field area will have runoff. The best scenario on the graph indicates the high-pressure impact heads (100-foot application diameter) will have some runoff on about 120 feet of the last pivot span. Sandy loam soils are represented in figure 16. Silt loam soil will have a reduced infiltration rate, and runoff is likely to be more on silt loam soil.

It may not be possible to eliminate all runoff from a field and deliver enough water to meet ET for the crop. However, these runoff losses can be reduced by choosing the proper application package for the pivot, using fore and aft booms to spread the water pattern, and limiting the water application depth per revolution.

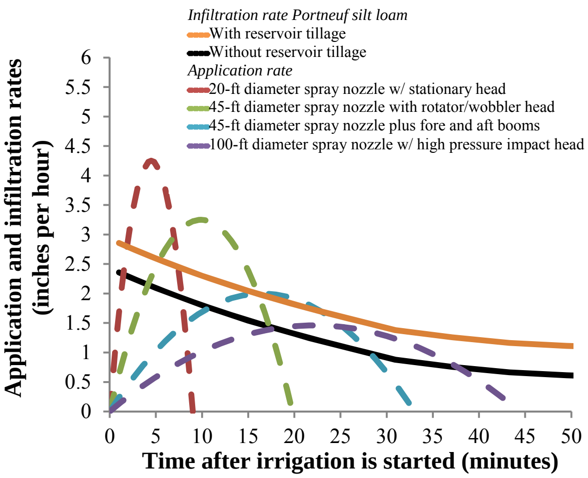

Figure 15. Estimated water application rates from three sprinkler devices under the last (outer) pivot span and from the 45-foot-wetted-diameter device with alternate fore-aft booms as compared with the infiltration rates with and without reservoir tillage for a Portneuf silt loam soil.

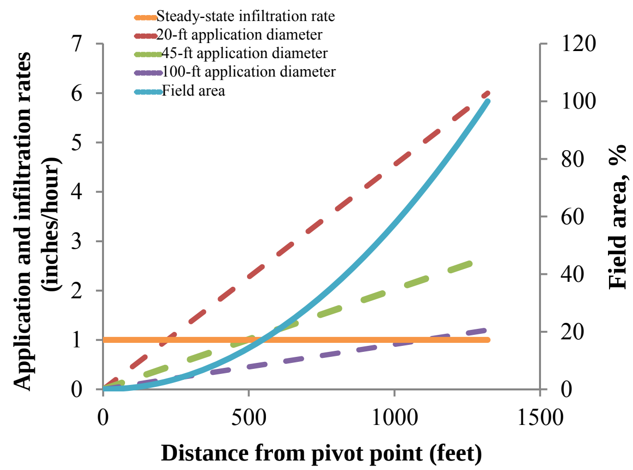

Figure 16. Steady-state infiltration rate on a sandy loam soil, sprinkler application rate, and percentage of field area with distance from pivot point.

ractices to reduce runoff.

In some situations aeration may be beneficial. Tillage practices can help improve or maintain infiltration rates as well. If the soil is compacted it will be a barrier to infiltration.

To minimize compaction, stay off the soil until it is dry enough to work or drive on without leaving ruts. On most soil, maximum compaction occurs near field capacity: about a day after irrigation on sandy soils and 2–3 days after irrigation on medium to heavy-textured soils. A chisel plow or a single pass cultivator with subsoil chisels can be used to break up the compaction layer.

There are a number of soil additives and conditioners on the market. These appear to be site/soil specific so a small on-farm trial would be beneficial to establish the effectiveness of the products on an individual field. USDA-ARS studies in southern Idaho have shown the application of polyacrylamide (PAM) to reduce runoff from some soils.

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