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Corn Kernels

Corn Information for Corn Growers

Vernon G. James Research and Extension Center, Plymouth, NC 27962

Irrigation Management in Corn

Ron Heiniger
Cropping Systems Specialist
North Carolina State University

The use of irrigation for growing corn has increased steadily over the past 30 years. The major advantages of irrigation in corn production come from an increase in yield potential and more consistent yields over time. Comparisons of commercial fields over a seven year period found that irrigated corn fields yielded over 215 bushels per acre on average; while non-irrigated fields on the same farm over the same period averaged only 140 bushels per acre. Furthermore, the irrigated yields during the seven years ranged from 194 to 245 bushels per acre; while non-irrigated yields ranged from 13 to 204 bushels per acre. The disadvantages of irrigating corn are the high initial cost of the equipment, the increase in management requirements, the cost of operation and maintenance, and the lack of good quality water resources. The lack of large quantities of good quality water is the primary limitation to the use of irrigation for corn production. Average net seasonal irrigation requirements for corn in the Southeastern US range from 5 inches on the organic soils in the tidewater region to nearly 16 inches on the sandy soils of the coastal plain region. The characteristic water use pattern of corn (Figure 4-1) shows that corn can use water at a rate of 0.35 inches per day just before and after silking. Single day peak use rates can approach 0.50 inches. Since many sandy soils contain less than 2 inches of plant available water, sandy soils in the coastal plain can sustain corn growth for only about a week during the silking period before more water is required. At a use rate of 0.35 inches per day and an irrigation system that is 85 percent efficient (modern center pivot) the gross water supply must be capable of producing 7.8 gallons per minute per acre. For center pivot system covering 130 acres, this translates into a system capacity of 1,000 gallons per minute. Because of the lack of high quality water, few, if any, center pivot systems have such a capacity. Under these conditions, the tendency is to try to spread too little water over too many acres. Southeastern growers tend to begin watering either too early or too late in the growing season and generally wait too long after rainfall events to resume irrigation. This leads to yield reductions and a failure to return a profit above the cost of the irrigation. The key to success in using irrigation is to keep the soil water storage reasonably full before the peak use period occurs (at tasseling and silking) and starting irrigation before crop stress is visible. Therefore, it is important to understand the water requirements of corn by growth stage and to use scheduling to determine when to irrigate and how much water to apply.

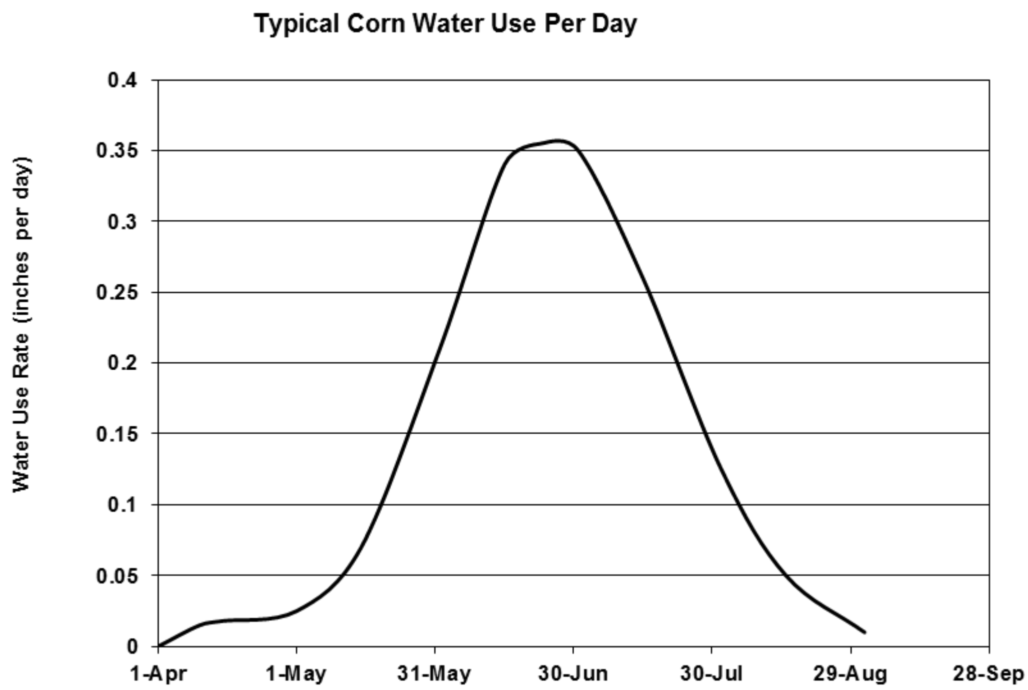

Figure 4-1. Water use requirement of a typical corn crop in the southeastern US.

Irrigation Requirements by Growth Stage

Germination and Seedling Stage (0 to 45 days after planting). Only a very small amount of soil water is necessary to germinate the seed, but adequate water in the top 12 to 18 inches of soil is essential to produce strong seedlings. On medium to fine textured soils or on organic soils, this early season water requirement is normally supplied by rainfall. On light textured, sandy soils, irrigation may be required to germinate the seed and continue proper development. Sands hold little water, so a physiological drought may occur at any time where soil water storage is limited.

During the rapid growth stage (14 to 45 days after planting), the corn plant is reasonably tolerant of soil water stress. During this period, the water use rate is increasing rapidly and some wilting in the late afternoon may be tolerated without harm if the plant regains its turgor by early morning. Available soil water can be depleted by 70 percent of capacity before yield losses occur. On medium and fine textured soils or organic soils, irrigation is seldom required during this period. On sandy soils in the coastal plain, some irrigation is usually necessary in the middle to late part of this growth period. During the late part of this period one-half to as much as an inch of water (either from rain or irrigation should be applied)

Reproductive Stage (1 week before silking to 2 weeks after the tassel appears). This is the most critical period for corn. The water use rate is near its high point. If the weather is hot, the plants need plenty of water to keep wilting to a minimum. Holding the soil water storage capacity in the top 20 to 30 percent of its available range is important to stay ahead of water depletion during a prolonged period of drought. On all types of soils, it is critical that they be near soil water capacity at the beginning of this period. Often this means that a single irrigation one week before silking is required and, in a good year, this may be the only irrigation necessary. On sandy soils, this early irrigation will, most likely, need to be followed up with supplemental applications of water every 2 to 3 days depending on the rainfall received. On low capacity systems or if the grower is using a traveling gun or cable-tow machine, water should be applied throughout this period whenever a rainfall event has not occurred for 3 days. Growers should plan on applying 1.5 to 2 inches of water per week through rainfall or irrigation.

Grain Fill (2 weeks after silking to black layer). While the corn plant is more stress resistant during this period than it was during the reproductive period, adequate water is still necessary to complete kernel development. Holding soil water in the upper 50 percent of the soil availability range until dent occurs is recommended. Following dent, soil water availability can fall to the 20 to 30 percent range without danger of hurting yield. Medium and fine textured soils and organic soils may require a single irrigation during this period depending on the amount of rainfall received. On sandy soils, the corn crop will most likely need to be irrigated at least once or twice.

In summary, the amount of soil water in the root zone should be viewed as an insurance supply. The time to rely on this insurance is when the rate of removal is slow and rainfall is adequate. This means that the time to use the soil supply is either early or late in the growing period when the use rate is low and the consequences of soil water stress on yield are also low. Irrigation should be considered the primary source of water during the reproductive stage and early grain fill stage.

Irrigation Scheduling

Irrigation scheduling should be used to determine exactly when to irrigate and how much water to apply. Scheduling can take many forms: calendar date, plant growth stage, crop condition, soil water status, and scheduling using evapotranspiration (ET). Scheduling using calendar date or plant conditions does not work well in Southeastern US. The weather is highly variable and waiting for the crop to show signs of wilt means that it is too late to prevent damage, particularly during the reproductive period. Scheduling using plant growth stage works well on medium and fine textured soils or on organic soils. Unless adequate rainfall is received, water should be applied one week before silking and every week thereafter until dent occurs. Unfortunately, plant growth stage does not work as well on sandy soils with low capacity irrigation systems because crop damage can occur before there is enough time to apply adequate water.

Monitoring soil water is a safe scheduling method with universal application. Soil water may be measured periodically using soil water blocks, tensiometers, or the hand feel technique shown in Table 4-1. Tensiometers are easiest to read, but are only meaningful in sandy soils. Soil water blocks will work in any soil, but the blocks take time to place and must be read with an electric meter attached to wires that lead from each block. The hand-feel technique is rapid and inexpensive, but is less exact and takes time to learn. Several sites in each field should be monitored and the evaluations must be made frequently enough to start irrigations on time. For assistance in using a soil moisture monitoring system consult your local county cooperative extension agent.

Scheduling can also be done using crop water use or ET calculations based on temperature and rainfall. Making use of estimated water use rates using a checkbook type routine is an excellent method of determining when to irrigate. A soil water estimate is necessary at the start of the scheduling period for each field. This soil water measurement is treated like money in the bank. Daily use amounts are deductions and rainfall and irrigation amounts are deposits. This way the amount of soil water is known at all times. Observing the trend in values can help growers anticipate precisely when to irrigate. Software programs are available to calculate water use rates from weather data.

Table 4-1. Chart for interpreting the amount of soil water in a given soil type.

Soil Water Remaining	Very SandySoil	Sandy Soil	Medium Texture or Organic Soil	Fine and Very Fine Texture
0 percent	Dry, loose, single-grained. Flows through fingers	Dry, loose, flows through fingers	Powdery, dry, sometimes slightly crusted but easily breaks down into a powdery condition	Hard, baked, cracked, sometimes has loose crumbs on surface
50 percent or less	Still appears to be dry. Will not form a ball[1] with pressure.	Still appears to be dry. Will not form a ball.	Somewhat crumbly, but will hold together with pressure	Somewhat pliable, will ball under pressure.
50 to 75 percent	Still appears to be dry. Will not form a ball.	Tends to form a ball under pressure, but seldom will hold together once released	Forms a ball, somewhat plastic, will sometimes stick slightly with pressure	Forms a ball and is very pliable. Sticks readily if high in clay content.
75 percent to field capacity	Tends to stick together, sometimes forms a very weak ball under pressure	Forms a weak ball, breaks easily, will not stick.	Forms ball, will ribbon out between thumb and forefinger	Easily ribbons out between fingers, has a slick feeling
At field capacity (100 percent plant available water)	Upon squeezing, no free water appears on soil but wet outline of ball is left on hand	Upon squeezing, no free water appears on soil but wet outline of ball is left on hand	Upon squeezing, no free water appears on soil but wet outline of ball is left on hand	Upon squeezing, no free water appears on soil but wet outline of ball is left on hand
Above field capacity	Free water appears when soil is bounced in hand.	Free water will be released with kneading	Can squeeze out free water	Puddles and free water form on surface

[1] Ball is formed by squeezing a handful of soil very firmly with fingers.

By knowing soil water capacity, the current soil moisture status, and crop use, precise amounts of water can be applied so that limited moisture supplies are not wasted and crop needs are met. This is where scheduling can be a real asset. Scheduling will indicate when the irrigation system can be shut down. Allowing the center pivot to run continuously during the bulk of the season is a common but costly procedure. In the Southeastern US, rainfall will often allow soil water storage to catch up with crop demand. On these days the system may be safely stopped and then restarted when soil moisture declines to indicated levels. Without scheduling, the grower is never sure when these periods occur and may be afraid to shut the system down or may fail to restart the irrigation system in time to meet a period of peak water demand during a long dry spell.

Management Practices that Maximize Irrigation Capabilities

Hybrid Selection. On fields that will be irrigated corn growers should select medium maturing, disease resistant hybrids that will tolerate high plant populations. With ample water, medium maturing hybrids yield as well as full-season hybrids and may be harvested at lower grain moisture. Hybrids should tolerate plant populations of 31,900 plants per acre or higher. Final plant populations of over 34,000 plants per acre produce optimum yields with irrigation.

Fertility. For optimum yields under irrigation, corn requires adequate fertility levels. Potash is particularly important to help prevent lodging and plant diseases associated with high humidity and plant populations. Apply 100 to 150 lbs/acre of K on irrigated fields whenever soil test levels indicate a need. Starter fertilizer with a 1:1 ratio of N:P is also critical to maximizing yield potential on irrigated fields. North Carolina research has shown that starter fertilizer on irrigated fields lowers grain moisture and increases yield even when soil test levels of phosphorus are high. Corn growers should plan on applying 200 to 225 lbs of N per acre in multiple applications. A proven approach is to apply 40, 120, and 40 lbs N per acre at planting, sidedress, and pe-tassel stages, respectively. Finally, additional sulfur may be necessary for irrigated corn. Additional S may be added with N applications to maintain a N:S ration of 12:1 or less.

Summary

To insure profitable production from irrigated corn, it is necessary to maintain soil water in the upper 50 percent of the soil's water availability range during the critical reproductive stage (just before and after silking). Knowing the irrigation system capacity and soil water storage capacity, it is possible to evaluate and manage irrigation requirements to maintain soil moisture levels. A corn crop uses a lot of water, but it is very good at turning water into yield. To maintain high corn yields, the grower must insure that adequate water is available.

Irrigation scheduling helps determine when to irrigate and how much water to apply. Scheduling reduces the amount of water applied and insures that adequate soil moisture levels are maintained at all times. Scheduling depends on the grower knowing the crop growth stage, the rate of water use, soil water status and holding capacity, and irrigation system capacity.