Best Management Practices for Colorado Corn

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Table 15. Estimated range of seasonal water use for major corn growing areas in Colorado.

Location	Seasonal Corn Water Use Low*		High**
	--- inches of water ---		
Front Range	22.0	----	24.3
Northeast /Lower SP	24.0	----	27.2
Central High Plains	26.2	----	30.7
Southeast High Plains	26.7	----	NA
Arkansas Valley	27.2	----	31.5
Uncompahgre Valley	24.0	----	26.9
Grand Valley	25.1	----	32.2

*Source: NRCS Colorado Irrigation Guide calculated using TR-21 Blaney Criddle equation

**Calculated from CoAgMet weather data using ASCE Penman-Monteith equation

Corn can consume up to 32 inches of water (Table 15) in Colorado, depending on location and weather. Effective precipitation during the growing season can vary widely, averaging from 4 to 12 inches across the state. In Colorado's arid climate, irrigation is needed for maximum yields. Good irrigation management requires understanding the relationships between crop plants and their environment. Producers are faced with providing adequate water to optimize corn growth and yield, while minimizing the environmental consequences of leaching and runoff.

Soil Water and Corn

Soil water holding capacity

Soils serve as a water storage reservoir for plants, but only part of the water that soil holds is available to plants. Following a heavy rain or irrigation, soil can become saturated, temporarily storing water that drains away fairly quickly to reach field capacity (Figure 22). Soil also holds water that is not available to plants, below the permanent wilting point. The soil water between the permanent wilting point and field capacity is plant available. The top 50% of this water is considered readily available water. As water depletes below half of available, it becomes less obtainable and the plant undergoes stress.

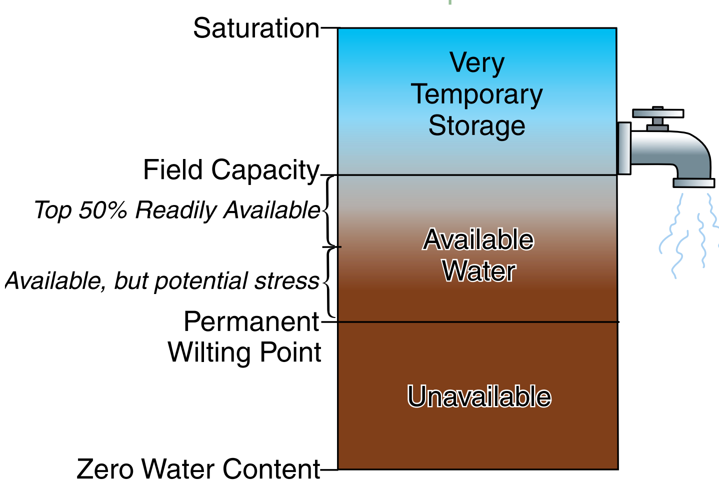

Figure 22. Soil water availability

Modified from Managing Irrigation and Nitrogen to Protect Water Quality, University of Nebraska, Lincoln.

Soil texture

Soil texture strongly influences the amount of plant available water. As clay content increases, so does the total water holding capacity. In fine textured soils, more of this water is held tightly and is unavailable to plants. Since soils are products of natural processes, textures have some variation in their water holding capacities.

Table 16. Typical ranges of allowable depletions for soils found in Colorado. Refer to a local soil survey for the most accurate value. The allowable depletion is based upon the typical rooting depth for the growth stage, the median available water holding capacity and the appropriate depletion percentage for the growth stage.

Soil Texture	Available water inches / foot Low	High	Approximate allowable depletion in rootzone at selected growth stages.* V6	V12	Tassel	R1	R3
			--------------inches water in rootzone--------------				
Coarse sands	0.6	0.8	0.5	0.8	0.9	1.1	1.7
Fine sands	0.8	1.0	0.6	1.1	1.1	1.4	2.2
Loamy sands	0.8	1.2	0.7	1.2	1.3	1.5	2.4
Sandy loams	1.2	1.5	0.9	1.6	1.7	2.0	3.2
Fine sandy loams	1.5	2.0	1.1	2.1	2.2	2.6	4.2
Sandy clay loam	1.6	2.1	1.2	2.2	2.3	2.8	4.4
Silt loams	2.0	2.5	1.5	2.7	2.8	3.4	5.4
Silty clay loams	1.8	2.4	1.4	2.5	2.6	3.2	5.0
Clay loam	1.6	2.0	1.2	2.2	2.3	2.7	4.3

*Assume unrestricted root zone

Root depth

The majority of corn roots are in the top 4 feet of soil, but they can reach a depth of more than 6 feet after silking. Most water is extracted from the top 3 feet of the rooting zone and this depth should be used for irrigation scheduling for the majority of the season, unless local knowledge or experience suggests otherwise.

Table 17. Irrigations should be timed according to the appropriate rooting zone for a given growth stage.

Growth Stage	Approximate GDU Accumulation	Approximate Rooting Depth for Irrigation Scheduling
		(inches)
Emergence	100	3 - 6
V3	250	8 - 12
V6	460	18 - 24
V9	650	24 - 30
V12	845	28 - 32
V15	1000	34 - 38
Tassle	1150	36 - 42
Silk (R1)	1300	36 - 48
Dough (R4)	1825	36 - 48
Dent (R5)	2100	36 - 48
Mature (R6)	2500	36 - 48

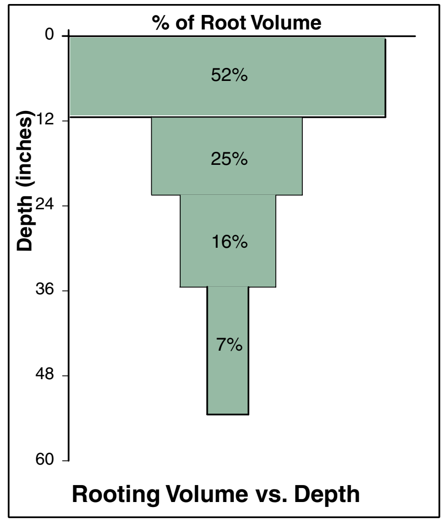

Figure 23. Although corn plant roots frequently reach to 4 to 6 feet by maturity, the average maximum rooting depth is about four feet, as found from post harvest observations*. Corn does not extract water uniformly throughout its root zone since over 75 percent of the roots occupy the top two feet and nearly 95% are in the top three feet.

*Average rooting density of 115 irrigated Colorado cornfields without any root restrictions (compaction) as observed post harvest from 1982 to 2001.

Source: Mike Peterson, NRCS

Estimating soil moisture

Estimating soil moisture status helps growers determine when to irrigate and how much water to apply. Measure moisture by the hand-feel method and moisture blocks. Consider using both for irrigation scheduling.

Soil moisture blocks measure electrical resistance within the block, which is affected by the moisture content of the soil. A drier soil will have a greater resistance than a moist soil. The two types of moisture blocks are gypsum and granular matrix blocks (WaterMark®). Fine-textured soils require gypsum blocks, since the structure of the block more closely resembles the soil structure. Use the granular matrix block for sandy soils.

Moisture blocks give a more accurate estimate of soil moisture, while the hand feel method can reveal field uniformity problems.

Place moisture blocks in at least two locations, at irrigation start and finish points and at 6", 18" and 30" depths.

The hand-feel method is a fast and inexpensive way to estimate soil moisture in several locations throughout the field, but requires some experience. Sampling the soil in the spring when the soil profile is generally at field capacity is a good way to "calibrate" your hand to that moisture and sampling dryland fields in fall for wilting point.

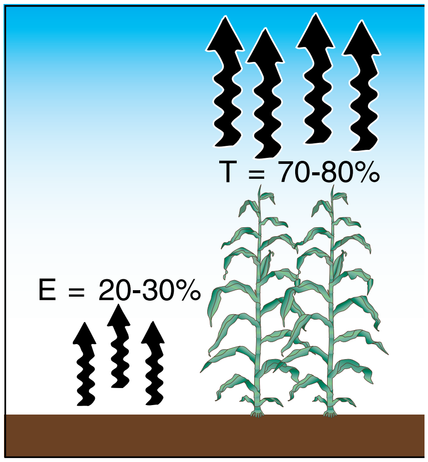

Figure 24. Percentages of seasonal evaporation and transpiration in ET.

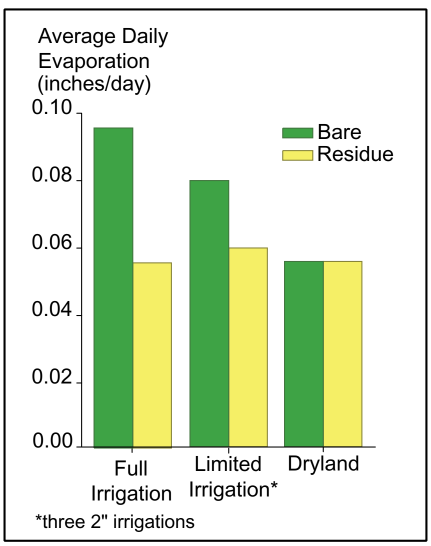

Figure 25. Average daily evaporation rates impacted by wheat straw mulch (3 tons/A). In fields under full irrigation, crop residue has potential to reduce soil moisture evaporation losses by up to 40% across the season. Although residue did not reduce soil evaporation losses as significantly under limited irrigation and dryland in these results, high residue traps winter precipitation, maintains soil infiltration and reduces soil erosion.

Source: R.W. Todd

Corn Water Use

Evapotranspiration

Water used during corn production is called evapotranspiration (ET). ET is the sum of evaporation from the soil surface and transpiration from the leaves, processes that are simultaneous. Transpiration accounts for most of the ET during the growing season and the remaining is from evaporation (Figure 24). At planting, nearly all of ET comes from evaporation, while at full canopy cover, more than 90% of ET comes from transpiration.

During evaporation, liquid water vaporizes and moves from the evaporating surface (soil and wet vegetation). Since the amount of sun reaching the soil and vegetation surfaces determines the amount of evaporation, crop residue reduces evaporation. Transpiration occurs when liquid water in plant tissues vaporizes, predominately through small openings on the leaf called stomates. Only a small fraction of all water taken up through the roots is actually used by the plant and most is lost by transpiration.

Weather affects on daily evapotranspiration

Solar radiation, air temperature, humidity, and wind speed all impact ET rates. Direct solar radiation and ambient air temperature provides energy to vaporize water. The difference between the water vapor pressure (relative humidity) at the evaporating surface and the surrounding atmosphere is the driving force to remove water vapor from the soil or plant. As ET proceeds, air surrounding the leaf or soil surface becomes gradually saturated to 100% relative humidity, and ET slows down. This is why faster wind speeds greatly increase ET by replacing saturated air close to the plant or soil surface with drier air from above.

Maximum ET rates occur on hot (greater then 90^0F), cloudless, windy days with low humidity. On hot days, a full corn canopy can use up to a half inch of water per day. In contrast, during cool (less than 80^0F), cloudy and calm days, ET rates can be 0.1 inches or less. Given the potential for considerable differences in ET rates due to Colorado weather, a reliable source of ET is valuable in estimating irrigation needs.

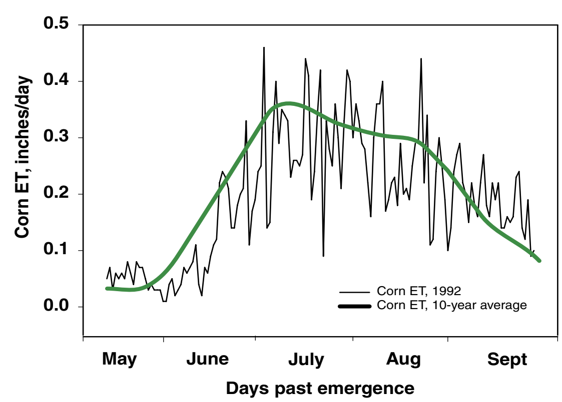

Figure 26. Daily vs. 10 year average ET in Burlington, CO.