

IRRIGATION WATER MANAGEMENT IN SUGARBEET PRODUCTION

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Proper timing of irrigation and application of the appropriate amount of water can maximize crop yield while minimizing disease, fertilizer and water use. Excess crop water stress, resulting from inadequate irrigation, can reduce crop yield. Over-irrigation can also reduce crop yield and create more favorable conditions for disease development.

UNDER-IRRIGATION EFFECTS

Because sugarbeets have a deep root system, which can efficiently extract water to depth of 3-3.5 feet in a deep soil with no restrictive horizons, effects of temporary under-irrigation can be minimal if adequate water is available somewhere in the crop root zone. On high water use days, beets may wilt because water cannot be supplied to the crop at a sufficiently high rate, even though adequate water is present in the soil. The plants will recover during the evening and night if sufficient water is available. If plants remain wilted the next morning, it is a strong indication that irrigation is needed.

Tensiometers or watermark granular matrix sensors are tools that can be used to monitor soil water status and schedule irrigation. Both instruments measure the amount of work required to extract water from the soil. Instrument readings are positive numbers that indicate soil matric potential in centi-bars (cbars), which is traditionally expressed as a negative value. A value very near 0 indicates saturated conditions, while field capacity is about -10 cbars (instrument reading of 10) for sandy soils and -30 cbars for silt loam and heavier soils. Optimum soil moisture for sugarbeet growth is between -40 and -60 centi-bars (cbars). Immediately following irrigation, readings will be about 0 and will rise as the soil dries. To avoid crop water stress, beets should be irrigated when soil moisture in the 12-18 inch range, or active root zone, approaches about -40 cbars in a sandy soil and -60 to -80 cbars in a silt loam or similar soils. At these values, about 50% of the available soil moisture has been depleted and 50% remains in the soil. Irrigating at these levels avoids excessive crop water stress, although several studies in Southern Idaho have indicated that beets can be moderately stressed with only a minor yield reduction.

Season-long deficit irrigation: Work in 1989 by Wright, et. al at Kimberly showed that beet tonnage remained constant for seasonal water application of 32-42 inches. Maximum seasonal ET was 35 inches. When seasonal water application was reduced to 13 inches, yield was reduced by about 30%. Rainfall during the growing season was 4.7 inches. The ET- yield response for the 28 – 35 inch ET range was about 1.4 tons of beets for each additional inch of water applied.

Late season irrigation management: Work in 1977 and 1978 by Carter, Jensen and Traveller showed that in deep silt loam soils, sucrose tonnage was essentially the same for beets well-irrigated for the entire season (last irrigation early October) and for beets fully irrigated until a last irrigation on August 1. Maintaining sucrose yield with about 11 inches less water applied was possible because the 3-3.5 ft soil depth and high soil water holding capacity stored about 8 inches of usable water. This stored water was available to maintain plant growth at a somewhat stressed state after August 1.

It must be emphasized that an August 1 cutoff maintained yield only on a deep silt loam soil where the entire root profile was filled to field capacity on August 1. For shallower soils or soils with lower water holding capacity, the combination of rainfall, irrigation and available soil water in the crop root zone should add to

about 8 inches. For example, if a soil holds only 6 inches of available water, an additional 2 inches of irrigation should be added after August 1 before irrigation is stopped for the season.

This irrigation strategy is easier to practice with surface irrigation or set-move systems than with center pivot or linear systems. Because of irrigation system capacity, it is possible to fill the soil profile during the late July-early August period with surface, solid set or set move systems while it is very difficult to fill a soil profile not already nearly full with a center pivot or linear.

Importance of entering peak use period with full profile with center pivots: On one study in 1996, soil moisture status was monitored with watermark granular matrix sensors at 8, 12, and 24 inches on plots irrigated by center pivot and buried drip. Due to the lack of availability of water, the beets under the center pivot entered the peak use portion of the season with only a partially full soil profile.

Because center pivot systems in this area are typically not designed to meet peak use, the system was never able to "catch up" and the soil profile continued to dry so that by mid- August, sensors at 1 and 2 feet were at -150 to -180 cbars (high water stress). The pivot was able to keep the surface 8 inches moist (0 to -100 cbars) during this period. Crop water stress was significant and beets were wilting daily. Soil moisture measurements indicated water use was from below 24 inches, which allowed the beets to continue to grow with relatively severe water stress in the top 2 feet of the soil profile.

On an adjacent subsurface drip irrigated area, system capacity was such that water could be added at greater than peak use rates and the watermark readings at all depths were never drier than -50 cbars. Plants never showed any sign of wilting. When final yields were measured, the never-stressed beets on the subsurface drip area yielded 28.5 tons/acre while the water-stressed beets under the center pivot yielded 25.8 tons/acre. Based on the appearance of the beets and the level of crop water stress, we would have expected a greater yield reduction under water stressed conditions.

EXCESSIVE IRRIGATION EFFECTS

Several sugarbeet diseases require high soil moisture for development. Development of rhizomania and both Pythium and Phytophthora root rots is maximum at saturation and decreases as the soil dries. Infection by Rhizoctonia root and crown rot is favored by excessive soil moisture. The ideal soil moisture environment for these diseases is that found in most soils during the first 2-3 days following irrigation. With excessive irrigation, those soil moisture conditions remain longer and increase disease severity and loss. Incidence of rhizomania at soil moistures of -30 cbars is about 1/3 that at saturation, while at -60 to -80 cbars incidence is less than 1/10 that at saturation. These data would suggest that, on soils prone to diseases favored by high soil moisture, disease development could possibly be slowed by keeping the soil a little on the dry side of optimum and lengthening the time between irrigations as much as possible.

An irrigation management study was conducted on a Rhizomania-infested sandy loam soil near Rupert, Idaho, in 1996. Results suggest that irrigation to maintain slightly drier than optimum soil moisture did provide higher beet yield. In an extreme comparison, beet yields were about 2.3 times greater for a Rhizomania-resistant variety grown in soil conditions maintained at slightly drier than optimum than for the same variety irrigated excessively to maintain optimum disease conditions.

Under a more normal range of irrigation conditions, yield was about 10% greater under drier than optimum conditions [matric potential kept at -50 to -70 cbars on a sandy soil (treatment 1)] relative to optimum soil moisture [matric potential of -30 to -40 cbars (treatment 2)] and about 15% greater for wetter than optimum conditions [matric potential of -20 to -30 cbars (treatment 3)]. Treatments 1-3 were irrigated every 2 to 3 days with sufficient water to keep soil moisture in the desired range.

Many fields are not uniform in soil texture and may dry more quickly in some areas. Irrigating when only a

small percentage of the field requires water may result in the majority of the field being excessively irrigated, favoring disease development. Where possible, use soil moisture sensors to monitor the majority of the field and schedule irrigations accordingly. Sugarbeets can be moderately stressed to about –100 cbars with only a minor yield reduction. In order to minimize disease problems from moisture-requiring diseases, scheduling irrigation when soil moisture is slightly on the dry side is preferable.

TIPS FOR IRRIGATION WATER MANAGEMENT ON SUGARBEETS:

1. If water is available, have the soil profile full before planting to minimize irrigation and potential crusting due to irrigation just after planting.
2. On soils that crust, sprinkler irrigate beets only when necessary for germination and emergence. Apply light, frequent irrigations.
3. After germination, keep soil moisture in the expanding beet root zone adequate, but not excessive, for disease control. Root zone depth will start at about 6 inches and expand to 3-3.5 feet by mid season.
4. After crop establishment and for the remainder of the season, tensiometer or watermark moisture sensor readings at 12-18 inches should rise to about -40 centi-bars on sandy soils or –60 to –80 centi-bars on silt or loamy soils before irrigation is required on surface-irrigated or set-move (hand or wheel line) systems. These values correspond to depletion of about 45-50% of available soil moisture (or about 50 -55% available soil moisture remaining).
5. On surface irrigated soils, use of PAM can increase the amount of water moved into the soil by about 15%. Use of straw mulch on slopes of greater than 1% can increase water intake and rate of wetting to the crop row significantly. For example, one study on a 3% sloping field of dry beans at Kimberly showed that wetting to the crop row could be achieved in 8 hours with straw vs. 30 hours without straw. This allows shorter set times, reduced runoff and the ability to divert water to other crops.
6. After establishment and up to nearly the peak use period, center pivots should be managed to keep the soil moisture at 50-55 % available or more moisture. As the peak use period approaches, the pivot should be managed to keep the entire root zone nearly full in anticipation of soil moisture mining by the crop during the peak use period when system capacity cannot meet peak crop water use.
7. Irrigation can be stopped about August 1 with little or no yield loss if an additional 8 inches of water can be supplied by soil moisture storage, irrigation or rain.