2011

2011 Chart Book: Irrigation Water Management

Peter Jeranyama
University of Massachusetts Amherst Cranberry Station, peterj@umass.edu

IRRIGATION WATER MANAGEMENT

Prepared by Peter Jeranyama

Water management is arguably one of the most critical issues affecting the cranberry industry for four major reasons, (a) crop production, (b) environmental concerns, (c) costs and (d) regulatory scrutiny. The objective of this section is to (i) introduce the concept of crop water stress index (CWSI), and (ii) discuss soil moisture monitoring devices such as tensiometers, moisture sensors and water level floats.

An evaporative demand study conducted by my predecessor showed that for many weeks during the growing season, most cranberry beds were too wet. Traditionally, cranberry beds receive one inch of water per week from either rain, capillary action from the groundwater, irrigation or some combination of these. We do not have scientific data to tell us what levels of moisture are optimum under a set of local conditions. In the absence of a standard recommendation, growers will continue to use the less reliable and familiar methods.

The conditions can vary from bog to bog. In general the following bog conditions exist in MA, (i) new renovations and constructions (0-10 years old) that have a constructed sub-grade, (ii) renovated beds that have a peat/hardpan natural underlayment, and (iii) older beds, that after sanding have developed a layered soil in the root zone, alternating sand and layers with root mass (organic layers). The layering structure of older bogs will present challenges to getting uniform contact with monitoring devices.

Plants maintain hydration and internal temperature through a process called transpiration in which water is moved from the soil, through the roots and shoots and out through pores (stomata) in the leaves. The plant can control the rate of transpiration through control of the opening of the leaf stomata to let the water out. As this process occurs, moisture is depleted from the soil.

Crop water stress index is a measure of plant transpiration calculated from canopy temperature and air dryness. The crop water stress index is the most commonly used index to detect plant water stress. However, no such index has been developed for the American cranberry (*Vaccinium macrocarpon* Ait.). When a plant is transpiring fully, its CWSI is 0 and on the other hand if a plant ceases to transpire its CWSI is 1. In other crops, CWSI has been correlated to yield, leaf water potential and soil water availability. Since there is evidence that cranberry has poor control over its transpiration process, leaf measurements alone may not sufficiently define CWSI for cranberry. There is a need to use a cafeteria approach, some measurements that include plant processes and others that measure the soil-water matrix to quantify water stress at different soil water conditions. This can then be used as the basis for irrigation scheduling over a wide variety of cranberry bogs.

Measurement of water status in other crops is based on two technologies: (i) measuring the amount of water [example - water float] and (ii) measuring the energy status (water potential) of the water [example - tensiometer]. Two desirable characteristics of a sensor or an indicator of plant water deficit are: (i) an ability to detect whether or not a plant is in fact under a drought stress, and (ii) an ability to determine the severity or degree of that water stress.

Water Level Floats. In cranberry, water level floats have been used to determine when to irrigate, but they only measure the level of the water table and do not include any plant processes or plant evaporative demand. And yet, it is the plants that in large part control the use of the soil water, thus depleting it and triggering the need for irrigation. Water level floats have the advantage that you can see the level of the water table without walking onto the bog. Instructions for constructing a water level float are available from the UMass Cranberry Station. Floats are also available for purchase at the Station.

Water demand by vines can be assessed by comparing the water level in the center of the bed to the water level in ditches to see if water is moving fast enough across the bed. By observing the water level float through several irrigation cycles, you can determine the number of hours required for an adequate irrigation.

Tensiometers. A tensiometer is a sealed, water filled tube with a vacuum gauge on the upper end and a porous ceramic tip on the lower end. Wireless versions without the tension guage are also available; these send a signal to a computer that then displays the tension reading. A tensiometer measures the soil water potential in the soil. As the soil around the tensiometer dries out, water is drawn from the tube through the ceramic tip. This creates a vacuum in the tube that can be read on the vacuum gauge. When the soil water is increased, through rainfall or irrigation, water enters the tube through the porous tip, lowering the gauge reading.

A measure of the energy status of water in the soil is valuable in providing a rigorous indication of the water availability to plants, with values that allow comparisons between a set of growing conditions.

A general problem with estimation of soil moisture potential arises because of the heterogeneity within soils, with single point measurements rarely being representative. A combination of a wide distribution of soil moisture sensors is required with an irrigation system. A tensiometer reading in the **2 to 5 cbar** range should be expected as long as the water table is between 8 and 18 inches. This range is adequate for cranberries (Table 1).

Some growers have not considered using tensiometers because they do not fully understand what they will be measuring. However, with some training, tensiometers can be powerful tools to schedule irrigation.

	Morning tension	Midday tension	Water table level
	--------cbars--------		in. below
Too wet	0 to 2	0 to 2	0 to 6
Adequate	>2 to 5	>2 to 10	>6 to 18
Too dry	>5 to 80	>10 to 80	>18

Table 1. Critical levels of tension for irrigation scheduling on cranberry beds

Volumetric Water Content: Soil water content indicates how much water is present in the soil. It can be used to estimate the amount of stored water in a profile or how much irrigation is required to reach a desired amount of water. Soil volumetric water content sensors provide a tool to measure the water content of the soil. Installing these sensors into the soil allow you to collect long-term measurements.

Based on our current research, cranberry beds seem to reach saturation when volumetric water content is close to 40% and at this water content the free air spaces are all filled with water. Irrigation should be stopped before saturation to promote water and solute uptake by the plant. On the other hand, field capacity occurs at around 10% volumetric water content. Field capacity is the water content after a saturated soil has been drained of all free water - this corresponds with when to start to irrigate.

Volumetric water content measurements are simple, reliable, and inexpensive.

Appearance and Feel Method. Although measuring soil water by appearance and feel is not precise, with experience and judgment the irrigator should be able to estimate the moisture level with a reasonable degree of accuracy.

Soil probing can be used as a check on other monitoring methods and is especially useful in monitoring the depth of penetration of irrigation applications and rainfalls. Sometimes other problems, like compacted soil layers, can be detected from the probing.

The following guideline is usually used on coarse textured soils; sandy loams and loamy sands. If soil in the hand is (i) dry, loose, flows through fingers - 0 to 25% available moisture, (ii) looks dry, will not form ball with pressure - 25 to 50% available moisture, (iii) will form loose ball under pressure, will not hold together even with easy handling - 50 to 75% available moisture, and (iv) forms weak ball, breaks easily, will not 'slick' - 75 to 100% available moisture.