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Irrigating Peppermint

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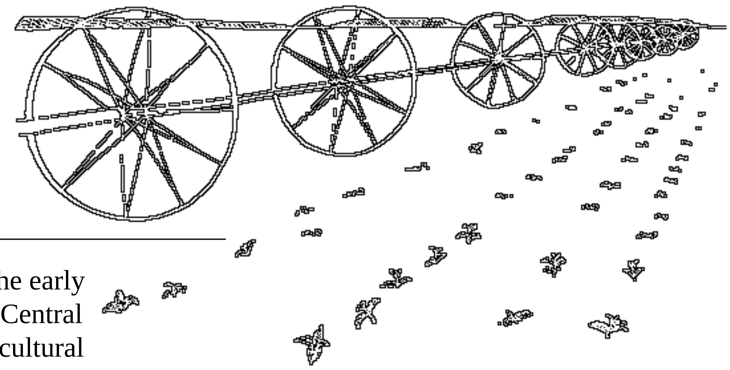

Peppermint (*Mentha piperita*, L) is a major crop in Oregon with over 50,000 acres harvested in 1995. Fifty years ago, most peppermint was grown in organic “muck” soils of the Midwest because of their plentiful supply of water. Because irrigation can overcome reliance on rainfall, in the past 40 years the majority of peppermint acreage has moved to irrigated regions of the Pacific Northwest.

The crop water use, or *evapotranspiration*, of most field crops is the dominant factor controlling yield in arid climates, and this is especially true for peppermint. In the dry summers of the Northwest, irrigation is necessary for peppermint to reach maturity. Peppermint’s dependence on irrigation was demonstrated in trials throughout the early 1990s at the Central Oregon Agricultural Research Center in Madras, OR. Inadequate irrigation reduces yield by limiting transpiration and plant metabolism. On the other hand, excess irrigation also can hurt yield (see Figure 1).

Excess irrigation may reduce yield for several reasons. Standing water limits the supply of oxygen to plant roots, and may promote root diseases, such as *rhizoctonia*. Too much water may carry plant nutrients, especially nitrogen, below the root zone. Excess water may cause the plant to lose more leaves than normal, and thus oil yield suffers because the oil concentration is reduced. Similar observations of excess water probably inspired Loomis’ hypothesis that water stress, effectively timed, may increase oil yield by influencing the plant to retain more leaves.

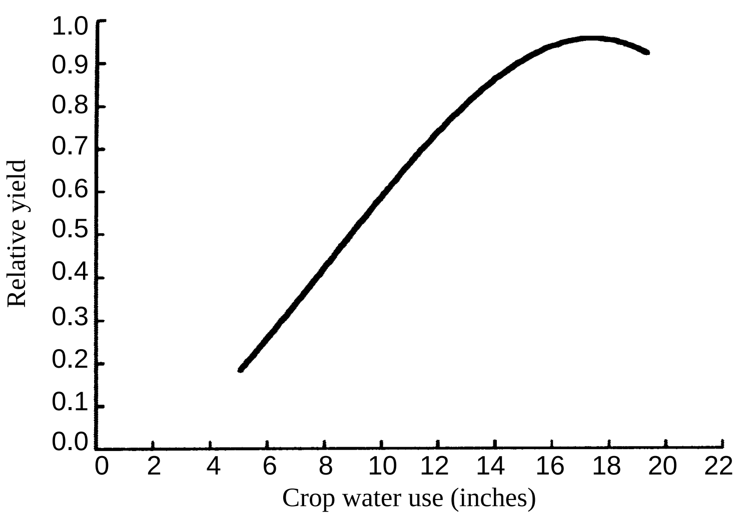

Figure 1.—Relative oil yield of peppermint as a function of crop water use for four trials over a 3-year period (Madras, OR 1992–1994).

Irrigation scheduling by crop demand

Irrigation scheduling requires knowing *how much* water to apply, and *when* to apply it. Knowledge of a soil’s water-holding capacity and the crop water requirements can provide the answers.

How much water to apply

The U.S. Bureau of Reclamation maintains an AgriMet network of more than 45 weather stations throughout the Northwest that automatically collect site-specific weather data and calculate crop water use daily. The potential crop water use is calculated from weather data by applying the modified Penman equation. Specific crop water use then is calculated using a crop coefficient, Kc, for each crop.

The Kc is an established ratio of actual to potential water use during the season, as shown in Figure 2 for peppermint in Madras, OR. The shape of the curve is typical for most crops: an initial stage as the crop starts growth, rising to a plateau as the crop

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canopy fills in, followed by a late-season decrease as the plant shifts energy from growth to setting seed.

In order to compare the Kc of 2 years with different weather, growing degree days (GDD Base 5C) based on daily maximum and minimum temperatures were used in Figure 2. The GDD, or thermal units, determine plant growth, and may be helpful in anticipating changes in the Kc.

The daily crop water use from AgriMet can be accessed directly by modem or through the Internet. For more information and an account, contact the Bureau of Reclamation's office in Boise, ID at 208-378-5282.

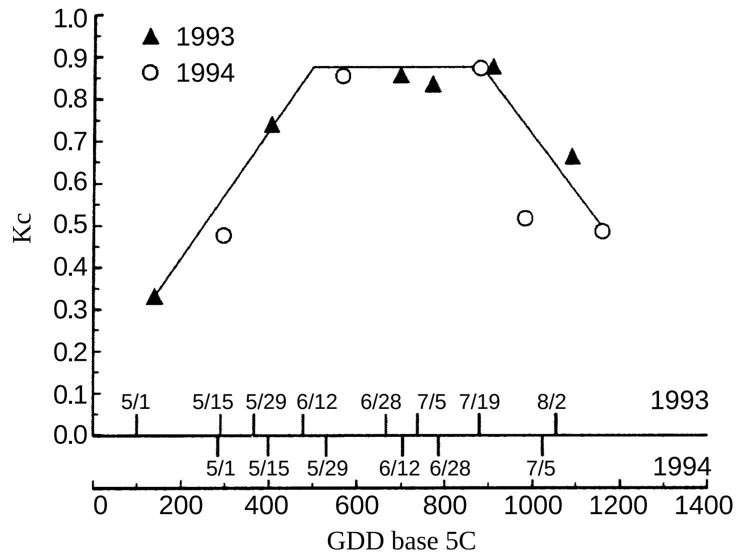

Figure 2.—Crop coefficient (Kc) for peppermint relative to potential evaporation (Madras, OR, 1993, 1994).

When to apply water

Once you have the daily crop water use data, you can determine *when* to irrigate using the "checkbook" method, in which irrigation and rainfall are "deposits" and crop water use is a "withdrawal." This is done by subtracting the daily crop water use since the last irrigation, and irrigating when the water level reaches a threshold based on certain soil conditions. This threshold equals a fraction of the available soil moisture, which is the product of the root zone depth (2 feet in most soils) and the soil's water-holding capacity based on soil texture (see Table 1).

For example, a 2-foot deep sandy loam has an available soil water of 2 feet times 1.5 inches per foot, or a total of 3 inches. For peppermint, you should irrigate when 35 percent of the available soil water is depleted; in this example, when about 1 inch is gone. If the crop water use for a certain summer period is 0.2 inches per day, then irrigation should occur every 5 days (1 inch ÷ 0.2 inches per day).

The amount to irrigate equals the soil moisture depletion plus additional water for use on the day of irrigation (the crop water use), and an extra amount to account for irrigation efficiency. Continuing the above example, you should add 0.2 inches of crop water use to the 1-inch soil moisture depletion, and divide by 70 percent efficiency. The result is 1.7 inches to apply. See also PNW 288, *Irrigation Scheduling* (see "For more information," page 4).

Irrigation scheduling by soil moisture

Soil moisture measurements provide an alternative method for scheduling irrigation. Instruments such as tensiometers, gypsum blocks, or Watermark sensors (Irrometer, Inc., Riverside, CA) can be used.

Four sensors should be placed in the middle of the root zone, a 4- to 6-inch depth for peppermint. One or two sensors should be buried at a depth of 18 to 24 inches to monitor deep soil moisture. Peppermint should be irrigated when the shallow (root zone) sensors reach a soil tension of 50 centibars (or kiloPascals, kPa), the units used to measure soil pressure.

The deep sensors indicate whether irrigation amounts have been adequate to replenish the root zone moisture. If

Table 1.—Water-holding capacity of different soil textures, and properties of soil moisture by the feel method.

Soil Texture	Water-holding Capacity (inches/feet soil)	Adequate Soil Moisture	Critical Soil Moisture for Irrigation (on squeezing)
Fine sand	0.7 to 0.9	Leaves wet outline on hand	No wet outline on hand
Sandy Loam	1.5	Forms weak ball	Forms weak ball under pressure
Loam, Silt Loam	2.0	Forms strong ball	Forms weak ball
Clay Loam	2.3	Easily ribbons between fingers	Forms ball, feels dry, not easily pliable

the deep sensor readings continue to increase in spite of irrigation, this indicates a reduction in soil moisture, and the amount of irrigation should be increased. This can be done by irrigating for longer periods of time.

If, on the other hand, the deep sensors indicate a wet soil of less than 10 kPa, then the amount of irrigation should be decreased. Figure 3 shows real Watermark sensor data for a field of peppermint during a growing season.

Instead of using sensors, an experienced grower can use the "feel method" of determining soil moisture. This method consists of collecting a handful of soil from a 4- to 6-inch depth and testing its consistency by feel to gauge the soil moisture. When the soil dries to a critical point, irrigation is necessary (see Table 1).

Another low-tech tool to measure soil moisture is a simple metal rod that can determine whether adequate soil moisture exists in the lower root zone. This is done by attempting to push the rod 2 feet into the soil. If the rod penetrates, then soil moisture exists. But watch for rocks and cracks!

Spring irrigation

When peppermint begins to grow in April, the top 3 inches of soil may dry out although the rest of the soil is wet. While irrigation probably is necessary to promote stem and stolon growth and emergence, there is a high risk of irrigating too much, which may promote root disease and wash nutrients from the soil. Small irrigation amounts (less than 1 inch) should be applied in order to avoid standing water on the crop. Sprinkler irrigation may need to be shortened to 6-hour sets.

Post-harvest irrigation

Peppermint should be irrigated as soon as possible after harvest, allowing time to fertilize and to propane-flame for verticillium wilt control. Peppermint that is not irrigated after harvest will lose carbohydrate reserves, thus reducing its winter survival, and the yield will suffer the following year.

Studies in 1992–1993 in central Oregon compared a fall irrigation treatment of only 3 sprinkler irrigations to a well-watered control of 10 irrigations. Though they were treated the same the following spring through harvest, the well-watered treatment yielded 12 lb mint oil per acre more than the water-stressed treatment.

Irrigation methods

Peppermint may be irrigated by sprinkler, center pivot, or furrow irrigation systems.

Side-roll sprinklers

Irrigation by side-roll sprinklers is the most common method used in Oregon. Many growers use a 1,320-foot-long side-roll sprinkler on 20 acres. Sprinklers usually are 40 feet apart and irrigation moves are 60 feet. Thus the 660-foot width of the 20 acres takes 11 moves. When moved twice a day, the system takes 5½ days to irrigate the entire field.

Although sprinkler irrigation is noted for its very even application, factors such as wind or equipment malfunctions can cause uneven water distribution. The uniformity of side-roll systems may be improved by offsets (see PNW 286, *Offsets for Stationary Sprinkler Systems*).

Center-pivot irrigation

Center-pivot irrigation has the advantage of automatically irrigating large fields, but less water typically is applied on the edges of the circle. Irrigating more often with center pivots can result in higher crop water use due to increased evaporation of water on the soil and plant surfaces.

Higher water use and the small amounts of water applied by the center pivot require that attention be given to deep soil moisture content. If deep soil moisture is depleted early in the season, it may be difficult to replenish during high water-use summer periods with the small applications of a center-pivot system.

Furrow irrigation

Furrow irrigation has the uneven distribution problems inherent in any flood irrigation system. A level field and uniform soil are necessary to ensure consistency of application, and even then, the efficiency of application usually is much less than that of sprinkler irrigation. Soil erosion also can be a problem on newly planted peppermint fields that have little or no crop residue to stabilize the soil.

In Oregon, most furrows are spaced 30 inches apart, although spacings may be increased, or alternate furrows may be irrigated to apply less water per irrigation.

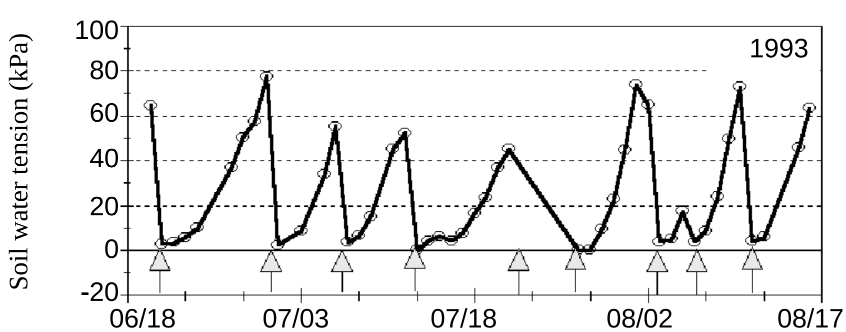

Figure 3.—Soil water tension measured by Watermark sensors, with irrigation designated by arrows (Madras, OR, 1993).

Furrow irrigation may improve the concentration of oil in the leaves, compared to sprinkler irrigation. It has been found that sprinkler irrigation promoted observable damage to the oil glands. However, before making a decision for furrow over sprinkler irrigation, the merits of reduced oil-gland damage and higher potential yield should be weighed thoughtfully with the costs of the two systems.

Annual irrigation amounts

For budgeting crop expenses, it's valuable to know the amount of irrigation water required annually as well as the cost to obtain and pump the water. Of course, as with any crop, weather factors will influence potential crop water use and crop growth patterns of peppermint, and thus the annual crop water use will vary for any given year and among the many peppermint-growing regions of the Pacific Northwest.

Peppermint crop water use as estimated by the AgriMet system is quite uniform when considered over a 7-year period, averaging 23 inches for most areas in the Pacific Northwest (Bureau of Reclamation, 1995). Other estimates were less, in the range of 20 inches per year depending on the region, but they did not account for post-harvest irrigation, which would add 4 to 8 inches to the total.

Central Oregon experiments showed 16.3 inches of water use until harvest in 1993 and 1994, and adding fall irrigation amounts gives approximately the same number, or 22 to 24 inches. Amount of rainfall and the inefficiency of irrigation systems, mentioned previously, should be taken into account to arrive at the total irrigation water need. For a typical 70 percent irrigation efficiency, over 34 inches would be required to net the 24 inches needed by the crop.

For more information

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