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Supplemental Irrigation Scheduling for Potato Production

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This factsheet is intended to help farmers reduce the risk of over- or under-irrigating potatoes in Prince Edward Island (PEI). Soil holds water by applying suction on the water against gravity. The potato plant pulls water and associated nutrients from the soil by overcoming the suction and gravity. Suction increases as the soil becomes drier, making it harder for the plant to pull out water and nutrients. As soil moisture drops below a certain level, the plant is no longer able to effectively pull water and nutrients from the soil, compromising tuber yield and quality. Excess soil moisture can also decrease tuber yield and quality by damaging the root system. Ideally, water management should maintain soil moisture within the potato plant's optimal range using irrigation and/or dewatering. This optimal moisture range varies with soil parameters and potato plant growth stage. Irrigation scheduling (determining when and how much water to apply) has to account for variations in soil parameters and crop growth stage in addition to weather. The soil parameters include:

- **Field Capacity (FC):** The upper limit of moisture that a soil can hold, or in other words, the amount of moisture held in soil after excess water is drained away by gravity.
- **Wilting Point (WP):** The soil moisture level at which most plants (including potato crops) can no longer pull water from the soil (they wilt and fail to recover upon rewetting).
- **Available Soil Water (ASW):** Soil moisture minus WP.
- **Water Holding Capacity (WHC):** The maximum amount of water that a given soil can hold against the pull of gravity for crop use (i.e. maximum ASW). $WHC = FC - WP$.

These parameters vary with soil texture (Table 1) and *soil organic matter* (SOM) level. Generally, a soil with higher SOM has a higher WHC than a similar soil with lower SOM. With an increase of 1% SOM, FC increases by about 5% and WP increases by 1% for the typical loam soils found in PEI. FC and WP values expressed as volumetric soil moisture content (V%) for various soils are listed in Table 1.

For water management purposes, potato plant growth can be divided into four stages: **I.** Initiation (sprout development); **II.** Development (vegetative growth); **III.** Midseason (tuber initiation and bulking); **IV.** Late season (maturation). The duration of each stage varies with potato variety.





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Typical stage durations for the common Russet Burbank variety are 0–25 (I), 30 (II), 45 (III) and 30 (IV) days in PEI.

Research shows that optimal ASW for the potato plant ranges from 65% to 85% WHC for the initiation, development and midseason stages, and from 50% to 65% WHC for the late season stage. This means that during the initiation, development and midseason stages, growers should irrigate if and when ASW falls to the 65% WHC level and the forecasted rainfall is insufficient to raise available soil water to the 85% WHC level. During the maturation stage, growers should irrigate if and when available soil water drops to the 50% WHC level and the forecasted rainfall is insufficient to rewet the soil to the 65% WHC moisture level. The soil moisture levels corresponding to these soil moisture thresholds for various soils are listed in Table 1.

Table 1: Soil moisture parameters and levels for potato irrigation scheduling

Texture	*Field Capacity (FC; V%)	*Wilting Point (WP; V%)	Soil moisture at 50% WHC (V%)	Soil moisture at 65% WHC (V%)	Soil moisture at 85% WHC (V%)
Sand	7–17 (10)	2–7 (4)	7	8	9
Loamy sand	11–19 (17)	3–10 (5)	11	12.8	15
Sandy loam	18–28 (23)	6–16 (10)	16.5	18.5	21
Loam	20–30 (25)	7–16 (11)	18	20	23
Silty loam	22–36 (30)	9–21 (12)	21	24	27
Silt	29–35 (32)	12–18 (15)	23.5	26	29
Silty clay loam	30–37 (33)	17–24 (18)	25.5	28	31
Silty clay	29–42 (36)	14–29 (21)	28.5	31	33.7
Clay	32–39 (36)	19–24 (21)	28.5	31	33.7

*Range (average)

An example is shown below for how to schedule a supplemental irrigation event. In this example, it is assumed that a grower plants Russet Burbank potatoes in a sandy loam soil and that the potato plants are in the midseason stage (Stage III). The current soil moisture reading (average of 3 measurements taken at 15, 30, and 45 cm depth from the top of the potato hill) is 18% and the forecasted rainfall over the next five days is 7 mm. The current soil moisture content (18%) is below the lower moisture level (18.5%), indicating that irrigation is needed if the forecasted rainfall will not raise the moisture to the upper level (21%) (Table 1). The grower does the following calculation to check if irrigation is needed:

$$\text{Irrigation Rate (mm)} = (\text{Upper Soil Moisture Level} - \text{Current Soil Moisture}) \times \text{Potato Root Depth} - \text{Rainfall} = (21\% - 18\%) \times 300 \text{ mm} - 7 \text{ mm} = 2 \text{ mm} = 0.08 \text{ inch}$$





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The calculation shows that the forecasted rainfall is 0.08" short of the upper moisture level. So, the grower needs to supplement 0.08" of water with irrigation. Another factor to consider is net irrigation versus gross irrigation. In our example, the 0.08" of water needed to be supplemented refers to net irrigation. Net irrigation is the amount of water stored in the soil after water application, whereas gross irrigation refers to the amount of water put out by the irrigation system. Generally, a low-pressure centre pivot with drop tubes applies water at 80 to 85% efficiency and a high-pressure pivot with impact nozzles is about 75% efficient. Assuming that the grower uses a low-pressure centre pivot with 85% efficiency in our example, the gross irrigation rate is $0.08/85\% = 0.09$ inches. The other possibility is that higher rainfall brings the available soil water above the 100% WHC level, which can occur in PEI in some wet seasons. In this case, a soil dewatering system such as tile drainage can help remove the excess moisture for optimal plant growth.

Over time, the rewetted soil gradually loses water to the atmosphere via evapotranspiration, decreasing the soil moisture. In a typical PEI growing season the moisture will likely fall below the triggering level again in about five days for a typical loam soil. Growers should monitor soil moisture the day after irrigating to confirm the target moisture level has been met and then monitor soil moisture and weather every two days for scheduling the next irrigation event. A practical alternative to monitoring soil moisture is to aim for a total of one inch of water supply to the potato plant every irrigation cycle in July and August. One irrigation cycle is considered to be five days for soils with more sand and lower SOM, and seven days for soils with less sand and higher SOM. Subtracting the forecasted rainfall amount from one inch gives the amount that needs to be supplemented with irrigation every cycle.

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