AGRI-FACTS
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Crop Water Use and Requirements

Crop water use is the amount of water used by a crop for growth and cooling. Crop water use can be determined on a daily, weekly or growing season basis.

The amount of water used by a crop is affected by a number of factors including the availability of soil water, precipitation during the growing season, stages of crop growth, crop rooting depths and environmental factors including amount of solar radiation, humidity, temperature and wind. A prolonged water deficit will have a significant effect on a crop.

Crop water use and evapotranspiration

Crop water use is referred to as "evapotranspiration" or "ET." It is the combination of water evaporation (E) from soil and plant surfaces as well as water used by plants for growth and transpiration (T). Transpiration refers to the water lost to the atmosphere through the stomata, which are small pores on the surface of plant leaves, as the plants work to avoid heat stress.

Crops need water for both growth and cooling

Evaporation is usually only significant when the soil surface is moist or when the crop canopy is wet, which is typically after precipitation or irrigation events. After the top 2 to 4 cm of surface soil has dried, evaporation of water from soil is usually minimal.

Evaporation from the soil surface is also greatly reduced as the crop canopy closes to completely shade the soil surface. At full crop canopy, almost all the ET is from transpiration by the crop. The maximum ET rate occurs when soil water is not a limiting factor.

Crops use their root system to extract water from the soil. The rate and amount of water taken up by a crop is affected by the soil water content, stage of plant growth and effective rooting depth.

The average amounts of ET for alfalfa, barley, canola, corn, flax, pea, potato, timothy and wheat are provided in Figure 1 for May to September, along with the approximate growing season water requirement. It is important to note that these moisture use curves and total crop water use values are based on optimum soil moisture conditions and, therefore, can be quite variable depending on environmental conditions.

From Figure 1, annual crop water use is low at the beginning of the growing season and gradually increases as the crop develops through the various vegetative growth stages, peaks at reproductive growth and then gradually declines as the crop matures.

Water use for vegetative growth

For annual crops such as wheat, barley or canola, a certain amount of moisture is needed to not only initiate germination, but to take the crop through the vegetative growth stages to the point where grain can be produced.

For wheat, barley and canola, it takes at least 100 mm (4 inches) and often closer to 125 mm (5 inches) of water to get a crop from germination to the point where it reaches reproductive growth to produce grain. The amount of moisture needed during vegetative growth varies because in a cool spring, crops do not need quite as much moisture for transpiration, compared to a warm, dry spring.

All crops shown in Figure 1 are cool season crops, with the exception of corn. For cool season crops, daytime high temperatures in the range of 20° C are ideal for growth as crops are able to use more of the available soil moisture for vegetative crop growth than for transpiration to keep cool.

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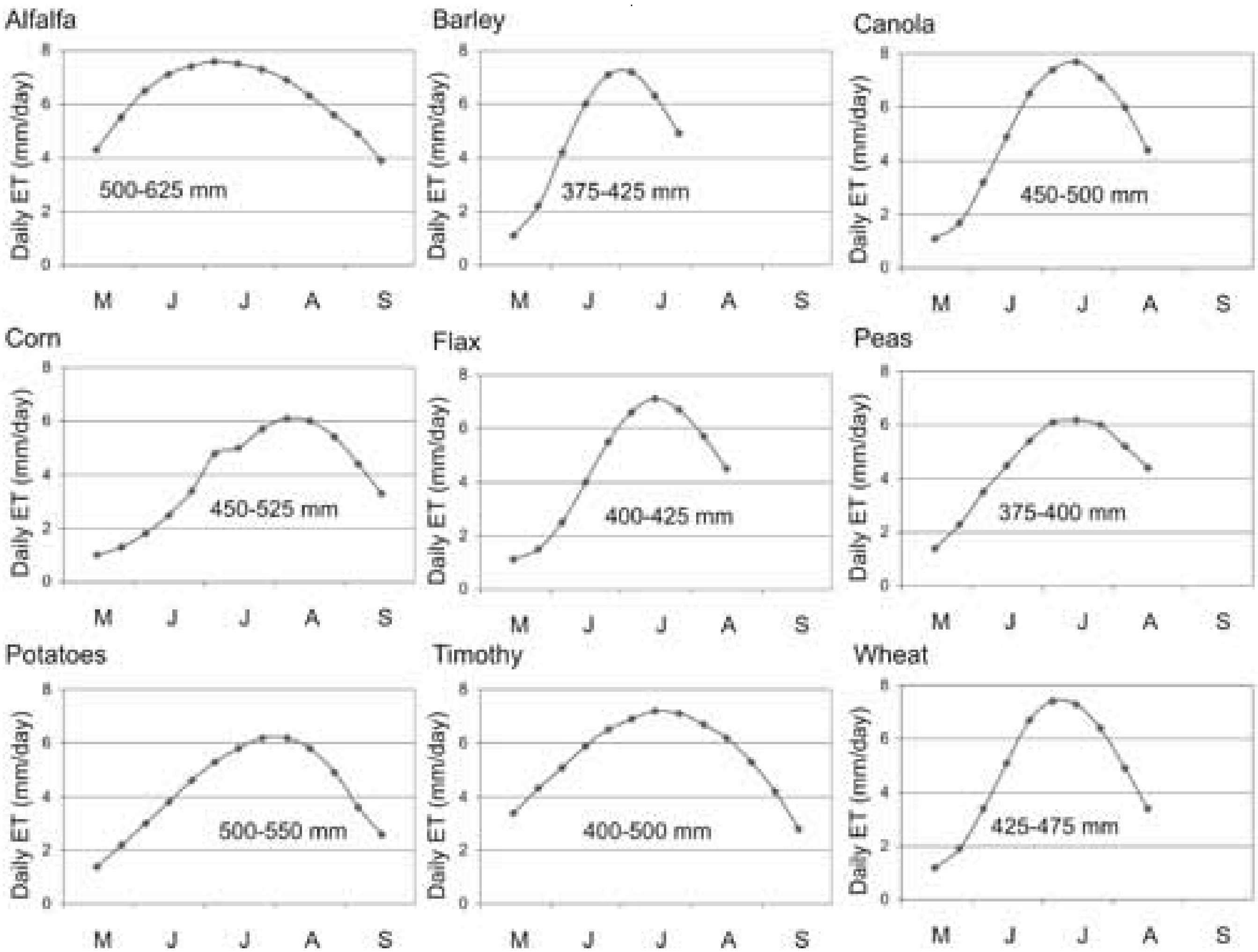

Figure 1. Approximate daily water use and total growing season water use in millimetres (mm) for some commonly grown crops in Alberta. Average water use shown is when soil moisture is adequate throughout the growing season.

Cereal crops at the tillering stage will use approximately 2 to 3 mm/day of water and at the stem elongation stage, they need about 3 to 5 mm/day of water. When temperatures are above 25° C, the moisture needed is about 5 mm/day. On warm days at the stem elongation growth stage, a cereal crop will use about 20 to 35 mm of water in one week, depending on environmental conditions such as solar radiation, humidity and wind.

When cereal crops are at the heading stage, often by early July, water use is in the range of 7 to 8 mm/day under ideal conditions. This situation means that peak water use is substantial from mid-June to late July or early August for cereal crops grown in Alberta. If moisture is lacking during this period, significant yield reduction can occur.

Water use for reproductive growth

Once a crop shifts from vegetative to reproductive growth, water use remains high. Cereal crops after heading and canola at the flowering growth stage will continue to use 7 to 8 mm/day of water from heading to flowering and to grain filling, under optimum growth conditions. As grain filling nears completion, crop water use declines and drops off rapidly as plants approach maturity.

Alberta research has shown that wheat needs 25 mm (one inch) of water to produce 5 to 7 bushels/acre. For barley, calculations show that 7 to 9 bushels/acre is produced, and for canola, 3.5 to 4 bushels/acre is produced under good environmental conditions for each 25 mm of water.

Effects of moisture stress on crops

When a crop is in a moisture deficit condition during vegetative growth, the first effect is a reduction in the growth rate of leaves and stem. When soil moisture availability is limited, cell expansion and division within the plant slows down. The effect is that plants will reduce the production of enzymes and proteins needed for growth.

As the soil moisture deficiency increases, plant roots cannot take up enough water to meet transpiration needs. Crops respond by closing their stomata, which are the small pores in leaves that release the water vapor for cooling the plants. Plant leaves become less rigid, and leaves exhibit wilting in mid-day heat. As air temperatures cool and solar radiation decreases later in the day and into the evening, plants will recover from wilting as stomata open to meet transpiration needs.

When cereal crops begin wilting, older leaves and tillers are aborted, and stem elongation is reduced. When oilseed crops wilt, plants respond by abortion of older leaves, reduced stem elongation and reduced branching, which will reduce crop yield potential.

If the moisture deficit becomes more advanced, wilting becomes more prolonged each day until plants reach a point that recovery overnight does not occur and, plants completely senesce and die.

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