AGRI-FACTS
Practical Information for Alberta's Agriculture Industry

Revised December 2011 Agdex 142/561-1

Irrigation Scheduling for Dry Bean in Southern Alberta

Irrigation management is about controlling the rate, amount, and timing of applied irrigation water in a planned and efficient manner. With good irrigation management, a dry bean crop can have high yield and quality potential.

Irrigation management

The goal of irrigation management is to use available irrigation water effectively in managing and controlling the soil moisture environment of crops to do three things: promote the desired crop response, minimize soil degradation, and protect water quality.

Proper irrigation management requires a good understanding of a number of factors:

- soil fertility (crop nutritional requirements)
- soil-water-plant relationships
- crop type
- crop sensitivity to water stress
- crop growth stages
- availability of a water supply
- climatic factors that affect crop water use such as rainfall, temperature, humidity, and net radiation

Equipped with such knowledge, an irrigator can develop a workable and efficient irrigation scheduling program.

Depleting soil water to less than 60 per cent of available can result in reduced dry bean yield and quality.

Strategies

A workable and efficient irrigation management strategy should be crop-specific. Crop-specific irrigation management strategies mean available water is used efficiently to meet a specific crop's water requirements for maximum water productivity.

Generally, the goal is to ensure that water is available at germination and in early development by applying light, frequent irrigations (if there is no rainfall). This method promotes vigorous growth and replenishes and increases available soil water content in the entire root zone during the pre-flowering growth stages. Such a strategy will allow irrigation systems to keep up to crop demand during the peak water use period, which typically occurs during the flowering and fruit-formation growth stages.

Crop-specific irrigation management strategies are usually applied to adjust for the following differences among crops:

- effective root zones
- sensitivity to water stress
- types (cool versus warm-season)
- vulnerability to diseases at various crop growth stages
- response to soil fertility levels
- plant population/densities
- physiologic maturity (timing of last irrigation)
- potential income

Government of Alberta

Dry bean water needs

Dry bean uses water for growth and cooling purposes. The water requirement or evapotranspiration (ET) for dry bean depends on variety, plant architecture (Type I, II, III, and IV), growth stage, bean class, canopy density, climatic conditions, and irrigation and crop management.

Dry bean grown under optimal conditions (well-fertilized, well-irrigated, well-drained soils, pest-free stand, and uniform and optimum canopy) requires from 300 to 375 mm of water per growing season in southern Alberta.

Average dry bean water use ranges from 0.1 mm per day soon after emergence to nearly 7 mm per day during flowering and early pod development stages (Figure 1).

Dry bean is shallow-rooted. Typically, the roots grow to an effective water extraction depth of 60 cm in a well-developed soil. Root distribution is concentrated near the surface; hence, dry bean obtains 85 per cent of its seasonal water from the upper 40 cm of the active root zone of 60 cm. The active root zone changes from a few millimetres at emergence to a maximum depth of 60 cm at the flowering growth stage.

Dry bean grows well and has high yield and quality potential when the soil water in the active root zone is kept between 60 and 100 per cent of the available water-holding capacity of the soil.

Irrigation scheduling strategy

Effective dry bean irrigation scheduling uses soil water levels in the root zone as a measure for starting and stopping irrigations. Adequate soil water is critical for dry bean during emergence, vegetative (pre-flowering), flowering and pod-set growth stages. Therefore, it is best to have a soil profile (0 to 60-cm depth) that is near field capacity at planting (field capacity is the maximum amount of water a soil can hold, provided the soil drains freely).

Dry bean needs to have water for germination and root development during the early stages of growth. If the seedbed (surface 10 cm) is dry (less than 60 per cent of available), a light irrigation of 15 mm should be applied prior to seeding. Inadequate soil water in these early growth stages results in reduced plant populations and biomass yield, which, in turn, reduces final yield.

Avoid irrigation just after seeding dry bean because it may lead to soil crusting, which results in problems with crop emergence, hence, reduced plant populations and reduced seed yield.

Dry bean will reach canopy closure early, mature early, and yield more if ample water is available in the root zone during the vegetative (pre-flowering) growth stages. To ensure ample water is available to dry bean during the vegetative growth stages, available soil moisture should not be depleted to less than 60 per cent in the 30-cm root zone. Figure 2 indicates how quickly the canopy closure

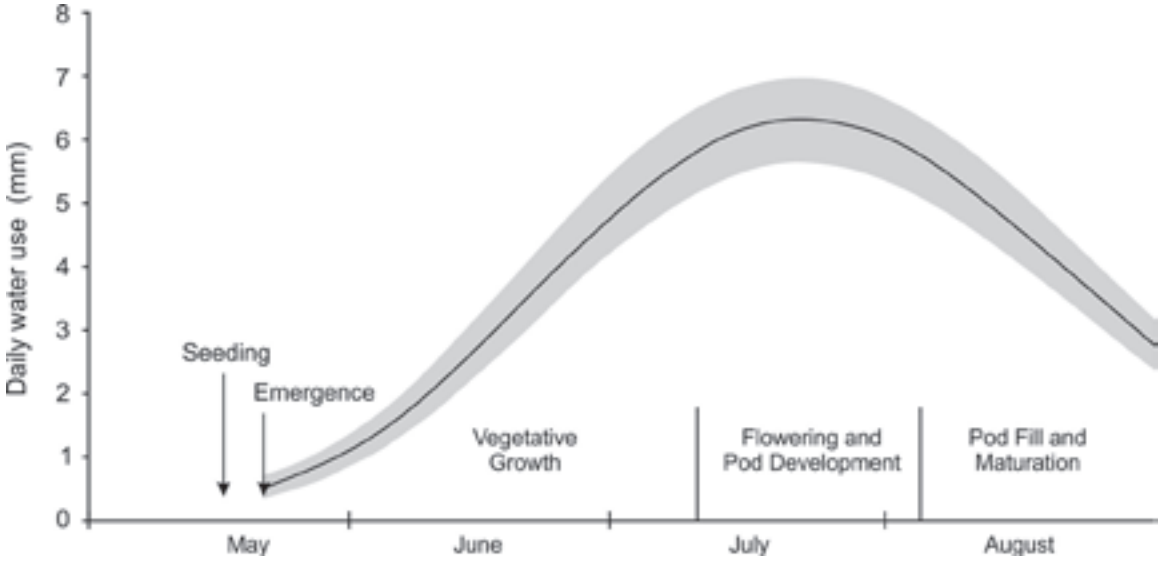

Figure 1. Daily water use during different growth stages of irrigated dry bean in southern Alberta. Shaded area indicates the variation in dry bean water use depending on plant type, cultivar, and climatic conditions.

30-cm root zone 60-cm root zone

Figure 2. Dry bean (Pinto) irrigated using a 30-cm versus a 60-cm irrigation management root zone during vegetative growth stages (third week in July).

occurs when a 30-cm root zone is used to manage irrigation on dry bean during the vegetative growth stages versus using a 60-cm root zone.

Managing soil water in a 30-cm root zone translates to light and frequent irrigation applications during the pre-flowering growth stages. Irrigation water applied during vegetative growth stages should meet crop water requirements and build up soil water to near field capacity in the 30 to 60-cm zone for later crop use during the peak water use period when flowering and pod-setting is occurring.

In general, dry bean is most sensitive to inadequate soil water during the flowering and pod-set growth stages. Inadequate soil water during these stages results in flower and pod abortions.

Dry bean roots reach maximum extension at the flowering growth stage. To ensure that soil water is adequate throughout the root zone, the monitoring depth of the root zone should be increased from 30 cm to 60 cm, and soil water should not be depleted to less than 60 per cent of available (i.e. allowable depletion should not be greater than 40 per cent of available).

Increasing the irrigation management root zone from 30 cm to 60 cm at the flowering growth stage requires less frequent and larger irrigation volumes and results in increased water availability to the mature dry bean roots. This increased time between irrigations keeps the soil surface dry, discouraging the growth of white mould.

Mould

Irrigation should be scheduled to fill the entire 60-cm root zone to field capacity at the beginning of the pod-fill growth stage to avoid frequent irrigation during the pod-fill and maturation growth stages when the crop is most vulnerable to white mould. This irrigation strategy may help reduce the severity of white mould infection.

Soil water may be depleted to near 50 per cent of available during the pod-fill growth stage (without significant yield loss) if conditions for white mould exist (cloudy and humid weather conditions) before the next irrigation.

Soil texture

Irrigation amounts required to replenish the root zone once the allowable depletion of soil water is reached will vary with soil texture and growth stage, as indicated in Table 1. Irrigation may be stopped when at least 80 per cent of the pods show yellowing (striping) or when 50 per cent of the leaves are yellowing on the plant.

Table 1. Soil texture-based estimation of total available water and water amounts per irrigation event for dry bean during vegetative, flowering, pod-set, and pod development growth stages				
Soil texture	**Vegetative (pre-flowering) growth stages**		**Flowering, pod-set and pod-fill growth stages**	
	Available water in a 30-cm root zone (mm)	**Water required to replenish soil to field capacity at 40% allowable depletion (mm)**	**Available water in a 60-cm root zone (mm)**	**Water required to replenish soil to field capacity at 40% allowable depletion (mm)**
Loamy sand	34	**14**	68	**28**
Sandy loam	42	**17**	84	**34**
Loam	54	**22**	108	**43**
Sand clay loam	46	**18**	91	**36**
Silt loam	60	**24**	120	**48**
Clay loam	60	**24**	120	**48**
Silty clay loam	66	**26**	132	**53**
Sandy clay	52	**21**	103	**41**
Silty clay	64	**26**	127	**51**
Clay	58	**23**	115	**46**

Conclusion

Using good irrigation strategies with dry bean can mean a healthy crop with high yield and quality potential. In addition to ensuring that the dry bean crop is well-fertilized and well-protected from pests, growers are encouraged to properly manage irrigation by regularly monitoring soil water to ensure that the availability of water does not become a limiting factor in producing a high yielding dry bean crop.

Applying irrigation just before the soil water is depleted to 60 per cent of available and replenishing available soil water near field capacity in appropriate root zones will greatly assist in producing a high quality and high yielding dry bean crop.

Prepared by

Alan Efetha
Alberta Agriculture and Rural Development

For more information, contact

Alberta Ag-Info Centre
Call toll-free 310-FARM (3276)

Website: www. agriculture.alberta.ca

12/11/100