Water Management

High rainfall during the fall and spring periods and during snow melt runoff often causes saturation, flooding and water erosion of most soils, while low rainfall during the summer period often causes a water deficit for most crops. High watertable and water deficit conditions are both detrimental to optimum crop production, but both may be largely overcome with irrigation, appropriate tillage, soil management and drainage.

GENERAL IRRIGATION COMMENTS

Evapotranspiration exceeds precipitation for the period from May through September in the interior of British Columbia. Climatic moisture deficits (Precipitation minus Potential Evapotranspiration from May to September) range from -498 mm at Oliver to -295 mm at Vernon Coldstream Ranch. Supplemental irrigation is, therefore, required to reduce the climatic moisture deficit and achieve maximum production. Designing an efficient irrigation system requires a good understanding of soil, crop and moisture relationships. The effects of soil type, crop rooting depth and climate are important when considering irrigation system application rates and set times. Four specific criteria must be considered when designing an irrigation system. Those criteria are:

- Maximum Soil Water Deficit
- Maximum Irrigation System Application Rate
- Maximum Irrigation Interval
- Irrigation System Water Requirement.

Note: *For a detailed examination of how to design an irrigation system, please refer to the British Columbia Sprinkler Irrigation Design Manual available from any irrigation dealer or contact your dealer.*

MAXIMUM SOIL WATER DEFICIT

The maximum soil water deficit is the maximum amount of water that can be removed from the soil before the crop is affected. It is calculated from the rooting depth and availability coefficient for the crop and the available water storage capacity for the soil that the crop is to be grown in.

EFFECTIVE ROOTING DEPTH

The effective rooting depth of a mature crop is that depth of soil from which a crop removes significant amounts of water. The standard depths used for an irrigation system design can be modified for soils which do not permit normal root development. Compaction of the surface or the subsurface soil layers, excessively coarse subsoil, impervious subsoil, poor soil drainage, high watertables, adverse soil chemistry and fertility problems are all factors which could reduce the effective rooting depth for irrigation.

Irrigation systems must be designed to meet crop requirements. Shorter duration and more frequent irrigations are required for crops that cannot reach their full rooting depth or do not like large amounts of water at one time.

AVAILABLE WATER STORAGE CAPACITY

The available water storage capacity of the soil is the depth of water that can be retained between field capacity and permanent wilting point. The capacity of a soil to store water depends upon the particle size composition (texture) and particle arrangement (structure) of the soil. To obtain an estimate of the water-holding capacity of a soil, it is necessary to determine the texture of the soil within the effective rooting depth of the crop to be irrigated. Soil textural classes are determined from the percent of sand, silt and clay present within the mineral fraction of the soil.

AVAILABILITY COEFFICIENT OF CROP

Different crops have varying capabilities of withdrawing moisture from the soil. Only a portion of the total available water storage capacity is readily available for plant use. The availability coefficient is the maximum fraction of the total available water storage capacity stored in the root zone that can be removed before irrigation is required. Allowing depletion of soil moisture to exceed the levels indicated by the availability coefficient, may result in a reduction of crop yields.

MAXIMUM IRRIGATION SYSTEM APPLICATION RATE

Water infiltration into the soil surface depends on soil texture, structure and type of ground cover. The irrigation system application rate should be limited to the infiltration capability of the soil. The objective is to eliminate runoff, ponding of water and puddling of the soil under the irrigation system. Exceeding the maximum design application rates shown below, could lead to soil degradation by compaction or erosion over the long term.

Soil compaction and erosion can result in lower crop yields if poor irrigation practices are continued from year to year. Proper nozzle selection and maintenance is important to ensure that maximum soil infiltration rates are not exceeded. For sloping ground the maximum rate must be reduced. A general rule is to reduce the maximum application rate by 25% for field slopes exceeding 10% and by 50% for fields with slopes exceeding 20%. Field tests under actual sprinkler conditions should be conducted to determine accurate application rates.

MAXIMUM IRRIGATION INTERVAL

The maximum irrigation interval is the maximum number of days between irrigations that a crop can sustain optimum growth and production. It is calculated by dividing the maximum soil water deficit by the peak evapotranspiration rate. The actual irrigation interval may differ from the maximum irrigation interval if the irrigation system does not apply the total amount of water capable of being stored in the soil at the maximum soil water deficit. Irrigation should be applied to most crops when 50% of the water in the soil, which is available to the plants, has been depleted.

EVAPOTRANSPIRATION RATES

Evapotranspiration (ET) is a measure of the rate at which water is transpired from plants plus the water evaporated from the soil and crop surface. The peak ET averaged over the irrigation interval decreases as the interval increases. Since the irrigation interval is related to the available water storage capacity of the soil, peak ET decreases with an increase in maximum soil water deficit. Ginseng is grown under shade and with a mulch cover so all the data collected from other crops will not work.

Irrigation Application Systems

In the interior of British Columbia you can be sure whatever your location, that irrigation will be needed from time to time. Some areas will need added moisture up to six or seven times per season. Extra irrigation volume may also be needed for land preparation when you are trying to germinate weeds and reduce large organic materials for a good seed bed.

The main uses of irrigation in an established ginseng garden are:

- General soil moisture maintenance needed for all crops
- Heat stress prevention which has become a valuable tool in ginseng production (see Heat Stress page 117).
- In ginseng at seeding time, it is also important to wet and settle the straw mulch immediately after application to reduce wind damage. It is also important to moisten the soil around the seeds to keep them moist throughout the fall. This process also triggers the germination of volunteer grains in the mulch that are used to help hold the mulch in place. (See Mulch page 67 for details)

Note: *Frost protection with irrigation is **not** recommended for ginseng as too much water would have to be applied to be effective, as water must remain turned on, until the temperature is above freezing.*

It is not our intention here to give a full blown course on irrigation structure and design. There are irrigation companies in business to do this. There is also the *British Columbia Sprinkler Irrigation Manual* produced jointly by the British Columbia Ministry of Agriculture, Food and Fisheries and the Irrigation Industry Association of British Columbia, available from irrigation companies that gives lots of details.

There are though some points to consider when choosing irrigation systems or setting up a ginseng garden, as ginseng is not a typical agricultural crop.

One of the major differences is that you are limited to 24, 30 or 36 foot irrigation pipe spacings down post rows, or multiples of these, for one of the dimensions in a design pattern. The second dimension, for sprinkler head placement, you are limited by the post spacings within the post row of 24 or 30 feet in most cases. (See the Ginseng Garden Planning section, page 57.) This has limitations in what can be done through the irrigation system because the water distribution pattern will not be as even as where you have a free design situation.

IRRIGATION SYSTEM TYPES

There are a number of systems available for applying irrigation water. These include solid set, hand move and giant reel. Careless application of water can lead to erosion on sloping land, so application rates should be sufficiently low so you don't exceed the infiltration capacity of the soil. Furthermore, care should be taken not to exceed the water-holding capacity of the soil, since further additions of water will cause saturation and eventually runoff, erosion and possibly encouraging soil born diseases to start. The placement of irrigation systems in ginseng gardens are:

- UNDER THE TARP/ OVERHEAD — This system is a solid set system (although it could be a hand move) that uses low angle heads that place water between the tops of the plants and the tarp.
- REEL AND GUN — This system would run along the side of the garden and place water over the top of the shade cloth. Generally this would be used where the need for irrigation is minimal and only needs to be supplied occasionally. This system would not be effective for heat stress prevention (see Heat Stress, page 117).

A typical ginseng garden would need to consider the following in their design:

- HEADS – low angle heads (6° – 9°) so water does not hit the shade cloth
  - pressure 45 – 55 psi
  - nozzle sizes $^{1}/_{8}$ – $^{5}/_{32}$ (3 – 5 gpm)
- PIPE
  - pipe sizes 1 – 2" but will depend on garden bed length and nozzle spacings
  - pipe strength of 160 – 210 psi
  - some mechanism to control pipe snaking (expansion / contraction) with the heating / cooling of air is necessary. (in a 30 foot garden the pipes run down a gutter so this is not a problem)
  - rows generally are kept to under 600 feet to reduce the need for larger sizes of pipes
  - make sure the pipe is extended past the last sprinkler, to the end of the garden so draining in the fall will not wash the beds.

IRRIGATION SCHEDULING

Determining how much water and when you need it is always a question and will depend on various factors:

- water in soil already
- soil type
- mulch depth
- plant age / root zone depth
- temperature and air movement
- long range forecast

The system has to run long enough to penetrate mulch and soil to the desired depth of the root zone. Since ginseng does not like wet feet, it is also imperative that overwatering does not occur. Tensiometers are available that will measure the soil moisture and can be a helpful tool in garden management. Call an irrigation dealer for information on these tools for measuring water. Because of the shade structure and the mulch, general irrigation measurements for evapotranspiration used for other crops cannot be followed and none have been established for ginseng.

Impact of large drops of water disperses soil particles and leads to compaction. Nozzles should be chosen to discharge water in small droplets. Also, soils that have been wetted by irrigation are more vulnerable to compaction from traffic. This would be a factor mainly in the preparation year.

You want to watch how early and how much you water in the beginning of the season, when evaporation and plant requirements are low, to reduce the potential for root disease. You need to watch this carefully all season as there could be a tendency to overwater during hot, dry periods.

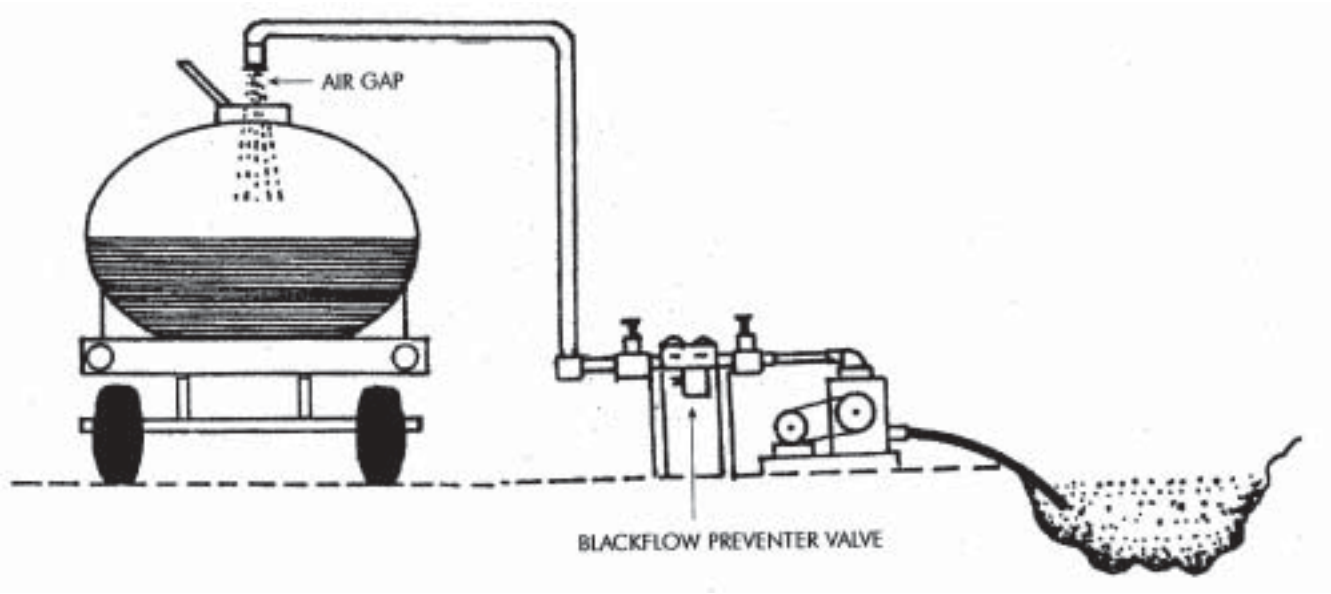
Soil must be kept adequately moist within a fairly narrow range in the root zone. Without a moisture meter or other mechanical or electrical devices that are available, you will need to develop techniques to assess this. If you take soil and squeeze it in your hand and it stays in a ball when bounced a bit in your hand, there should be adequate water. If it falls apart then you may need to water. Sandier soils will not hold together well and soils high in clay content will hold together with less water so some adjustment for soil types will be necessary.

If possible you should water in the early morning so the crop has adequate time to dry before mid-day heat. You also want to assure that plants are not wet going into the evening, reducing the potential for fungal disorders getting started.

BACKFLOW PREVENTION VALVE

In any system where siphoning of water could take place into a waterway or public system, a backflow prevention valve is necessary by law. It is also good to have a water break when filling tanks for spraying so chemicals cannot flow back into the system. See figure 18 for details.

FIGURE 18. Diagram of tank filling system



FERTIGATION/CHEMIGATION WITH IRRIGATION SYSTEM

This is where fertilizer or pesticides are injected through the irrigation system. Most ginseng gardens are not designed adequately to give an even distribution of water so this practise is generally not recommended.

TRICKLE IRRIGATION

Just a short statement on this system. It is not used on ginseng for two major reasons:

- Cost — it would be very expensive to install, especially on lighter soils where lines would have to be placed quite close together.
- Soil saturation around emitters for long periods in this type of system would allow diseases to start, such as phytopthora root rot.

Note: *All the above and much more is in the British Columbia Sprinkler Irrigation Manual available from your irrigation supply company. The British Columbia Ministry of Agriculture, Food and Fisheries does not handle this item.*