B.C. IRRIGATION MANAGEMENT GUIDE

Chapter 9

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Prepared by

B.C. Ministry of Agriculture, Food and Fisheries
Resource Management Branch

Published by

Irrigation Industry Association of British Columbia

2005 ISSUE

LIMITATION OF LIABILITY AND USER'S RESPONSIBILITY

The primary purpose of this B.C. Irrigation Management Guide is to provide irrigation professionals and consultants with a methodology to assess the irrigation system performance and manage the system effectively.

While every effort has been made to ensure the accuracy and completeness of these materials, additional materials may be required to complete more advanced assessments. Advice of appropriate professionals and experts may assist in completing assessments that are not covered in this Guide.

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9 CHEMIGATION, FROST PROTECTION AND CROP COOLING

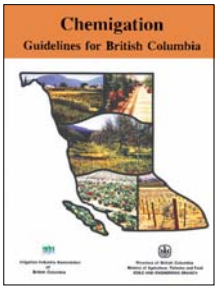
Irrigation systems are often used for other purposes, such as the application of fertilizers, pesticides and other chemicals, frost protection and crop cooling. Irrigation systems that are applying chemicals must be designed and operated at the highest distribution uniformity (DU) possible. A level 3 irrigation management plan should be done to ensure that the system is operating at peak performance.

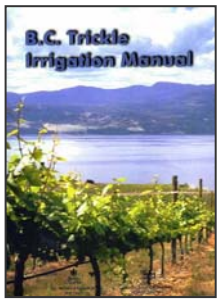
The distribution uniformity is not as important from an environmental perspective for crop cooling or frost protection. However, better uniformities will improve the performance of irrigation systems for both frost protection and crop cooling.

9.1 Chemigation

Chemigation is the practice of injecting chemicals into an irrigation system. Chemicals may be injected to improve the performance of the irrigation system, such as chlorine or acids in drip systems, or applied to the crop or field to treat pests, such as fertilizers, herbicides, insecticides, fungicides, nematocides and growth regulators. If used effectively, chemigation may reduce the amount of fertilizers and pesticides applied annually due to better timing of applications and improved efficiency in the case of drip systems.

The manual "Chemigation Guidelines for British Columbia" provides guidelines on the laws and regulations regarding chemigation use as well as information on how to operate irrigation systems for chemigation. If





planning a new irrigation system that will be applying chemicals, a Certified Irrigation Designer (CID) should be retained to design and provide a certified irrigation plan. Two important components of chemigation are safety and environmental protection.

📖 **Chemigation Guidelines for British Columbia**

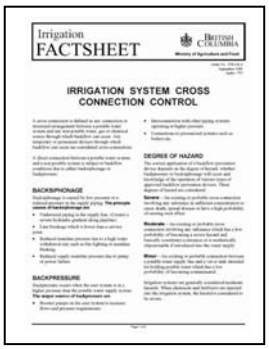
📖 **B.C. Trickle Irrigation Manual**

System uniformity is essential to prevent over-application of fertilizers or pesticides. Also, the risk of contamination of the water source due to back-siphonage and back-pressure (as in unexpected shutdown of the irrigation system during injection) is a concern. Use the following good practices:

- Design the irrigation system to ensure good uniformity throughout.
  - sprinkler systems should have a minimum uniformity of 80%
  - trickle systems should have a minimum uniformity of 90%
  - if unsure of the system uniformity, conduct an audit as outlined in the next section
  - if the audit indicates poor uniformity, retain a Certified Irrigation Designer (CID) to evaluate the system and suggest system improvements
- Calibrate equipment and follow proper chemigation procedures to minimize the risk of excessive application and chemical drift.
- Install an approved back-flow prevention device.
- Follow the regulations system operation information provided in the Chemigation Guidelines

➔ **Irrigation System Uniformity Check, Chapter 4**

Safety


Irrigation
FACTSHEET
BRITISH COLUMBIA
IRRIGATION SYSTEM CROSS CONNECTION CONTROL

Safety considerations include personal safety and protection of drinking water supplies. Many of the water sources used for agricultural irrigation purposes are also potable water supplies. Proper cross-connection control procedures should be used to prevent contaminated water from entering a potable water source. Before applying herbicides or insecticides through an irrigation system, check to ensure that the product label specifies:

- the chemical is registered for the pest to be controlled
- the chemical can be used for the crop to be treated
- the irrigation system used is an acceptable method of application

📖 **Chemigation Guidelines for British Columbia**

📖 **Irrigation System Cross Connection Control**

Environmental Protection

Environmental protection must be a key consideration when using irrigation systems to apply chemicals. To protect the environment while chemigating, check the following:

- ensure that the irrigation system has a high uniformity
- the system be operated in a manner to ensure chemicals are applied to the target area only
- apply chemicals for only a portion of the irrigation set to ensure that the irrigation system lines can be properly flushed
- do not exceed the soil water storage capacity to ensure that chemicals are not leached from the crop root zone
- do not operate in windy conditions

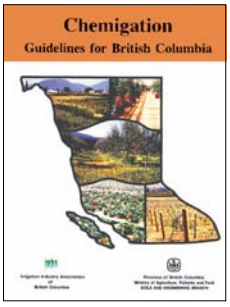
Sprinkler irrigation systems that are operating at 80% uniformity could still be applying two to three times more water to some portions of the field than other areas. If fertilizers or other chemicals are being applied with the water, excessive chemicals may be applied to portions of the field, especially if the uniformity is much less than 80%.

The information in the previous chapters provides much of the information required to evaluate and improve the irrigation system performance. The following section provides information on assessing irrigation system uniformity.

Preparing a Chemigation Worksheet

To operate a chemigation system properly there are a number of parameters that need to be determined for each zone. There are also a number of calculations and that are required to determine a proper chemigation application rate and operating schedule. When operating the system for a number of different crops, irrigation zones and chemicals it can be easy to make mistakes. A chemigation worksheet should be prepare for each zone and posted at the chemigation site. The worksheet is especially useful as a future reference when additional applications are required.

Sprinkler Irrigation Worksheet



Worksheet 28(a) lists the type of information that should be recorded for sprinkler irrigation systems applying chemigation. The worksheet provides the basic information required to operate a chemigation system. The blank worksheets at the back of this guide provide enough space to record data for a number of different fields or the application of various chemicals. For each data set recorded for each field, the sets or zones should be equal in area and be applying the same chemical.

Refer to the Chemigation Guidelines for British Columbia for information on how to calculate injection rates and injection times.

Chemigation Guidelines for British Columbia

Sprinkler and travelling gun irrigation systems generally do not cover a large portion of the farm for each set or zone. Quite often 15 to 20 sets or zones must be operated to cover the entire farm. Considerations for sprinkler chemigation are:

- If all the laterals are the same length, the amount of chemical to be applied for each set will be the same. If some laterals are

longer than others the amount of chemical to be applied must be adjusted accordingly.

- If fertilizer is the chemical to be applied, irrigation after injection has ceased may be required to move the fertilizer down into the crop rooting zone.
- The chemical application must be accomplished within the normal set time of the irrigation system.

Example 9.2 Sprinkler Irrigation System in Armstrong (VIII)

Worksheet 28(a) Chemigation Information – *SPRINKLER*

Question: A grower is applying 20 kg of nitrogen through a wheel line system using calcium nitrate that has 15.5 % nitrogen content. The application will be repeated three times over the season. The following irrigation system information and chemigation operation information are recorded for future use.

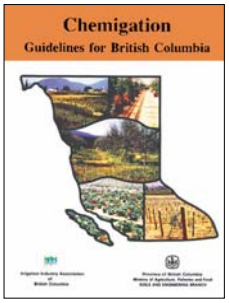
Information:

INFORMATION	Value	Unit	Source
System Information			
	Field 1		
Crop	*Alfalfa*		Worksheet 10(a)
Field area	*69*	ha (170 ac)	Worksheet 3(a), Box 10
Number of irrigation sets	*26*	sets	Worksheet 15, Box 16
Area covered per set	*2.6*	ha	Worksheet 1, Box 16
Sprinkler Spacing	*30 x 60*	ft x ft	Worksheet 12, Box 1
Nozzle size	*11/64 x 3/32*	in x in	Worksheet 4(a)
Operating pressure	*50*	psi	Worksheet 4(a)
Sprinkler flow rate	*8.0*	US gpm	Worksheet 4(a), Box 7
Application rate	*0.32*	in/hr (8.1 mm/hr)	Worksheet 15, Box 11 or 12
Irrigation set time	*12.7*	hr	Worksheet 15, Box 13
Chemical Applied (obtain all information from system operation)			
Number of applications per year	*3*		
Date of application	*May 1, 2004*		
Area to be treated per application	*2.6*	ha	
Chemical	*Calcium Nitrate*	*15% Nitrogen*	
Amount of nutrient to be applied per application	*20*	kg/ha	
Total amount of chemical to be applied	*132*	kg/ha	
Amount of chemical required for area	*343*	kg	
Injection rate	*1.5*	L/min	
Injection start time after irrigation begins [hr]	*8*	hr	
Length of injection time per set [hr]	*2*	hr	

Trickle/Drip Irrigation Worksheet

Drip irrigation zones may cover a larger area than sprinkler irrigation zones. The calculations for drip systems are based on each zone. Zones should be designed so the crop type, crop maturity and soil type are the same through the entire zone. Considerations for drip irrigation system chemigation are:

- Drip irrigation systems do not apply water to the entire field but are generally designed to apply water directly to the plant. The chemical to be applied must therefore also be calculated on a plant basis. The number of plants within the zone must be tabulated.
- To prevent plugging from occurring in the drip system, the injection rate must be matched to the zone flow rate to ensure that the concentration of injected material in the irrigation lines does not exceed 1 – 2%.
- Sufficient flush time should be allowed to ensure that the lateral lines are cleared of all chemicals.
- The run time for drip systems is usually less than sprinkler systems. Drip systems also apply water more frequently than sprinkler systems. The amount of chemical that is applied per application is therefore usually less. However, the application time available is also less. More frequent applications with less chemical applied per application is better than more chemical being applied less frequently.



Worksheet 28(b) lists the type of information that should be recorded for drip irrigation systems applying chemigation. The worksheet provides the basic information required to operate a chemigation system. The blank worksheets at the back of this guide provide enough space to record data for a number of different zones or the application of various chemicals. For each data set recorded for each field, the zones should be equal in area and be applying the same chemical.

Refer to the Chemigation Guidelines for British Columbia for detailed discussion on chemigation calculations.

Chemigation Guidelines for British Columbia

Example 9.3 Trickle Irrigation System in Kelowna (IV)
Worksheet 28(b) Chemigation Information – *TRICKLE*

Question: A grower in the Okanagan is applying nutrients to an apple crop. The 5.7 ha orchard and vineyard is irrigated with a drip system and is divided into four zones. See Figure 4.2. The zones are not of equal size so a separate worksheet is required for each zone. The worksheet for zone 4 is shown here. The grower wishes to apply a total of 10 grams of nitrogen and 15 grams of phosphorus to each plant in five equal applications early in the growing season. Ammonium Polyphosphate is to be used as the nutrient source.

Information:

INFORMATION	Value	Unit	Source
System Information			
Zone	*4*		
Crop	*Apples*		
Treated area	*0.75*	ha (1.8 ac)	Farm Plan – Figure 4.2
Plants per zone (zone 4)	*378*	plants	Farm plan
Emitter spacing	*3*	m	Farm plan
Emitter flow rate	*21.5*	L/hr – (5.7 gph)	
Emitters per plant	*2*		
Operating pressure	*20*	psi	
Zone flow rate	*72*	US gpm	
Zone operating time	*2.5*	hr/d	

Chemical Applied (obtain all information from system operation)

Date of application	*May 1, 2004*	*May 1, 2004*
Area to be treated per application [ha]	*0.75*	*0.75*
Chemical	*10% Nitrogen*	*34% Phosphorus*
Amount applied per application [g/plant]	*2*	*3*
Total amount of chemical to be applied [kg or L]	*5.5*	
Injection rate [L/hr]	*11*	
Injection start time after irrigation begins [hr]	*1.5*	
Length of injection time per set [hr]	*0.5*	

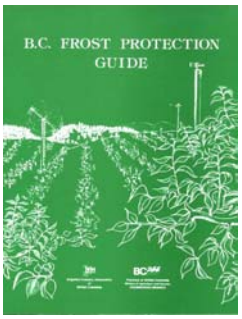
9.2 Frost Protection

Sprinkler irrigation systems are also often used as a means of frost protection. Water is applied to a crop when a frost freezes which releases heat to protect the crop. As long as water is continually applied during the frosting period, the freezing will keep a protective layer of water adjacent to the plant material, protecting the plant from frost. If designed and operated properly, irrigation systems can protect crops for up to 3 – 4 ^{o}C of frost.

The environmental concerns with respect to using irrigation for frost protection is the quantity of water required and the potential runoff that

may result from the ice melt and the large amount of water that needed to be applied during the frost.

Water Supply



Frost protection is usually done in the spring. The amount of frost protection that can be accomplished with irrigation will be limited by the water source. If water supply is a concern, on-farm water storage should be considered.

The peak flow rate required for frost protection is 100 – 125 gpm per hectare of protected area. If 40 days of frost protection are required for 10 hours per day, the amount of water required would be 10 ac-ft per hectare (4 ac-ft per acre) of protected area.

B.C. Frost Protection Guide

Surface Water

A water licence for frost protection is required if taken from a surface water source. The annual water requirement will vary from year to year depending on frost conditions. The number of days and hours of frost protection must be estimated to determine the annual water requirement for the licence.

A storage pond is often used to augment the water supply for a frost event. The pond can then be used to collect any runoff that may occur due to the frost protection.

Irrigation District or Municipal Supply

An irrigation district or municipal system will often not be able to supply enough water to protect the entire farm. Municipal supplies often limit users to a flow rate that matches the irrigation needs during peak summer conditions. Frost protection using water supplies from irrigation districts or municipalities will be limited to 10 – 15% of the farm area.

Groundwater

The area that can be protected from frost with irrigation from a groundwater source is limited by the well supply and the pumping capacity that has been installed.

Runoff Control

Using irrigation for frost protection often applies much more water than what can be stored in the soil. Once frost protection with irrigation has begun, it must continue to operate until the ice has melted from the crop. Stopping irrigation prematurely can cause more damage than if frost protection had not even been attempted.

Frost protection may also be required for many nights in a row, compounding the problem. Runoff in these situations is likely and should be controlled. The amount of water that is required may also be excessive.

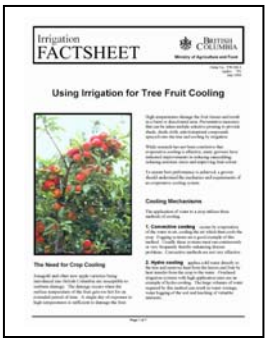
An on-farm storage facility can help control runoff from the farm and provide a reliable water supply for frost protection. Up to 75% of the daily water used for frost protection can be returned to storage. The storage facility should be sized to accommodate a frost protection supply of three to four days minimum. This should be calculated using the area to be protected and assuming 10 hours of operation. The storage facility will need to be topped up as required.

If a storage facility cannot be constructed, the runoff from frost protection should be collected in small diversion ditches, screened and returned to a surface water supply.

9.3 Crop Cooling

Crop cooling with irrigation during summer heat spells has become more prevalent as higher value crops are being produced. The mechanism of cooling is to evaporate the water from the crop surface; thereby, providing an evaporative cooling effect. A good cooling system does not add any appreciable moisture to the soil. Cooling is usually required at the same time of year that irrigation needs are at the highest.

A water licence cannot be obtained for crop cooling. Irrigation districts do not supply additional water for crop cooling needs. Therefore, a grower who wishes to use water for crop cooling purposes would have to take a portion of the irrigation allotment for crop cooling. This can be done by increasing the efficiency of the irrigation system and saving a portion of the water for crop cooling purposes. For example, installation of a drip irrigation system can save 35 – 50% of the irrigation water. Approximately one third of the farm can then have a crop cooling system operating.


Irrigation FACTSHEET

Using Irrigation for Tree Fruit Cooling

Another option is to develop additional water supplies through on-farm storage or drilling of a well.

Using Irrigation for Tree Fruit Cooling