Irrigation, Mulches and Frost Control

Commercial vegetable and potato growers are showing an increased interest in irrigation. Optimum yields are necessary if growers are to stay in business. Research and practical experience has shown that lack of water at critical stages of crop development is a very important factor affecting yields. With today's marketing situation, more emphasis is being placed on product quality. Water is an essential component for vegetable growth and health. Not only do vegetable crops contain a high percentage of water (80-95%), they also use a large amount of water, through transpiration, as they grow. To produce almost any crop in Ohio, large quantities of water are needed from either rain or irrigation, or a combination of both. For some crops, 400-600 pounds of water will be needed to produce one pound of dry matter. For additional reading on irrigation and drainage in Ohio, refer to AEX-370 and AEX-320, available through your county Extension office.

Sprinkler Irrigation

There are numerous considerations for growers thinking of investing in an irrigation system. Proper soil tilth, organic matter and weed control are necessary for vegetables to benefit from irrigation. Crops grown on sandy soils generally respond better to irrigation than those crops grown on medium- or fine-textured soils that hold moisture.

Good drainage is very important for successful irrigation. Tile and surface drainage should be installed before irrigation to avoid crop damage. Generally, a well yield or stream flow of 6-15 gallons per minute (gpm) is required per acre to be irrigated.

Where a farm pond is the water source, 1.0-1.5 acre feet of water should be stored for each acre to be irrigated. When an irrigation well is to be drilled, the ODNR Division of Water, Fountain Square, Columbus 43224, should be contacted to determine if an adequate groundwater supply is available.

One man-hour of labor per acre is required for a handmoved irrigation system. Mechanically moved systems require only 10%-15% as much labor. Each system must be tailored to fit the particular job. Most irrigation equipment suppliers provide engineering service and cost estimates on request.

Growers with irrigation systems have found uses for the systems every growing season. However, irrigation is not a substitute for other cultural practices. The water must be applied in the right amount, at the right time and at the proper rate. There are many management decisions involved in irrigation, including soil texture, soil structure, crop rotation patterns and the amount of water needed by different crops.

Many growers wait too long before applying water. Unfortunately, research and experience show that damaging water shortages can exist before the plants show any visible evidence of a water shortage. Therefore, do not allow more than 50% depletion of the available waterholding capacity of the soil in the main root zone before beginning irrigation.

There are several methods for estimating soil moisture. However, a discussion is beyond the scope of this bulletin. Consult Ohio State University Extension or the USDA Soil Conservation Service for more information.

Frost Control: Irrigation and Chemical

Irrigation can be used to protect vegetable crops, although it is not a common practice in Ohio. With the proper equipment, sprinkling must begin as soon as the temperature reaches 34°F. Place a calibrated thermometer at the lowest point of elevation in the field at plant level, facing skyward. To check the accuracy of the thermometer, place it in a water/crushed-ice mixture, stirring occasionally. After 20 minutes, the thermometer should read 30°F. Sprinkling should continue until the air temperature is above 30°F and the ice has melted from the plants.

Approximately 0.1 inch of water per hour is needed, but the sprinkling must be continuous, and the sprinklers should rotate at least once per minute. If conditions become windy and temperatures drop, it may be necessary to increase the amount of water to as much as 0.5 inches/hour. Keep in mind that it is the freezing of the water that gives off the heat to protect the crop. Therefore, liquid water must be present during the freezing period to protect the plants.

Critical Periods of Water Need	
Crop	**Critical Period**
Carrot	Root enlargement
Radish	Root enlargement
Turnip	Root enlargement
Onion (dry)	Bulb enlargement
Snap bean	Pod enlargement
Pepper	Planting to fruit set and enlargement
Tomato	Early flowering, fruit set and enlargement. (For mechanical harvesting, use no water during latter part of fruit-ripening period.)
Cabbage	Head enlargement
Cucumbers	Fruit enlargement
Lettuce	Head development
Eggplant	Flowering and fruit enlargement
Asparagus	Plant development after harvest
Sweet corn	Silking and tasseling, ear development
Potato	Tuber set and tuber enlargement

Plastic Mulches and Trickle Irrigation

The use of plastic mulch involves either clear or black plastic. Clear plastic is used to warm the soil, primarily for early crop production, but it does not control weeds. Black plastic provides weed control and is used with several warm-season crops. An advantage of plastic mulches is that they provide an even moisture supply. Yields of peppers, eggplant and summer squash are higher most years, and harvest can be up to 7 days earlier then unmulched plantings.

Clear plastic mulch commonly is used to produce early sweet corn. Sweet corn can be planted in hills, single rows or double rows. Herbicides are applied prior to laying the plastic. Clear plastic mulch warms the soil and contributes to early harvest and quality produce. Weed control from herbicides applied before the mulch is laid may break down in advance of crop maturity. Unless otherwise advised, herbicides should never be applied over the top of plastic mulch. An alternative to the clear mulch/herbicide system is the IRT or *wavelength selective mulch* system. IRT mulches provide similar soil warming to clear film, while controlling most weeds like black plastic.

In research conducted at Penn State by Dr. Bill Lamont, IRT plastic worked well on melons and peppers. These materials should perform well for other heat-loving vegetable crops. IRT films also seem to be a good fit for herbicide-sensitive fruits and vegetables.

Sources for IRT films include Climagro (514-454-6638 or www.climagro.com), Ken-Bar (781-944-0003) and Poly-West (619-279-6393). After the corn presses on the plastic surface or if temperatures become too hot, the plastic is split to allow the plants to emerge above the plastic.

Irrigate the field if soil moisture is not adequate prior to laying the plastic. Apply all fertilizer before laying the plastic, but reduce the total amount applied by 10%-15%. Mulch layers are available at various widths. They also can be adapted for raised beds and for the laying of trickle irrigation tubes all in one operation.

Aluminum-foil mulches are used in certain parts of the country for late-planted squash. The reflective action helps in repelling the aphids that attack squash and spread mosaic virus.

Plastic mulch comes in various widths, with 4- or 5-ft widths most popular. Thickness usually is 1.5 mils. A common practice is to use wide plastic and plant double rows with the plants staggered on the plastic.

Trickle irrigation is combined with plastic mulch because of several advantages: economy of water use, less energy required for pumping, less wetting of the leaf surface, fertilizer application, uniform moisture supply and application of certain insecticides and fungicides.

Line-source emission is used for row crops. Water is applied down a narrow band adjacent to the crops. A supply pipe or manifold runs perpendicular to the rows. Some manifolds are made of a flexible material that permits the passage of equipment over them. A feeder tube is then inserted into each hole of the manifold tube and the other end is connected to the line emitter.

Three types of emitters are available: twin wall, bi-wall and soaker hose. The trickle tube runs down the middle between the two rows. Whatever the planting arrangement, the trickle tube must be placed where it will not be punctured at the time of planting transplants through the mulch.

A typical distance between the double rows for peppers or tomatoes is 1.5 ft. Significant yield increase in peppers has been observed with such a planting system. The cost of application and materials is approximately $225-$250/A. The plastic mulch and emitter line are not reusable.

Water Needed for Vegetable Crops in Ohio

Depth of rooting	Water Needed for Crop (inches)		
	12	12-17	18-24
Shallow (less than 2 ft)	spinach[1]	cabbage cauliflower onions (early) broccoli sweet corn	celery[2] lettuce onions (late) potato
Moderately deep (2-4 ft)		pole beans snap beans cucumber	beets carrots eggplant pepper squash (summer)
Deep (4 ft or more)		lima beans watermelon	asparagus muskmelon squash (winter) tomato

Source: California Agricultural Experiment Station litho print, 1943.
[1]Spinach grown in the spring may require less water with lower temperatures.
[2]Celery usually requires more than 24 inches.
A common rule of thumb: Provide 1 inch of water per week, either from rainfall or irrigation.

Fertigation

Fertigation is the application of water soluble fertilizers in irrigation waters. The most common nutrient used in fertigation is nitrogen since it is readily available in several water soluble forms and it is the nutrient that moves most readily in our soils. The main advantage of fertigation is the ability to provide precise amounts of fertilizers to the root zone of the crop when the crop needs them.

Injection Pumps

Various types of injectors can be used. The most common ones are those which do not require a power source. Examples are venturi type injectors and water driven pumps. The water driven pumps are popular because they are inexpensive, adjustable and accurate.

Fertilizers

Nitrogen is the nutrient most often applied through fertigation. Many N fertilizers are water soluble and have a high nutrient concentration. Examples are 28%, urea-ammonium nitrate solutions, ammonium nitrate, urea, calcium nitrate and potassium nitrate. If you make your own nutrient solution from dry fertilizers use either greenhouse grade materials or allow mixtures to settle overnight and decant off the liquid before injecting into the drip irrigation system.

Filtration

It is important to make sure that only clean water passes through your injector to prevent clogging. It is also important to filter downstream of the injector to trap any particulates that may have entered through the injector. Once drip tubing is plugged, it can be very difficult or impossible to unplug.

Scheduling

Under Ohio conditions, 25 to 50% of the N fertilizer should be applied preplant. The remaining N fertilizer can be applied through the irrigation system. Since regular scheduling of irrigation is difficult in Ohio, 5 to 10 pounds of N

should be applied per irrigation until the total amount of N desired has been applied. This ensures that the crop will have sufficient fertilizer for early growth and reduces the risk of N leaching out of the root zone. It is also important to make sure that crops are not over-irrigated. Since nitrogen tends to move on the wetting front over-irrigation can move nitrogen out of the root zone where it will not be available to the crop.

Fertilizer Rates

Current Ohio fertilizer recommendations are based on the fertilizer being soil applied. Researchers in other states have found that they can reduce N fertilizer rates when fertigating from 20 to 40% without reducing yield or quality. Research is currently being conducted to see if we can reduce fertilizer rates with fertigation in Ohio without negatively affecting yield. At this time, it would be more prudent for growers to learn how to optimally manage drip irrigation and fertigation on their farms before significantly reducing N fertilizer rates.