Offsetting Drought for Small-Scale Vegetable Production in North Carolina

NC STATE EXTENSION

Hot, dry periods are common during most growing seasons in the southeastern United States. Weather data may indicate that rainfall was adequate for crop production during a given month; but if the bulk of the rain falls during a one-week period, the remainder of the month may be too dry for the crop to grow properly. On average, you can expect a 40 to 60 percent reduction in yields due to inadequate rainfall. The greatest losses in a drought are usually in the marketplace because of poor quality and inconsistent supplies.

Irrigation Improves Yields and Quality

Since most vegetables are about 95 percent water, they require a fairly constant supply of water during the growing season to produce the best possible yields and quality. Because vegetables are high value crops, irrigation makes good economic sense. In general, commercial vegetables should not be grown in the southeastern United States without irrigation, otherwise, you will not be able to deliver the consistent supply and quality produce markets demand and long term your business will fail.

With irrigation yields per acre will usually increase resulting in a lower cost per unit of production. This increases total efficiency.

Choosing Irrigation Equipment

First determine how and on what crops the irrigation system may be used. For instance, there may be need for equipment to irrigate vegetables in the summer, irrigate direct seeded vegetables for emergence in the summer and fall, provide evaporative cooling in the midsummer, and provide frost-freeze protection of strawberries in the spring and vegetables in the fall. This information will influence the final equipment selection.

Although it is practical and necessary for many producers, irrigation is expensive. Depending on the type and size of system selected, the initial investment for relatively smallscale systems (less than five acres) may vary from $1,500 to over $3,000 per acre. Annual operating costs may add $50 to $100 per acre depending on system type and frequency of use. Therefore, be sure to obtain professional assistance to determine the most costeffective irrigation system.

Irrigation systems can be divided into two major groups:

High-Volume Systems: Include overhead sprinkler and selfpropelled gun traveler systems. One advantage to these systems is that they are relatively inexpensive compared to lowvolume systems. Since the technology is rather simple, installation, operation, and maintenance of these systems is fairly easy to learn. Also, if equipped with the proper nozzles, sprinkler systems can be used for frostfreeze protection and evaporative cooling.

One disadvantage to high-volume systems is the wetting of plant leaves that occurs each time the system is used, which may promote foliar disease problems. Wind may also cause problems with maintaining an even distribution of water. The labor required to move much irrigation equipment can be a challenge and should not be taken lightly. For example, the time required to move pipe and set up each different 1 to 2 acre zone to be irrigated is typically 4 to 5 manhours. The movement of 20- or 40-foot long sections of aluminum pipe is physically demanding and can be awkward to handle, especially in tall crops.

Low-Volume Systems: This includes drip or trickle irrigation, and low-volume sprinklers such as microsprays and microspinners. In field vegetable production, drip tape is normally used.

The major advantages of low-volume systems over high volume systems are the ability to manage timing and placement of soil moisture and to use less total water to produce a crop. Low-volume systems reduce energy costs, keep foliage drier, and can be used to apply fertilizer and insecticides directly to the root zone, and are known as fertigation and chemigation, respectively.

Other advantages are reduced in runoff, the ability to do other cultural practices while irrigating, and, in some cases, reduce labor requirements. When combined with other practices, such as raised beds, black plastic mulch, and closer plant spacings, the use of low-volume systems can result in increased yields, earlier harvests, better quality, and higher profits.

Water conservation is especially important during droughts. In addition to more efficient use of water, low-volume systems lend themselves to automation. One common problem with irrigation systems is forgetting to turn off the water. To solve this problem the pump should be connected to a timer or a soil-moisture sensor electrically interfaced to a pump (such as a switching tensiometer) to shut off the pump at the right time. This saves water, labor and energy.

The major disadvantage to low-volume systems is the higher startup and operation costs. Low-volume systems also require learning a new technology and the willingness to manage a more intensive system. For example, fields must be monitored regularly for clogged emitters and leaks. However, these disadvantages usually are offset by many of the previously mentioned advantages.

Water Quantity

Before purchasing an irrigation system, determine if you have a water source which can adequately supply the quantity and quality necessary to irrigate your crops under all conditions (including drought). Typical water sources for irrigation are wells and ponds. During peak use periods, most crops can use up to 0.25 inch of water per day. Computed over an entire acre, this represents 6,750 gallons of water. To replenish this water through irrigation, the pumping rate is 4.7 gallons per minute (gpm) from the water source. When irrigation inefficiencies are factored in, the recommended water source capacity is about 7 gpm per acre to be irrigated. This value is based on pumping 24 hours per day, 7 days per week. To apply the required water in shorter pumping periods requires proportionally more capacity for each reduction in pumping time (Table 1).

Table 1. Pump capacity required to supply daily crop water needs during peak demand periods (hot, dry day).

Pumping Period (hours/day)	Pump Capacity to Irrigate Area Shown (GPM)				
	1 acre	2 acres	3 acres	4 acres	5 acres
24	7	14	21	28	35
12	14	28	42	56	70
8	21	42	63	84	105
4	42	84	126	168	210
2	84	168	252	336	420

To irrigate a 2-acre field in a typical 8-hour workday requires a water supply capacity of 42 gpm. This capacity is often costly to obtain from groundwater i.e. wells. For comparison, the typical private home water system has a capacity of 5 to 10 gpm. If you do not have a good water supply, arrangements to get an adequate source need to be made before investing in any irrigation equipment. Common sources of irrigation water include ponds, rivers, large streams, wells, and municipal water. The cost of the water supply can usually represent the single most expensive component of an irrigation system. Depending on availability, water supply costs may vary from about $50 per acre to more than $500 per acre. Local well drillers can provide information on well drilling and groundwater sources in your area. The Natural Resources Conservation Service (NRCS) can provide technical assistance for the design and construction of a pond.

Water Quality

Have your water source tested for minerals and contaminants. This can point to potential problems such as high levels of sodium, iron, or bicarbonate; low pH; or hard water. Excess levels of some minerals in irrigation lines can plug nozzles and emitters, precipitate nutrients when fertigating, or be toxic to some plants. The potential problem may not be serious; however, the problem will be easier to manage if it is identified as early as possible.

A filtration system is a normal part of most low-volume systems. Surface water (from ponds and streams) normally contains more dirt and debris than does well water. Sand or disk filters are required for surface water. Although expensive, the purchase of sand filters should not stop you from considering low-volume systems since the benefits will more than pay for the filters in the long run.

Scheduling Irrigation

The most often asked question following the purchase of an irrigation system is, "How do I know when to turn the water on and off?" During summer in the southeastern United States, two inches of rainfall per week are normally considered adequate for most vegetable crops. However, this may vary with the crop, stage of development, and temperature. With all systems, you should buy a rain gauge and keep a daily record of the rainfall. This information will help determine if there has been adequate water for the crop to grow. With high-volume systems, irrigate weekly to bring the total water received by a crop up to two inches. For example, if 0.5 inch of rain fell during the week, apply 1.5 inches to make up the shortfall. With high volume systems it is advantageous to irrigate in the evening or early morning when evaporation rates are lowest.

It is important to realize that low-volume, drip irrigation systems are managed differently from high-volume systems. Drip irrigation supplies small amounts of water near the plant when the plant needs it. This does not mean once every 5 to 10 days, but daily, or even hourly, in intensively managed systems. Since only a small area near the plant is being irrigated, water use can be reduced by 50 to 60 percent. This reduction in water use will normally be partially offset due to the higher plant populations and frequent wetting of the soil surface in intensively managed drip systems. Although nearly as much water per acre may be used, the higher yields of such systems normally result in less applied water per unit of product produced. Thus wateruse efficiency is increased.

With a drip-irrigation system, it is necessary to monitor the soil moisture in the crop root zone. This can be done by manually feeling the soil, but more accurate results can be monitored and obtained with several devices to determine soil moisture. A tensiometer or gypsum block (electrical resistance block) is the simplest and cheapest. Tensiometers are best suited for use in coarse-textured soils (sand, loamy sand and sandy loam). Gypsum blocks are best suited for use in fine-textured soils (silts and clays). Watermark sensors, that operate on the same principle as a gypsum block, are superior to gypsum blocks and are suitable for both types of soils. Both Watermark sensors and gypsum blocks require a meter to read the sensor. All of these devices read in units of centibars (of soilwater tension) that can be related to soil moisture. The amount of water in the soil at a given soil-water tension varies by soil type.

The soil-moisture sensor should be placed on the opposite side of the row from the drip tube, about 4 inches from the row at a depth of 6 inches and between plants. The "turn on" point for the tensiometer should be at 70 to 80 percent of available soil moisture (ASM) and the "turn off" point should be 90 percent of ASM. The tensiometer reading will vary with soil type. For sands and sandy loams, 20 to 30 centibars is the "turn on" and 10 centibars is the "turn off." For clays, 35 to 40 centibars is the "turn on" and 15 centibars is the "turn off."

To use the manual method of determining when to turn the system on or off, take several soil cores on both sides of the row and feel the soil. With time, you can learn the proper moisture level by this feel method. At the end of an irrigation cycle, soil on the drip tube side should be too wet to plow and about ready to plow on the side away from the drip tube. With some crops, like tomatoes, faint color changes can be seen when the crop needs water, but in others, this is very difficult to see. Wilting should not be seen at any time. Another quick field check is to feel the softness of the soil with your foot on both the drip tube and opposite sides. The side away from the drip tube should have some give. This will vary with soil type.

An example of drip system irrigation schedule for tomatoes is to run the system for 1 to 2 hours every other day, early in the season when the crop is young and the weather cool. As the crop grows, irrigation may be required 2 to 3 hours daily. During fruit sizing and hot weather, the system may need to be run 3 to 5 hours daily and the crop still may experience some stress.

Diversification

The devastating effects of a drought may be partially avoided by making multiple plantings (several plantings over several weeks) of one or more crops. It is then hoped that at least a few of these plantings will survive and yield during the drought. In general, it is a good strategy to have several different crops, i.e., cucumbers, tomatoes, and greens, planted at different times of the season to provide a hedge against adverse weather or market conditions. As the old adage goes, “don’t put all your eggs in one basket.” Some growers choose not to irrigate the spring and fall planted crops, such as cabbage, kale, collards, and lettuce, because they are less prone to drought, but all of these crops would benefit from irrigation.

Although drought may occur at any time during the year, some crops such as cabbage, kale, collards, turnip greens, lettuce, and spinach are grown during the fall and spring. This tends to make these crops less prone to drought problems. However, irrigation will also enhance the yield and quality of these crops. As with all crops, the market dictates the price of these crops too. For these reasons, you should not choose a crop simply to avoid a drought. Choose a crop that makes a profit. An investment in irrigation probably will pay off in the long run.

Mulches

Mulches are beneficial in decreasing water loss from the soil around plants. Mulches serve other purposes, i.e., to reduce weed growth and to warm or cool the soil. Some growers use organic mulches, such as straw, without irrigation to hold in soil moisture. Organic mulches can be used with overhead or drip irrigation systems. Plastic mulch, however, should not be used without irrigation and is most effective with drip irrigation. It is important to have good moisture in the soil when mulch is applied. Irrigation and rainfall will penetrate organic mulch, but not plastic mulch. Soil under plastic mulch should never be allowed to dry out, because rewetting the entire bed is difficult with drip-irrigation.

Summary

Water is a simple but necessary requirement for plant growth. Strategies such as crop diversification and mulches can be used to cope with drought situations, but, nothing will substitute for the timely application of water. Growing vegetables in the southeastern United States without irrigation is risky and can be costly. There are many different irrigation systems available. You must decide which system fits your needs and budget. A good source of water is a necessity for producing quality vegetables.

Additional Information

Evans, R.O., R.E. Sneed, and J.H. Hunt. 1991. *Irrigation management strategies to improve water & energy use efficiencies*. Raleigh: North Carolina Cooperative Extension. AG-452-5.

Evans, R.O., R.E. Sneed, and D.K. Cassel. 1991. *Irrigation scheduling to improve water and energy-use efficiencies*. Raleigh: North Carolina Cooperative Extension. AG-452-04.

Evans, R.O., D.K. Cassel, and R.E. Sneed. 1991. *Measuring soil water for irrigation scheduling: monitoring methods and devices*. Raleigh: North Carolina Cooperative Extension. AG-452-02.

Evans, R.O., J.H. Hunt, and R.E. Sneed. 1991. *Pumping plant performance evaluation*. Raleigh: North Carolina Cooperative Extension. AG-452-06.

Evans, R.O., D.K. Cassel, and R.E. Sneed. 1991. *Soil, water, and crop characteristics important to irrigation scheduling*. Raleigh: North Carolina Cooperative Extension. AG-452-01.

Johnson, G.L., K.B. Perry, and R.J. Sladewski. 1990. *Probabilities of dry periods in North Carolina*. Raleigh: North Carolina Agricultural Extension. AG-411. [no longer published]

Perry, K.B. 2006. *Weather and climate information for North Carolina farmers*. Horticulture Information Leaflet 706.

NRCS. 1997. Ponds – Planning, Design, Construction. Agricultural Handbook 590. United States Department of Agriculture.

Sanders, D.C. 2001. *Using plastic mulches and drip irrigation for vegetables*. Raleigh: North Carolina Agricultural Extension. Horticulture Information Leaflet 33.

Sneed, R.E., and R.O. Evans. 1996. *Selection and management of efficient hand-move, solid set, and permanent sprinkler irrigation systems*. Raleigh: North Carolina Cooperative Extension. Bulletin EBAE-91-152.

Sneed, R.E., and R.O. Evans. 1996. *Selection and management of efficient low-volume irrigation systems*. Raleigh: North Carolina Cooperative Extension. Bulletin EBAE-91-153.

This file is one in a series of electronically available drought information publications produced with support from the US Department of Agriculture, Extension Service, under special project number 93-EFRA10013.

Authors

Jeanine Davis
Extension Specialist, Herbs/Organics/Specialty Crops/Vegetables Horticultural Science

Robert Evans
Professor Biological & Agricultural Engineering

Garry Grabow
Interim Department Head, Extension Specialist and Associate Professor Biological & Agricultural Engineering

Bill Jester
Emeritus

Billy Little
Extension Agent, Agriculture Wilson County

Allan Thornton
Extension Associate Horticultural Science

Jonathan Schultheis
Department Extension Leader and Specialist, Sweetpotato/Curcurbits/Sweet Corn Horticultural Science

Publication date: Sept. 1, 2007
AG-519-04

This publication printed on: Jan. 10, 2020
URL of this page