

Irrigation Systems

PLANTS OF ALL TYPES need water to grow properly. Irrigation water has been used for centuries. As time passes, human dependence on water increases. Agriculture is one area where this is true. Plants need water to grow, and the soil can only hold so much water at one time. Too much water is not good for plant growth, and too little water can cause plants to wither up and die. Thankfully, modern power sources—with the use of deep well pumps and underground water reservoirs—have provided a major contribution to irrigation water.



Objective:



Describe the operating principles of irrigations systems, equipment used, calibration, and maintenance.

Key Terms:



available water
border-strip irrigation
center-pivot irrigation
chemigation
evapotranspiration
field capacity

furrow irrigation
permanent wilting point
sprinkler irrigation
subsurface irrigation
surface irrigation
water efficiency

water-application efficiency
water-conveyance efficiency
water-use efficiency
wheel-move irrigation

Understanding Irrigation Systems

As a natural resource, water is precious and limited. Therefore, it is imperative to use water as efficiently as possible.

PRINCIPLES OF IRRIGATION SYSTEMS

Irrigation water is a major source of water for many field crops and vegetables, especially those grown on sandy soils. Therefore, you must ensure that irrigation systems are designed to use just the proper amount of water at various times. As crops grow, they are continuously using water. However, the water use varies with crops as they grow throughout the growing season.

Evapotranspiration is moisture lost from the plant due to evaporation and transpiration. Water loss is huge when evapotranspiration occurs. To make maximum use of available water sources, the irrigator must fully understand how much water (on average) falls in the form of rain. Knowing this will assist in determining whether irrigation water is needed. Rainfall needs to be considered when determining how much moisture crops need. However, not all rainfall is effective—just the portion that contributes to evapotranspiration.

In addition to rainfall, the soil types being irrigated or wetted from rain are just as important. How much water soils can hold and drain is considered extremely important for optimal plant uptake. If too much water is distributed at one time, leaching of leachates, minerals, and nutrients may occur. Yet too little water can cause severe wilting in plants. There must be some amount of water retained in the soil water reservoir so it is available for plant uptake at all times. Irrigation water should be scheduled so the water in the reservoir does not become too low. Therefore, the water-holding capacity of the soil water reservoir must be known and carefully monitored.

Soil Water Reservoir

There are ways to understand and monitor what the soil reservoir is able to retain. For instance, **field capacity** is a situation in which the soil is wetted and allowed to drain for a couple days. The moisture adhering to the soil left after natural soil drainage is said to be at field capacity.

The **permanent wilting point** is a situation in which the lower limit of water is available to plants. Therefore, water molecules are very tightly held to the soil particles and are virtually unavailable to plants. The difference between field capacity water and permanent wilting point is the **available water**—water that plants may consume.

Irrigation Scheduling Methods

Irrigation systems include three basic scheduling methods. Each varies in terms of its output of water and actual operations. Soil water can be measured by using a soil probe, screw auger, and/or a shovel and by estimating how much water is available to plant roots.

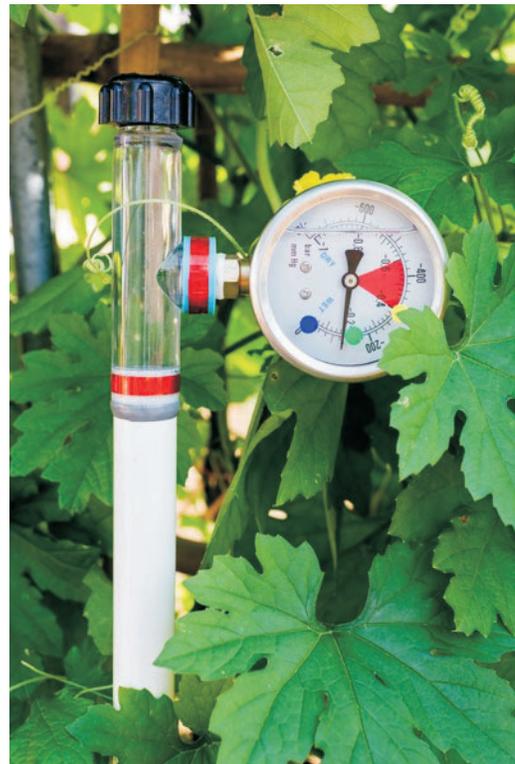


FIGURE 1. Soil water is being measured with a tensiometer in a vegetable garden.

Digging up a small area of soil randomly throughout a field will help determine this. Instruments (e.g., tensiometers and electrical resistance blocks) may be used by inserting them in the soil to be checked and then taking readings at various intervals. Plants should be observed to determine if they are under stress from lack of moisture.

IRRIGATION SYSTEMS

The use of irrigation water takes a lot of planning and monitoring throughout the growing season. Irrigation water may be applied in different ways and methods.

Subsurface Irrigation

Subsurface irrigation is a system that waters plants and their roots lower in the soil profile.

Surface Irrigation

Surface irrigation is a system in which the soil surface is flooded as water is released from canals, streams, or piping systems. Surface irrigation is best on moderately permeable soils and on slightly sloping or gently sloping land. Piped in water comes from canals, lakes, or streams and uses gravity to carry it to farm fields.

Border-Strip Irrigation

Border-strip irrigation is a system in which the entire surface of a field is covered in water. This system is used when fields are divided into smaller areas by the use of low dykes. Since the surface is flooded, some loss of water occurs due to evapotranspiration.

Furrow Irrigation

Furrow irrigation is a situation in which water is distributed through furrows with the crops being grown between the furrows. Furrow irrigation is best for row crops being grown. In furrow irrigation, evapotranspiration is not as much an issue because water is distributed in the furrow, not flooded on the surface.

Sprinkler Irrigation

Sprinkler irrigation is a system in which water is pumped under pressure through pipes to



FIGURE 2. This is a sprinkler system in a green vegetable garden.

sprinklers located on a long boom and then sprayed out in a circular pattern. This system may be used where the soil is too permeable or too impermeable or if the ground is not level.

Chemigation is a situation in which sprinkler systems are used in conjunction with fertilizers or herbicides. The fertilizers and herbicides are added to the main water source and are mixed with the irrigation water. It is a good and economical way to add these inputs.

Center-Pivot Irrigation

Center-pivot irrigation is a system that operates on a central pivot point with the watering line elevated several feet above the growing crops. As this system operates, the line slowly turns around the pivot point. This method is the least laborious method of all the irrigation systems used in agriculture.

Wheel-Move Irrigation

Wheel-move irrigation is a system that has a line of sprinklers mounted on the wheels of the system and rolls slowly down the field until it reaches the end of an attached hose.

Trickle or Drip Irrigation

The trickle or drip irrigation uses hard plastic pipes on the ground that run parallel with the crop row, with special-sized emitters evenly spaced up and down the pipe. The emitters drip or trickle water through them and onto the soil (at controlled amounts) at the soil surface. This system is effective. After several operations, however, the emitters may become plugged. Then the water is not emitted at a proper rate or at all.

Wise Practice

Using irrigation systems is a wise investment only if the area to be watered is dry and if the soil types are conducive to extensive irrigating. A wise practice is to fully understand the needs of the crop, the properties of soils, and the appropriate irrigation system.

CALIBRATION AND MAINTENANCE

Irrigating crops is beneficial when planned and used in an efficient crop management program. Each irrigation system is designed differently and must be fully understood for proper operation. Calibration and maintenance of irrigation focuses on the overall performance or efficiency of a system. **Water efficiency**, or water output divided by water input, may include various water concepts and is used in calibration of the various irrigation systems.

Water-conveyance efficiency is a situation in which the water output is delivered by a distribution system, and the input is the water introduced into the distribution system. **Water-application efficiency** is the output of the water being stored in the root zone by irrigation, and the input is the water being delivered to the crops being irrigated. **Water-use efficiency**



FURTHER EXPLORATION...

ONLINE CONNECTION: The Importance of Water

Water is one of the most precious natural resources to humans. It is needed in varying quantities by all living things. It is interesting to note that water is the only natural substance found in all three physical states: liquid, solid, and gas.

Plants need water at various times throughout the growing season. Plants take in water by imbibition. Plant cells fill up with water and keep the plant hydrated. If plants do not receive enough water, they will wilt. Over time, the lack of water causes the plant cells to shrink and not function properly. Thus, the plants will eventually die.

<http://www.usgs.gov/water/>

is a situation in which the output is the water being beneficially used, and the input is the water delivered to be used as irrigation water.

When calibrating and maintaining irrigations systems, it is necessary to consider:

- ◆ Using the most water-efficient system practical to each cropping system and uniform in water distribution
- ◆ Leveling and designing land to reuse any excess water
- ◆ Scheduling the irrigation water system to water crops when they actually need it, not on a “time” schedule



FIGURE 3. Calibrating irrigators produces optimal water output.

OTHER CONSIDERATIONS FOR IRRIGATORS

- ◆ Always follow the manufacturer’s recommendations found in the owner’s manual for the irrigation system purchased. The operator’s manual provides the best use and maintenance of the irrigation system as well as a listing of parts needed if breakdowns occur.
- ◆ Avoid water pollution at all costs, and always use the most efficient system when irrigating crops.
- ◆ Always use the best method of irrigation that preserves or saves on water usage. Never waste water. For systems that use a pump, saving water means also saving on energy costs. Follow the steps in the operating manual for all maintenance procedures so water is always used efficiently.

- ◆ If there is sand in soils, there could be sand at the nozzle openings on some irrigation systems. Knowing this ahead of time will help in keeping nozzles cleaned properly.
- ◆ All systems should contain devices to measure and control water flow.



FIGURE 4. Proper calibration and maintenance on irrigation systems produce ideal water for growing crops.

Summary:



Using water efficiently is a major consideration in producing any crop. The proper irrigation system will preserve water and avoid excess water being wasted. There are many irrigation systems from which to choose. Knowing and understanding how water is held in the soil water reservoir provides the farmer with useful information so water is preserved and used when the crop needs it most. Calibrating irrigation systems insures that irrigators will remain in proper working order. When finished using irrigation systems, maintenance and storage is essential. Follow the operating manual instructions on how to properly calibrate and maintain irrigation systems.

Checking Your Knowledge:



1. What are the operating principles of irrigation systems?
2. What are the various types of irrigation systems?
3. How is water measured in the soil?
4. What are three important considerations of calibrating irrigators?
5. What are the best ways to maintain irrigation systems?

Expanding Your Knowledge:



Use the Internet as a source, conduct a search of the various types of irrigation systems, and identify the types of equipment used to irrigate crop fields. Interview a farmer who has an irrigation system, and find out the approximate cost to use the system. Are there any problems with the irrigation system? If so, what are they? Is the farmer satisfied with the irrigation system? Why or why not? Write down your answers to share with your class.

Web Links:



Irrigation Water Usage

<http://water.usgs.gov/edu/wuir.html>

Irrigation Techniques

<http://water.usgs.gov/edu/irmethods.html>

Importance of Irrigation Water

<http://www.ers.usda.gov/topics/farm-practices-management/irrigation-water-use/background.aspx>

Irrigation Use

<http://www.ers.usda.gov/topics/farm-practices-management/irrigation-water-use.aspx>

Water Management and Irrigation Systems

<http://extension.cropsci.illinois.edu/handbook/>

Irrigating Crops

<http://www.epa.gov>

Sustainable Crop Production

<http://www.sustainabletable.org>