Nebraska Irrigation and Water Management Curriculum

Subsurface Drip Irrigation

Grade Level
7-12th Grades

Lesson Length
60-90 minutes

Key Terms:
Dripline
Emitter
Filter
Main line
Subsurface drip irrigation

STEM Careers
- Agronomist
- Biological Systems Engineer
- Design Engineer
- Irrigation Specialist
- Irrigated Farmer

Related Activities

Types of Irrigation
Center Pivot, Variable Rate Technologies

Learn More

water.unl.edu website
cropwatch.unl.edu website

Virtual Fun

Check out Nebraska Extension's Interactive [Agricultural Water Management Guide]!

Overall Goal
Students will demonstrate how subsurface drip irrigation systems operate and will understand their advantages and limitations.

Learning Objectives
By the end of this lesson, students will know or be able to:
- Define subsurface drip irrigation.
- Explain how subsurface drip irrigation systems are installed and operate.
- Compare the advantages and disadvantages of subsurface drip irrigation.

Educational Standards Supported
Nebraska Science Standards: SC.7.7.3.D, SC.7.8.4.E , SC.7.13.5.C, SC.HS.7.2.E, SC.HS.15.5.5.A, SC.HS.15.5.D, SC.HS.6.1, SC.HS.13.3, SC.HS.15.4

Materials List
- Paper cups
- Large straws
- Felt squares
- Thumb tack
- Water
- Notecards
- Poster or flipchart paper

Preparatory Work
- Print Science Notebook pages.
- Write key terms and associated definition on separate notecards. Place throughout the room.
- Gather and separate materials for groups of students to build irrigation system.
- Print and cut advantages/disadvantages cards.
- Load subsurface drip irrigation videos from Obj. 2.

Introduction (5 minutes)

KWL Chart

Today we'll be exploring a type of irrigation system called subsurface drip irrigation. Before we get started, let's take a few moments to create a KWL chart with three vertical columns. Label the column on the left "What I Know", the middle column "Want to Know", and the column on the right "Learned".

Take the next two minutes to fill out the first two columns – the "What I Know" and "Want to Know" about subsurface drip irrigation.

Ask students to share one idea they listed for the "Know" and "Want to Know" columns. Capture this information on a KWL chart in the front of the class.

Preview (1 minute)

Thank you for sharing. This information tells us where we need to go to learn the basics of subsurface drip irrigation. By the end of this lesson, let's be sure we've addressed the items listed in the middle column. Today we'll dig into subsurface drip irrigation systems, how they operate, and their relative advantages and disadvantages.

Objective 1 | Define subsurface drip irrigation (8 minutes)

Experience

Direct students to search the room for note cards with key terms and definitions. Instruct students to work together to match the terms and definitions.

Have students read aloud the matching terms and definitions.

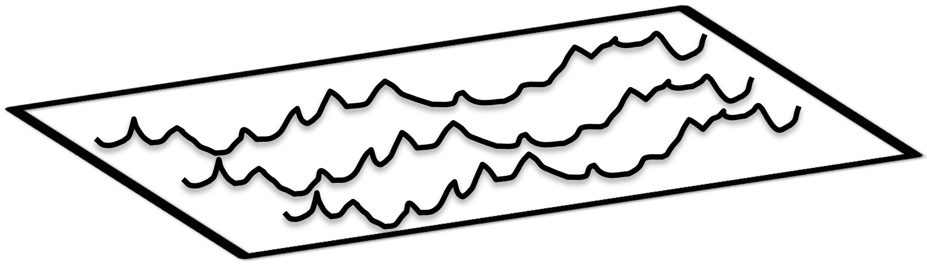
Point

These definitions cover primary components of subsurface drip irrigation systems. Capture these definitions in your science notebooks:

> **Subsurface drip irrigation** (SDI): irrigation system where water is applied directly to the crop root zone using buried polyethylene tubing.
>
> **Dripline:** tubing placed underground and between crop rows that carries water through the field laterally. Can vary in diameter and thickness.
>
> **Emitters:** small holes where water passes through to irrigate soil.
>
> **Main line**: located at the top end of the field and provides water to the driplines.
>
> **Filters:** removes particles and impurities in the water.

The overall concept of subsurface drip irrigation systems is that the irrigation system is entirely underground. It targets the roots of the crop rather than the entire land area the crops cover to increase water efficiency. Water is applied to plants at a very low rate of application. When managed correctly, subsurface drip irrigation has the potential to be the most efficient form of irrigation.

Application
Using the definitions above, ask students to draw the 1) main line, 2) dripline, and 3) emitters of a subsurface irrigation system in their science journal.



Lead a discussion about how subsurface drip irrigation is similar and different from other irrigation systems that have been discussed in class or that students are familiar with, such as conventional furrow irrigation and center pivot irrigation. Consider the following questions:

- How does subsurface drip irrigation appear to be similar to other irrigation systems we've learned about? (conventional furrow and center pivot irrigation)
- How is it different?

Objective 2 | Explain how subsurface drip irrigation systems are installed and operate (25 minutes)

Experience
Instruct students to work in a group to build a model of a subsurface drip irrigation system. The goal is to soak a felt square, which represents soil in crop root zone, with the subsurface drip model. Students will build this model using two paper cups, a straw, felt square and thumb tack.

Hint: Students should poke a hole near the bottom of two cups so the end of a straw will fit snug. Using a thumbtack, poke several holes in the straw and connect the two cups with the straw. Lay felt over top of straw and pour water into one cup.

Upon construction, have students demonstrate and explain their model of a subsurface drip irrigation system.

Process:
- How effective were our systems in soaking the felt square, or soil?
- What changes could be made to improve the system?
- What might be advantages to irrigating crops in this way? Disadvantages?
- What do our models demonstrate about subsurface drip irrigation systems?

After building a model, let's dig deeper into how subsurface drip systems are installed and operate.

Point
Show students the following videos that demonstrate

1) Installation of a subsurface drip irrigation system, and
2) Managing Subsurface Drip Irrigation.

Instruct students to answer questions from the videos in their science notebook.

Summarize the videos and drive home the following:

Once the water is in the soil, its movement depends on the physical characteristics of the soil. In fine-textured soil, water will tend to move laterally (sideways) and upward. In sandy soil, water tends to move mainly downward.

The amount of water that can be delivered through a drip system depends on:

- Dripline diameter
- Emitter spacing
- Emitter design
- Emitter size
- Operating pressure

Application

These videos provided a great overview of how these systems are installed and operate. Now a local producer needs you to put this new knowledge to work!

A local farmer is interested in learning more about subsurface drip irrigation. The farmer asked you to provide information about how the system operates and the steps to install the system. Create a flow chart to explain the installation process and a one-paragraph summary of how the system works. Capture this information in your science notebook. (This can be assigned as homework)

Objective 3 | Compare advantages and disadvantages of subsurface drip irrigation. (30 minutes)

Experience

Print the advantages/disadvantages cards found at the end of this lesson. Distribute these cards in random order to students. Instruct students to work as a class to categorize these cards as “advantages” or “disadvantages” of subsurface drip irrigation systems.

Advantages	Disadvantages
○ Water application efficiency ○ Level of soil surface evaporation ○ Yield level ○ Labor requirements ○ Enables field operations even during an irrigation event ○ Fits varying field sizes, shapes and terrain ○ Energy Usage ○ Exposure to natural hazards ○ Application of fertilizers and chemicals	○ Investment cost ○ Water supply and system capacity ○ Management time ○ Limited dripline lengths ○ Installation ○ Inflexible design ○ Emitter clogging ○ Rodents ○ Seed germination ○ Soil salinity ○ Surfacing or chimney effect ○ Root intrusion

Capture these advantages and disadvantages in your science notebook.

Point

Information Gallery

Ask each student to select two to four cards from the advantage/disadvantage group. Each student will research and investigate the advantage or disadvantage they selected in further detail. Students will share what they learned with a visual presentation, such as a PowerPoint slide, poster, or infographic that will be displayed as a gallery for others to view. Encourage students to utilize the Agricultural Water Management Guide and this Nebraska Extension Resource to conduct their research.

Allow students 15 minutes to read and create a visual to share their information. Place these visuals around the room and have students gallery walk to learn more about the advantages and disadvantages of subsurface drip irrigation.

Ensure the following points are covered in the visual presentations:

- **Water application efficiency:** Has potential to be most efficient irrigation method available today. Depends on proper design, install, and management. Wets only a fraction of soil volume, while leaving space to store rainfall. Soil surface stays dry, reducing evaporation and runoff. Has potential to reach 95% water efficiency.

- **Decreased level of soil surface evaporation:** Has potential to reach 95% water efficiency, reducing the amount of water pumping expenses. Soil surface stays dry, reducing evaporation and runoff. Switching from furrow irrigation to SDI can result in significant water savings.

- **Potential yield level increases:** Can be automated for frequent water applications and inject fertilizers or chemicals to enhance yield and crop need.

- **Labor requirements:** Manual labor required is similar to center pivot system, but much less than a surface system. Can be automated, which could significantly reduce labor.

- **Enables field operations even during an irrigation event:** Allows farm equipment to enter field at any time because entire system is underground. Allows irrigation to start earlier in growing season without losing considerable water due to high evaporation rates. Could be used to dispose of smelly wastewater.

- **Fits varying field sizes, shapes and terrain:** Adapts well to fields of any shape or size, but does nto work well in rolling terrain.

- **Potential Energy Savings:** Operate at relatively low pressure and delivery small flow rates, so can be operated with smaller pumps. Energy used depends on flow rate, pumping depth, pressure at the pump, and time of use.

- **Investment cost:** Has high initial investment cost and are expensive compared to other systems. Cost per acre varies, with estimated cost between $500-800 per acre in Nebraska. As fields get smaller, subsurface drip systems become more cost effective. The large the irrigated area, the more attractive center pivots are.

- **Water supply and system capacity:** Water delivery schedule may not be flexible enough for growers obtaining water from an irrigation district, or it would require a storage tank or reservoir. Makes most sense for areas where water is readily available.

- **Management time:** Steep learning curve in first few years of using because system requires special period maintenance that different from other systems, such as chlorination and acid injection.

- **Limited dripline lengths:** Dripline lengths have to be limited, meaning that larger fields may need to be divided into smaller irrigation zones. The maximum dripline length is limited to about ½ mile.

- **Installation:** Requires special equipment, is labor intensive, and represents a significant portion of the initial cost. Must run water through soon after install. Installation would be very difficult in rocky soils.

- **Inflexible design:** Cannot be changed after installation. System is not forgiving of errors made in design decisions, such as dripline diameter, length, depth, and emitter spacing. Once installed, could limit the type of crops that can be grown and tillage practices used.

- **Emitter clogging:** Emitters can be clogged by very small particles, making it necessary to keep those particles out of the system. Difficult to fix once clogged. Can avoid clogging by filtration and flushing.

- **Rodents:** Gophers and field mice like to chew on driplines, causing leaks. Difficult to fix because it requires digging.

- **Seed germination:** Because soil surface is dry, can be a problem to get adequate water to seeds for in early growth stage. Especially an issue in sandy soils.

- **Soil salinity:** Soil salinity above the dripline can increase with time. Unlikely to occur in areas receiving enough precipitation. Not a large concern in most Nebraska systems.

- **Surfacing or chimney effect:** When water is applied at a rate greater than the infiltration rate of the soil, a saturated zone will develop around the dripline and water and soil particles will rise to the surface. The objective of keeping soil surface dry is not achieved. Can cause erosion away from the dripline.

Application

As students gallery walk, instruct them to capture important information about the advantages/disadvantages of subsurface drip irrigation and write any questions they have that needs clarified.

Lead a discussion about what students learned from the gallery walk. Ask students if they would recommend that a farmer install a subsurface drip system. Why?

Review & Reflect (5 minutes)

KWL Chart

Revisit the KWL chart from the beginning of the lesson. Provide students with 2-3 minutes to complete the “Learned” column of this chart. Ask students to share with a partner two things they learned during this lesson.

Celebrate Student Success (1 minute)

Thank students for their help in teaching one another about subsurface drip irrigation systems. Encourage students to share what they learned today with someone outside of class. Provide final announcements and review the next lesson.

References

VanDeWalle, B., Nygren, A., Burr, C., Zoubek, G., Irmak, S. (2016) Agricultural Water Management Guide. Extension Publication. University Of Nebraska - Lincoln Extension.

Payero, J., Yonts, D.C., Irmark, S., and Tarkalson, D. (2005). Advantages and Disadvantages of Subsurface Drip Irrigation. EC776. University of Nebraska-Lincoln Extension.

Irrigation and Water Management
Science Notebook

Completed by:_______________________________ ***Date:*** ________________

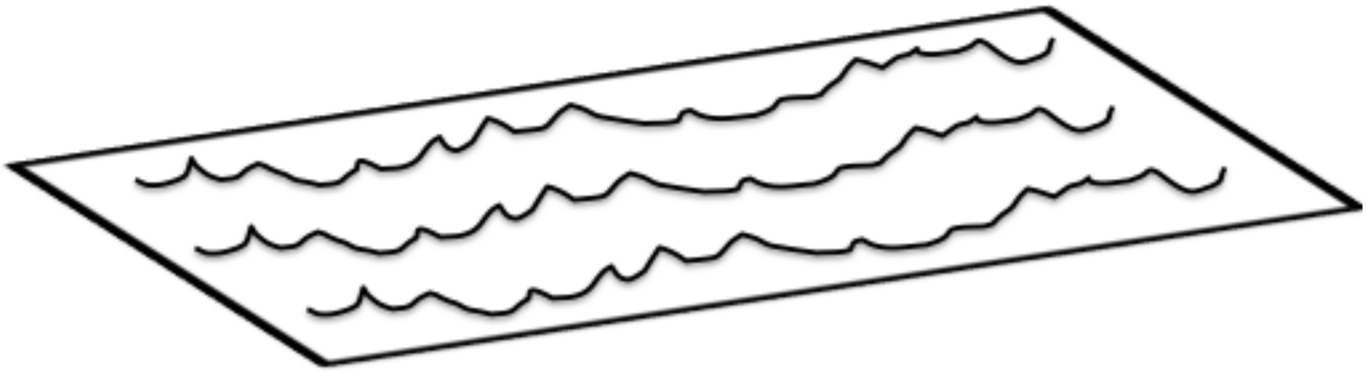
KWL CHART:

What I KNOW	WANT to Know	LEARNED

Key Terms	Definition
Subsurface drip irrigation	
Emitters	
Main line	
Dripline	
Filter	

Draw and label the following:

1) Main line
2) Dripline
3) Emitters



Subsurface Drip Design:

Important Lessons from Bill Kranz, University of Nebraska Extension Irrigation Specialist:

- A ________________ is important to remove silt or other deposits formed in the driplines.
- The dripline is located **above/below** the tillage zone.
- Spacing between the emitters is between ______ and _____ inches.
- Filtration is critical because _____________________________.
- Water pattern is dependent upon _______ _____________.
- Sandy soil will have a **wider/narrower** water pattern compared to finer soils.
- Over irrigating with subsurface drip could lead to _________ ___________.
- The soil surface should remain **wet/dry** with subsurface drip irrigation
- _______________ are one of the main issues with subsurface drip irrigation.

A local farmer asks you to provide information about subsurface drip irrigation! Create a flow-chart describing the steps of installation and a one-paragraph summary of how the system works.

Advantages	Disadvantages
○ Water application efficiency ○ Potential of water savings due to reduced ___________________________ ○ Potential ____________ increases ○ ___________ requirements could be reduced ○ Enables field operations even during an irrigation event ○ Fits varying field ___________, __________ and __________ ○ Potential __________ savings ○ Not prone to tornado, hurricane, or other natural hazards ○ Ability to apply _____________ and ___________ injected directly through the system	○ ________________cost ○ Water supply and system capacity ○ _______________time (requires learning in first couple of years) ○ Limited dripline lengths ○ ___________ ○ Inflexible ______________ ○ Emitter ____________ ○ Rodents ○ __________ germination ○ Soil _____________ ○ Surfacing or ___________effect ○ __________intrusion (mainly for tree crops)

GALLERY WALK INSIGHTS

Water application efficiency

Labor requirements

Level of soil surface evaporation

Enables field operations, even during irrigation event

Yield level

Fits varying field sizes, shapes and terrain

Energy Usage

Investment cost

Exposure to natural hazards

Water supply and system capacity

Application of fertilizers and chemicals

Management time

Limited dripline lengths

Emitter clogging

Installation

Rodents

Inflexible Design

Seed germination

Soil salinity

Applying water at a faster rate than infiltration rate of soil
(Surfacing or Chimney effect)

Dripline alignment

Root Intrusion