

SOIL SLEUTHS

The Case of the
Grieving Gardeners





SOIL SLEUTHS MYSTERY

Grade Level

4-7

Length of Lesson

20-45 minutes

Objective

By the end of this lesson, students will have a better understanding of the factors that affect soil health.

Materials

- Copies of the Case File
- Copies of the Evidence File
- Pencils
- Scissors

Standards

Common Core

CCSS.ELA.RL.4-6.1;
RL4-6.4; RI.4-6.1; RI.4-6.2;
RI.4-6.4; RI.4-5.5;
SL4-6.1

NGSS

4-ESS2-1; 4-ESS3-2; 5-LS1-1;
5-LS2-1; 3-5-ETS1-3; MS-LS1-5;
MS-LS2-1; MS-LS2-4

Lesson Summary

This lesson is designed to mimic an escape room, adding excitement to learning about soil and the factors that affect soil health! Students have to work together to solve the mystery of why their garden vegetables did not do very well during the growing season.

Suggested Sequence of Events:

1. Set Up: Print enough copies of the Case File and the Evidence File for each group of 2-3 students. Separate the Case File and the Evidence file into separate manila folders. **Read through the Teacher Tips and Tricks page before completing this activity in your classroom.**
2. Read [Erosion](#) by Darcy Pattison to capture student interest and learn about how laws were put in place to protect soil.
3. Read through the [IAITC Soil Ag Mag](#) to learn more about soil! Interactive online versions can be found on our website.
4. Complete the activity following the procedures:
 - Put students into small groups of 2-3.
 - Give each group a students the Case File and the Evidence File.
 - Read through the letter from "The Grieving Gardeners" together as a whole class. This can be found in the Case File.
 - Give students time to work through the puzzles to solve the mystery. An answer key is included in the teacher instructions section which includes notes on which pieces of evidence should be or can be used to solve that puzzle.
 - Students will need scissors for 1 puzzle, the "Soil Texture Triangle Analysis" sheet.
5. Whole class discussion and reflection of activity. Have students share how they worked through puzzles if they were having trouble. Why are these factors of soil health important for us to understand? Share their answers from the last page on the Case File. Are there any other solutions to these problems that they have learned or had experience with?

TEACHER RESOURCES

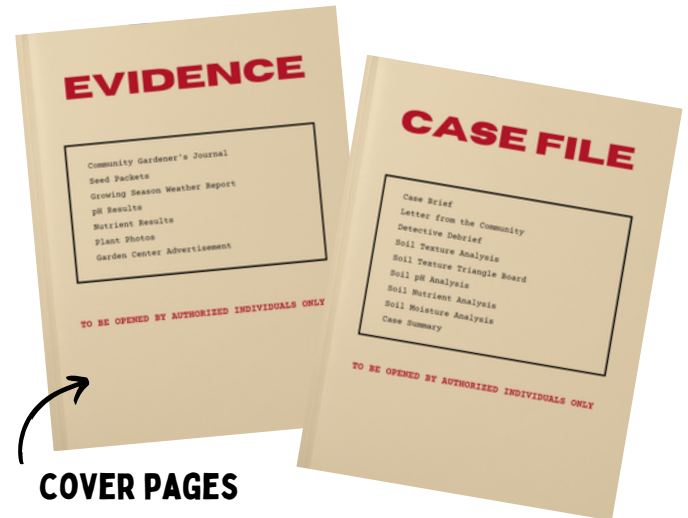
Extension Ideas

- Using their information from the last page of their Case File, have students work with their groups to design a garden plan for the "Grieving Gardeners" for their next growing season.
- Have students choose one factor of soil health to learn more about. Have them research and describe this factor and why this factor is important for scientists to study.
- Collect soil for students to study. Use microscopes for a closer look and what might be found in the soil.
 - Compare soil from different locations or compare soil to compost, sand, etc.
- Focus on scientific inquiry and complete our Soil Sam lesson. Have students choose a soil health factor to focus on as one of their variables for the experiment.
- Complete our Say it With Soil activity and learn discuss soil quotes from various people throughout history.
- Invite a soil scientist into your classroom to talk to students about what their job consists of and why it's important to study soil.
- Learn more about all the little critters that live in the soil.
- Go to agintheclassroom.org to contact your County Ag Literacy Coordinator for free classroom sets of our Ag Mags!

TEACHER TIPS & TRICKS

This escape room consists of two main parts: the Case File and the Evidence Folder. These two parts should be kept separate to follow the investigation theme. Use the provided cover pages and/or manila envelopes to separate the Case File from the Evidence.

Students should work through the problems in the Case File in the order they are printed. Pieces of evidence should be analyzed and used to help solve the puzzles in the Case File.



PAIN-FREE SET UP!
JUST PRINT, SEPARATE, AND HAND OUT!

It may be beneficial to read through the Letter from The Grieving Gardeners and the Case Brief together as a whole class before students start working through the case file. Working in groups of 3 or less works best.

The full answer key is included in this first section and includes information, in red text, on which pieces of evidence should be used to solve the puzzles. Make sure to read through all of the answer key before having students complete the investigation so that you can easily help guide students if they get stuck.

We suggest to print everything single sided, especially the evidence. If you need to print double-sided, make sure to at least print the Soil Texture Triangle Analysis sheet and the Soil Texture Triangle Board sheet separately as single-sided documents so students can complete the activity as directed.

*Students/groups will only need a pencil and a pair of scissors.

For more resources, visit www.agintheclassroom.org



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@ilaic



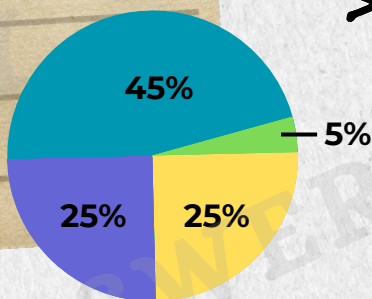


Detective Debrief

Soil is more than just dirt!

Here is what it's made of:

- Mineral Particles
- Organic Matter
- Water
- Air



Mineral Particles are made of broken down rock! The three mineral particle sizes in soil are sand, silt, and clay.



Organic Matter consists of living and decomposing plants and animals. There are a lot of critters living in the soil like insects, fungi, and microbes!

Soil is organized into layers, called horizons. Read about each horizon below.

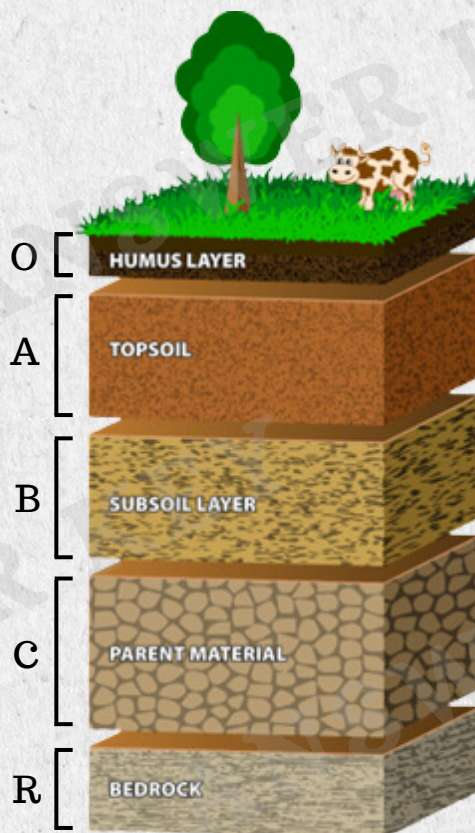
O Horizon: Humus Layer. Top layer of decomposing organic matter.

A Horizon: Topsoil. This layer is made up of mineral particles (sand, silt, and clay) along with organic matter.

B Horizon: Subsoil. This layer is rich in minerals that have moved down from the layers above it.

C Horizon: Parent Material. This layer is made up of the rock from which the soil originally formed.

R Horizon: Bedrock. This is a layer of unweathered rock, such as granite, basalt, quartzite, limestone or sandstone.



Use the letters on the soil horizon diagram and the alphabet below to decode a secret word that describes soil!

A L I V E

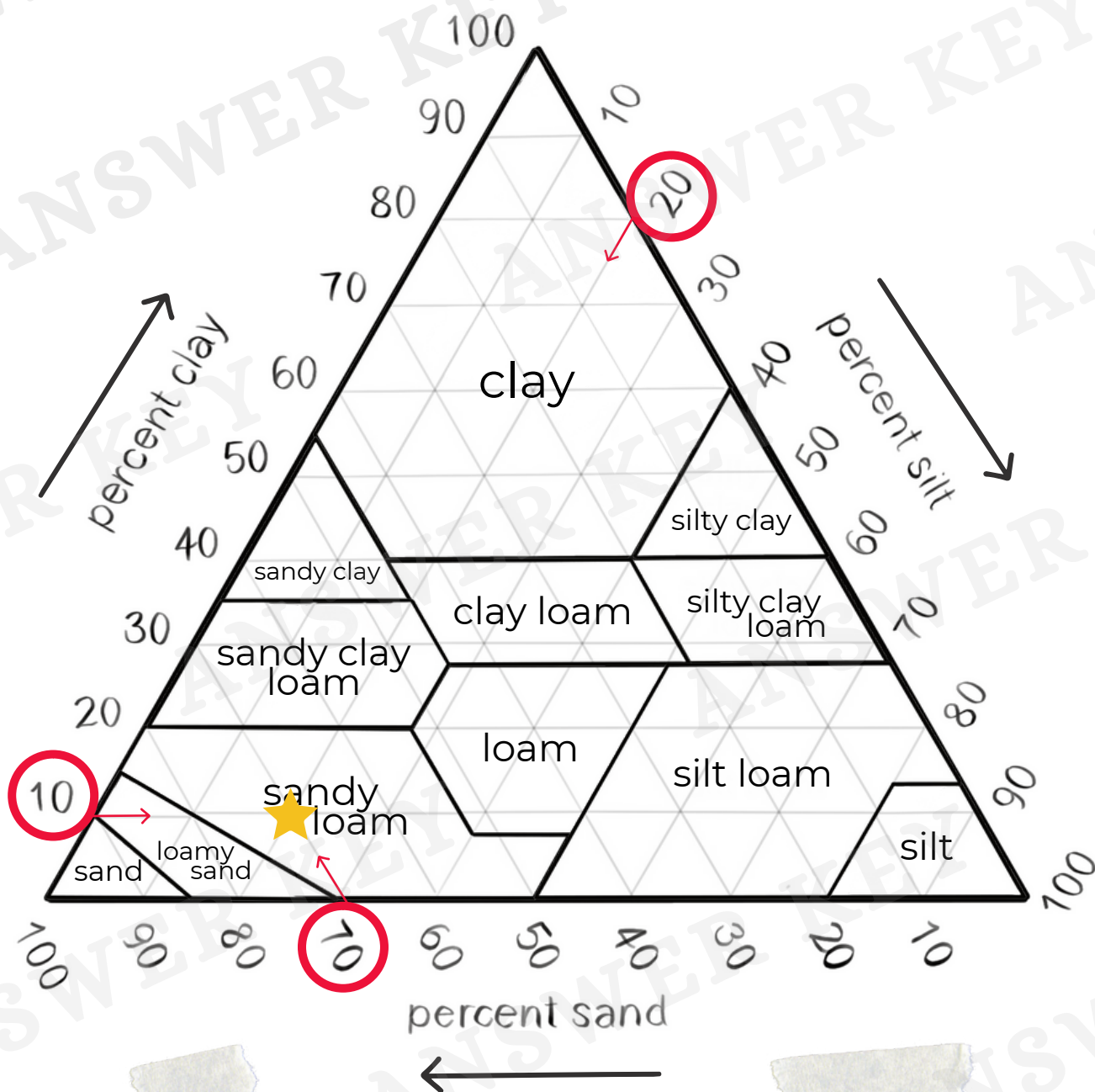
Use the information from this page to explain why this word describes soil.

THERE ARE MANY INSECTS, FUNGI, AND MICROBES LIVING IN THE SOIL.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
L	I	V	F	W	T	X	Q	B	P	S	D	G	K	A	R	U	E	Z	H	O	C	N	Y	J	M



Soil Texture Triangle Board



What type of soil is the community garden made up of?

SANDY LOAM

What percent of each particle makes up that type of soil?

70 % Sand

20 % Silt

10 % clay

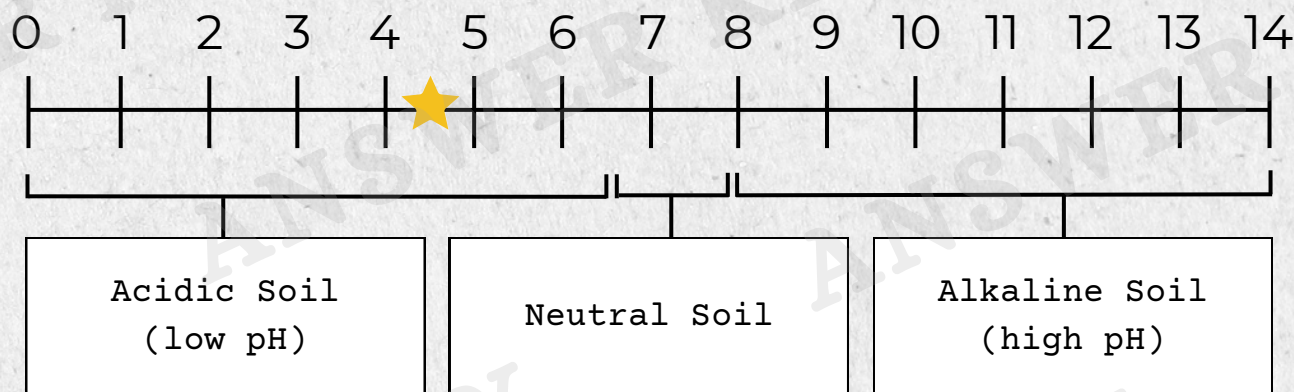


pH Analysis

pH is the measure of how acidic or alkaline the soil is.
The pH of soil determines how well the soil will absorb
nutrients and water.

What is the pH of the soil at the community garden plot?
Plot the pH on the number line below.

USE THE PH METER READING IN THE EVIDENCE FILE



The ideal pH of the crops in
the community garden are:

Tomatoes: 6.2-6.8

Peas: 6.0-7.5

Onions: 6.0-7.0

Carrots: 6.0-7.0

Broccoli: 6.0-7.0

Lettuce: 5.5-6.0

**USE THE PH INFORMATION
FROM THE SEED PACKETS IN
THE EVIDENCE FILE**

The pH of the soil is:

A) Neutral

☒ B) Acidic

C) Alkaline



Nutrient Analysis

Use the "pigpen" alphabet in the whit box to decipher the message below!

CAN USE THE ARTICLE CLIPPING IN THE GARDENER'S JOURNAL FROM THE EVIDENCE FILE TO CROSS REFERENCE/CHECK ANSWERS

A	B	C	J.	K.	L.		
D	E	F	M.	N.	O.	T	X.
G	H	I	P.	Q.	R.	V	Y.
							Z.

The three main

M A C R O N U T R I E N T S

that plants need in the soil are

N I T R O G E N

P H O S P H O R U S

and

P O T A S S I U M







Are there any nutrient deficiencies in the soil of the community garden? Provide two pieces of evidence to support your answer.




DEFICIENT IN NITROGEN, CAUSING YELLOW LEAVES



USE THE NUTRIENT TESTS AND THE PHOTOGRAPHS FROM THE EVIDENCE FILE, AND THE NUTRIENT ARTICLE IN THE GARDENER'S JOURNAL

Water/Moisture Analysis


 +  = 10


 +  = 7


 x  -  = 6


 /  = 5

What are the values of each symbol?

 = **5**

 = **2**




 = **4**




 = **10**




What type of soil was found at the community garden? Choose that equation to determine the minimum inches of rainfall that crops need per month.

USE THE TEXTURE TRIANGLE PUZZLE AS REFERENCE

- clay soil
- ★ sandy soil
- silty soil

 +  -  =

 x  -  = **5 INCHES**

 x  -  =

USE THE GARDENER'S JOURNAL TO DETERMINE LENGTH OF GROWING SEASON

How much total rainfall did the community garden need to get throughout the growing season?

5 IN X 4 MONTHS = 20 INCHES

USE THE WEATHER REPORT FROM THE EVIDENCE FILE

How much total rainfall did the community garden actually get throughout the growing season?

8.1 INCHES



Case Summary

You solved the mystery! Fill out the table below to officially close this case.

Look back at the evidence folder to help you with this column!

USE THE CATALOG CLIPPING FOR THIS COLUMN

Soil Factor	What was the problem with this factor and why is it bad for plant growth?	What could be done next year to fix the problem?
Texture	THE SOIL IS TOO SANDY (70%) AND IT DOESN'T RETAIN NUTRIENTS AND DRIES OUT QUICKLY USE THE GARDENER'S JOURNAL	ADD COMPOST TO SOIL TO IMPROVE SOIL TEXTURE
pH	THE PH IS TOO ACIDIC, MOST PLANTS NEED A NEUTRAL PH USE THE SEED PACKETS AND PAGE FROM CASE FILE	ADD A PH ADJUSTER LIKE "LIGHTNING LIME" TO THE SOIL TO RAISE PH
Nutrients	THE NITROGEN IS DEPLETED FROM THE SOIL. NITROGEN IS ESSENTIAL FOR CHLOROPHYLL, CAUSING LEAVES TO TURN YELLOW USE THE GARDENER'S JOURNAL	ADD FERTILIZER LIKE "UREA" TO SOIL TO INCREASE NITROGEN LEVELS
Moisture	IT ONLY RAINED 8.19 INCHES IN 4 MONTHS INSTEAD OF THE MINIMUM 20 INCHES PLANTS REQUIRE USE THE PAGE FROM THE CASE FILE	ADD COMPOST TO SOIL TO IMPROVE SOIL TEXTURE AND RETAIN MOISTURE AND HAND WATER MORE FREQUENTLY

SOURCES

Nutrient Article

<https://kidsgardening.org/wp-content/uploads/2020/12/Plant-Needs-Nutrients-complete-packet1.pdf>

Know Your Soil Article

<https://www.lawnstarter.com/blog/lawn-care-2/soil-types-guide/>

Photo Sources

pH test photo: [iStock by Getty Images](#)

Nitrogen test photo: [Amazon User: John Brown - Amazon Reviews](#)

Phosphorus test photo: [Amazon User: Saba - Amazon Reviews](#)

Potassium test photo: [Amazon User: Tad W. Theno - Amazon Reviews](#)

Tomato plant picture: tomatobible.com

Pea plant picture: [MSU Extension | Montana State University](#)

Onion plant picture: [HDC Factsheet: Interpretation of Leaf Nutrient](#)

Analysis

Broccoli plant picture: [What's wrong with my plant? : Garden : University of Minnesota Extension \(umn.edu\)](#)

Soil Texture Triangle

<https://www.sciencedirect.com/science/article/pii/S0169131722002848>

Seed Packets

Burpee Garden Products Co.

Catalog Clipping

www.farmandfleet.com

Overall Design and Elements

www.Canva.com



CASE FILE

Letter from The Grieving Gardeners

Case Brief

Detective Dictionary

Detective Debrief

Soil Texture Analysis

Soil Texture Triangle Board

Soil pH Analysis

Soil Nutrient Analysis

Soil Moisture Analysis

Case Summary

TO BE OPENED BY AUTHORIZED INDIVIDUALS ONLY



Dear Soil Sleuths,

We need your help! We live in a neighborhood that once had a vacant plot of land covered in trash. It was such an eye-sore. So we put our heads together and decided to clean up the plot and create a community garden. Not only would this make our neighborhood look nicer, but then we would all have fresh food to enjoy!

We planned, prepped, planted, and waited patiently for harvest time. We were so excited to see all our hard work pay off and enjoy fruits of our labor. But harvest is here and our plants don't look very good. They actually look sick!

It seems like our hard work did not pay off. Please help us solve this mystery so we can grow a beautiful garden for all our neighbors to enjoy!

Sincerely,

The Grieving Gardeners





CASE BRIEF

The Case of the Grieving Gardeners

Operative

Help The Grieving Gardeners figure out why the vegetables in their community garden plot did not grow well. Analyze the evidence collected from the scene to determine possible problems with the four main factors of soil that influence plant growth: Texture, pH, Nutrients, and Moisture.

Evidence

Pieces of evidence from the scene have been compiled into a folder to help you analyze the soil factors. Read the evidence closely, as some pieces may be used more than once.

Case File

Read through the Detective Debrief to complete your background research, then work your way through the case file to help you solve the mystery!



Detective Dictionary

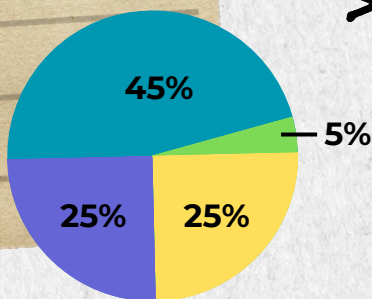
Acidic	A substance with a pH less than 7.0
Alkaline	A substance with a pH greater than 7.0
Analyze	To study or examine something carefully and closely
Decipher	To figure out, or translate from a code
Evidence	Something that is used to support an argument or give proof
Factor	Something in the environment that contributes to a result
Matter	Anything that has weight and takes up space
Nutrients	Substances that living things require in order to properly function
Organic	Things that are natural or related to nature
Particle	The smallest unit of measurement of something
pH	The measure of how acidic or alkaline (basic) a substance is, based on the concentration of hydrogen ions
Soil Horizon	A vertical cross-section of the soil, perpendicular to the earth's surface



Detective Debrief

Soil is more than just dirt!

Here is what it's made of:



Mineral Particles are made of broken down rock! The three mineral particle sizes in soil are sand, silt, and clay.



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Soil is organized into layers, called horizons. Read about each horizon below.

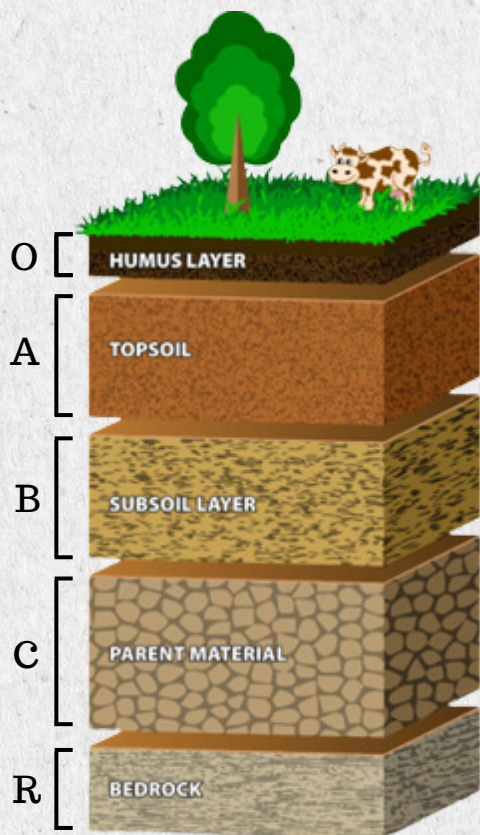
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C Horizon: Parent Material. This layer is made up of the rock from which the soil originally formed.

R Horizon: Bedrock. This is a layer of unweathered rock, such as granite, basalt, quartzite, limestone or sandstone.



Use the letters on the soil horizon diagram and the alphabet below to decode a secret word that describes soil!

In the space to the right, use the information from this page to explain why this word describes soil.

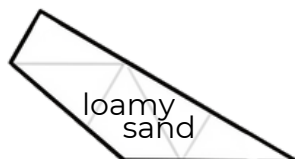
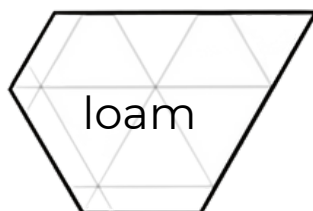
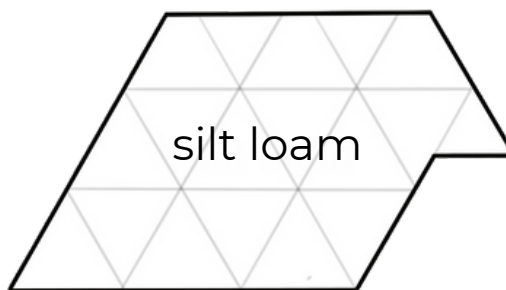
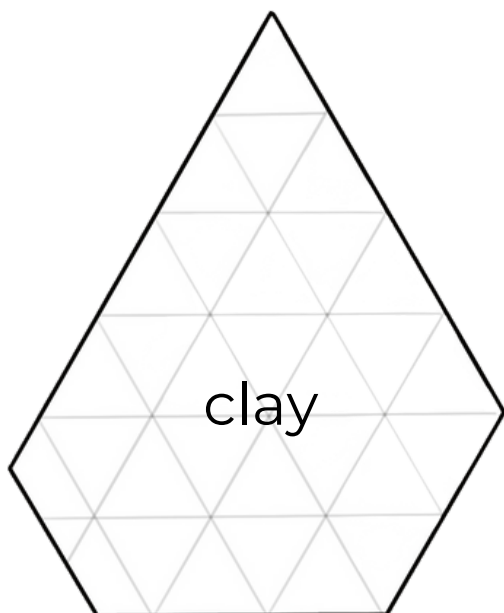
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
L	I	V	F	W	T	X	Q	B	P	S	D	G	K	A	R	U	E	Z	H	O	C	N	Y	J	M



Soil Texture Analysis

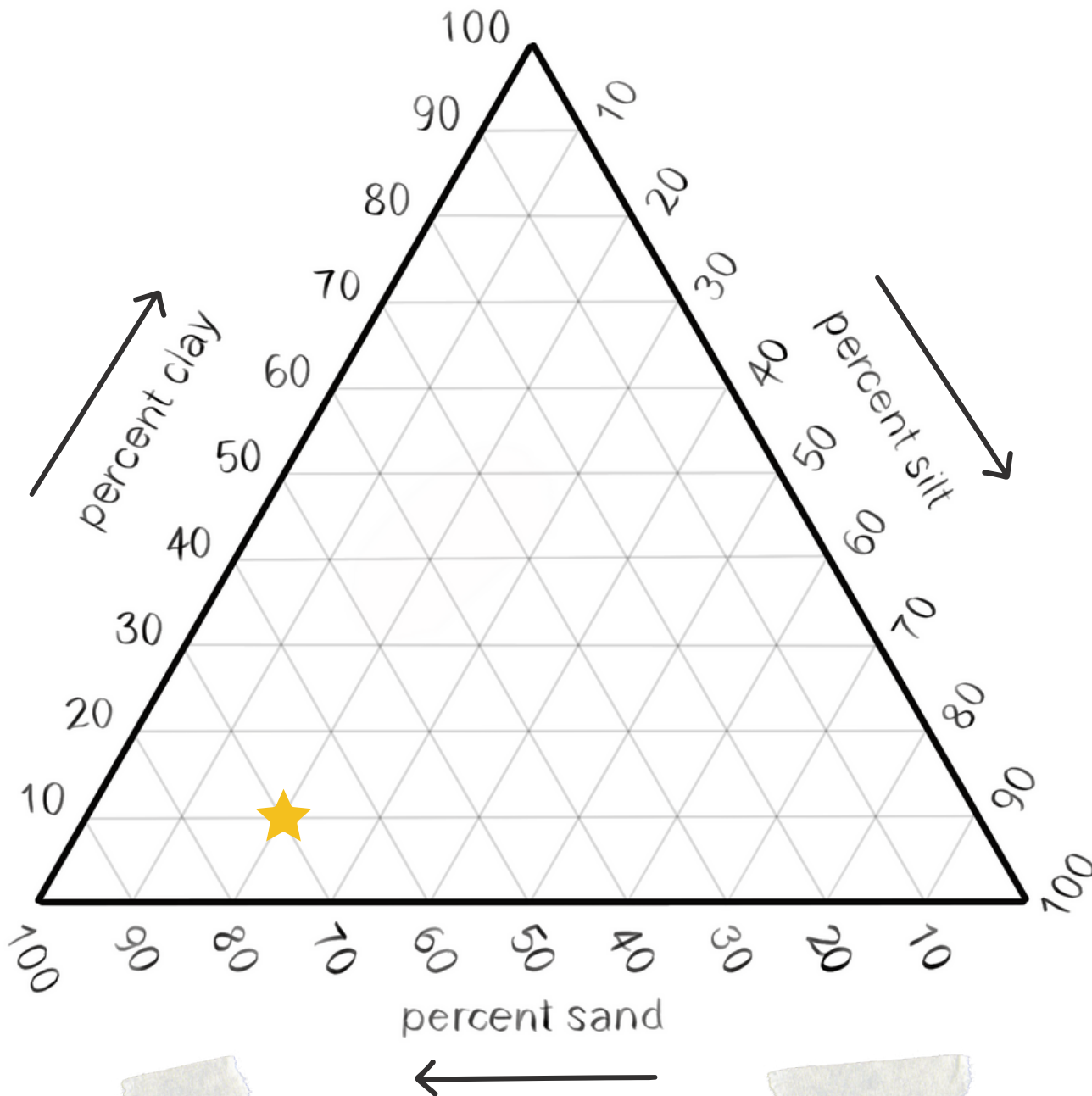
Soil texture is determined by the amount of mineral particles - sand, silt, and clay - in the soil. Cut out the pieces below and fit them into the Soil Texture Triangle board to determine what type of soil is at the community garden site.

The pieces will stay this same direction when placed on the board!





Soil Texture Triangle Board



What type of soil is the community garden made up of?

What percent of each particle makes up that type of soil?

____ % Sand

____ % Silt

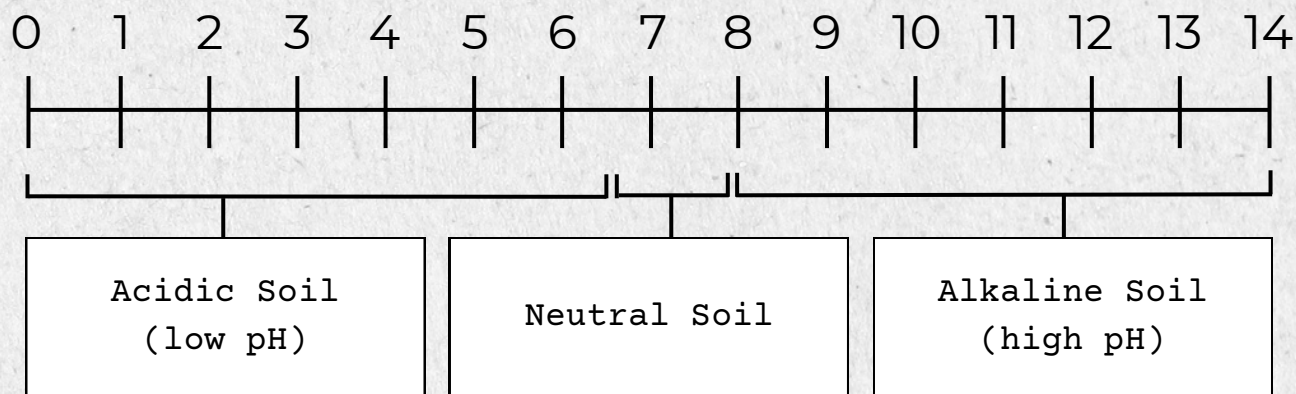
____ % clay



Soil pH Analysis

pH is the measure of how acidic or alkaline the soil is.
The pH of soil determines how well the soil will absorb
nutrients and water.

What is the pH of the soil at the community garden plot?
Plot the pH on the number line below.



The ideal pH of the crops in
the community garden are:

Tomatoes: _____

Peas: _____

Potatoes: _____

Carrots: _____

Broccoli: _____

Lettuce: _____

The pH of the soil is:

A) Neutral

B) Acidic

C) Alkaline



Soil Nutrient Analysis

Use the "pigpen" alphabet in the white box to decipher the message below!

A	B	C	J.	K.	L.		
D	E	F	M.	N.	O.		
G	H	I	P.	Q.	R.		

	S	
T		U
	V	

	W	
X	.	Y
	Z	

The three main

☐.┐└┐┐☐.☐<>┐┐☐☐.>∨

that plants need in the soil are

☐┐>┐☐┐☐☐.

┐┐☐.∨┐┐☐┐.<∨,



and



┐☐.>┐∨∨┐┐<☐.








Are there any nutrient deficiencies in the soil of the community garden? Provide two pieces of evidence to support your answer.

Soil Moisture Analysis


 +  = 10


 +  = 7


 x  -  = 6


 /  = 5

What are the values of each symbol?

 = _____




 = _____




 = _____




 = _____

What type of soil was found at the community garden? Choose that equation to determine the minimum inches of rainfall that crops need per month.

- clay soil
- sandy soil
- silty soil

 +  -  = _____

 x  -  = _____

 x  -  = _____


How much total rainfall did the community garden need to get throughout the growing season?

How much total rainfall did the community garden actually get throughout the growing season?



Case Summary

You solved the mystery! Fill out the table below to officially close this case.



Look back
at the evidence
folder to help
you with this
column!

Soil Factor	What was the problem with this factor in the community garden soil?	What could be done next year to fix the problem?
Texture		
pH		
Nutrients		
Moisture		

EVIDENCE

Community Gardener's Journal

Seed Packets

Growing Season Weather Report

pH Results

Nutrient Results

Plant Photos

Garden Center Advertisement

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COMMUNITY GARDEN JOURNAL



- ✓ Clean up trash
- ✓ Buy seeds
- ✓ Prepare soil
- ✓ Plant seeds
- ✓ Patiently wait for harvest!



Crops to grow: tomatoes, peas, potatoes, carrots, broccoli, lettuce



→ Planted seeds: June 1st

→ Harvest: October 1st



COMMUNITY RESEARCH



Make sure to do these tests:

→ Nutrient test

→ pH test

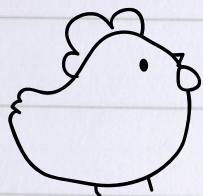
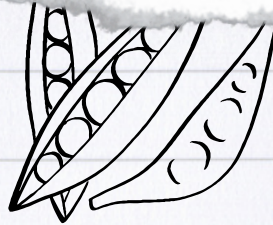
Nutrients: The Big Three

Although plants need all of the macronutrients and micronutrients listed above for optimum growth, scientists have identified three that are needed in larger quantities. These three are often limiting factors for plant growth and are more likely to be missing from soil, especially in a garden setting. The big three plant nutrients are nitrogen, potassium, and phosphorus. Here is a brief overview of why plants need these nutrients, as well as signs that might show plants aren't getting enough of them:

Nitrogen is needed for the plant to make a number of essential compounds, including chlorophyll. A plant that does not have enough nitrogen will look weak and have light green to yellow older leaves.

Phosphorus plays an important role in helping plants make flowers, fruits, and seeds. If a plant does not have enough phosphorus, it may have small, purple-tinged leaves, and will develop few fruits.

Potassium impacts how well water can move around a plant and the opening and closing of the stomata. Common signs of potassium deficiency include stunted growth and yellowing or browning of leaf margins and weakened stems.



COMMUNITY RESEARCH

Know Your Soil: The Pros & Cons of Soil Texture Types

by Dr. Dirt, May 5 2022

The soil below your surface plays a large role in the success of your garden. This article will give you some basic information about the pros and cons of each basic soil type! Keep reading to learn more about how you can grow a successful garden!

Silty Soil

Pros

- ✓ Good balance of retaining moisture and draining well
- ✓ Rich in nutrients for plants
- ✓ Soft and easy to cultivate/dig

Cons

- ✗ Prone to erosion
- ✗ Easily becomes compacted

Sandy Soil

Pros

- ✓ Drains well
- ✓ Good aeration
- ✓ Easy to cultivate
- ✓ Quick to warm up in spring so plants start growing earlier

Cons

- ✗ Can't retain essential plant nutrients
- ✗ Dries out very quickly, especially in summer
- ✗ Tends to be more acidic

Clay Soil

Pros

- ✓ Retains many plant nutrients
- ✓ Retains water for long periods of time

Cons

- ✗ Very poor drainage
- ✗ Easily becomes compacted so that water and nutrients can't reach roots
- ✗ Heavy and difficult to cultivate

Loamy Soil

Pros

- ✓ Holds moisture and nutrients well
- ✓ Good drainage
- ✓ Quick to warm up in spring so plants start growing earlier
- ✓ Easy to cultivate

Cons

- ✗ Somewhat prone to erosion



Seed Packets

Vegetable Tomato Rutgers

Tall vines and bright red in color, this legendary tomato is perfect for both slicing and cooking.

Keep moist. Seedlings emerge after 7-14 days. Prefers soil with a pH level between 6.2-6.8.

FULL SUN (6+ HOURS)
DEPTH 1/4"
SPACING 3-4"
74 DAYS TO HARVEST
Container Friendly 1 PLANT PER 12" CONTAINER (OR PLANT IN GROUND)

Outdoor Sown/Planting Zone Map

May - June (Blue)
Apr - June (Yellow)
May - June (Green)
Mar- May & July - Aug (Orange)

ATC Garden Products Co.
1701 Towanda Ave., Bloomington, IL 61701
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ENCLOSED SEEDS ARE FOR PLANTING PURPOSES ONLY AND ARE NOT FOR HUMAN CONSUMPTION

0 00035 54562 0

Vegetable Pea Burpeeana Early

3" pods are filled with 8-10 sweet, tender peas.

Sow seeds 2" apart in double rows space 6" apart with 24" between each set of rows. Seedlings emerge in 7-14 days. Thin to stand 4-6" apart when seedlings reach 1-2" high. Prefers soil with a pH level between 6.0-7.5.

FULL SUN (6+ HOURS)
DEPTH 1"
THIN 6"
63 DAYS TO HARVEST

Outdoor Sown/Planting Zone Map

May - June (Blue)
Apr - May & Aug (Green)
Feb - Apr & Sept (Yellow)
Jan - Feb & Sept - Oct (Orange)

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ENCLOSED SEEDS ARE FOR PLANTING PURPOSES ONLY AND ARE NOT FOR HUMAN CONSUMPTION

0 00035 54562 0

Vegetable Broccoli Sun King Hybrid

A very tasty broccoli with 6-8" heads and great leaf cover.

Sow seeds 1/4" deep. Keep moist. Seedlings emerge in 10-21 days. Prefer soil with a pH level between 6.0-7.0.

FULL SUN (6+ HOURS)
DEPTH 1/4"
SPACING 16"
71 DAYS TO HARVEST
Container Friendly 1 PLANT PER 12" CONTAINER (OR PLANT IN GROUND)

Outdoor Sown/Planting Zone Map

July - Sept (Blue)
Apr - May (Yellow)
July - Aug (Green)
Sept - Nov (Orange)

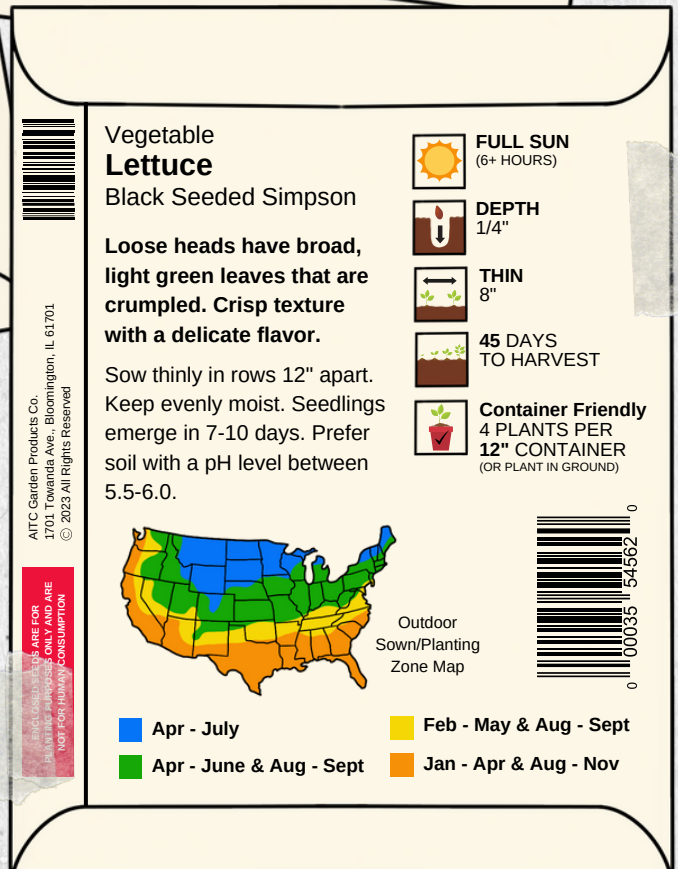
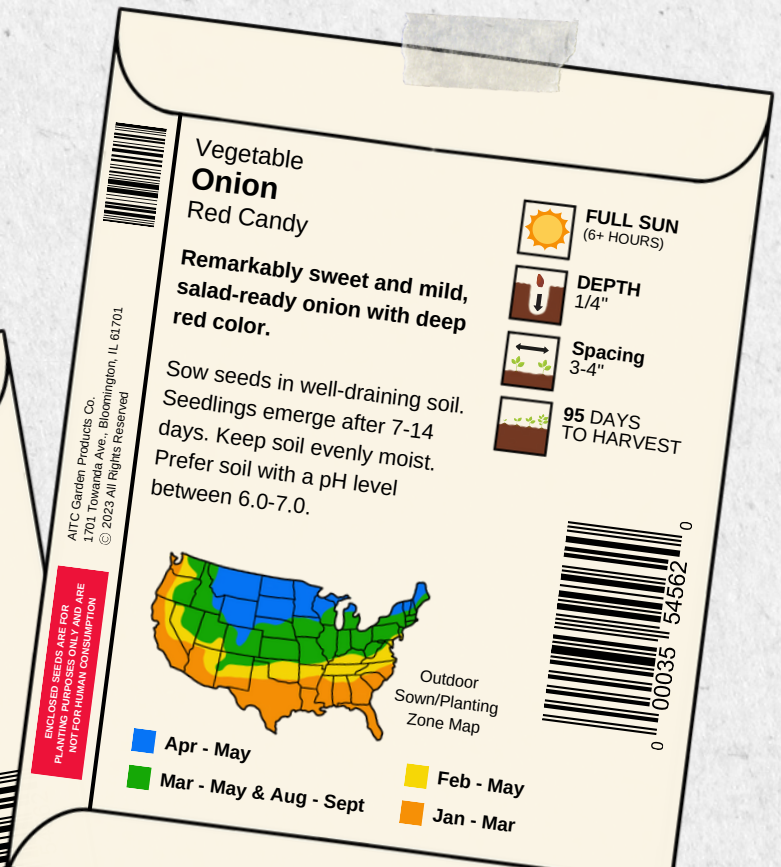
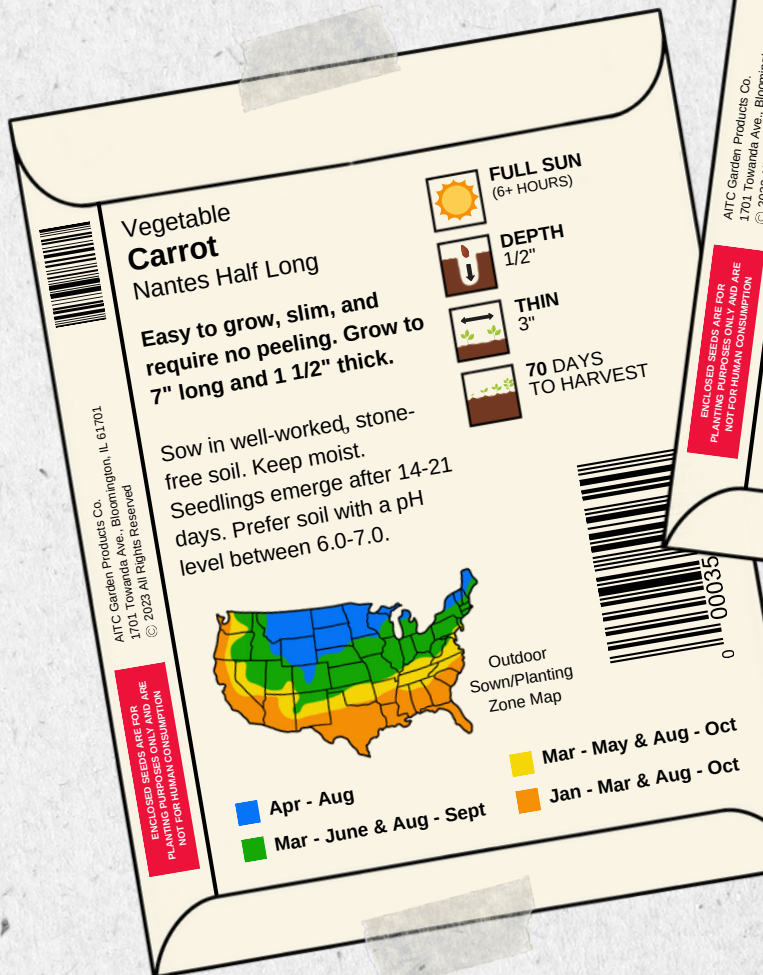
ATC Garden Products Co.
1701 Towanda Ave., Bloomington, IL 61701
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ENCLOSED SEEDS ARE FOR PLANTING PURPOSES ONLY AND ARE NOT FOR HUMAN CONSUMPTION

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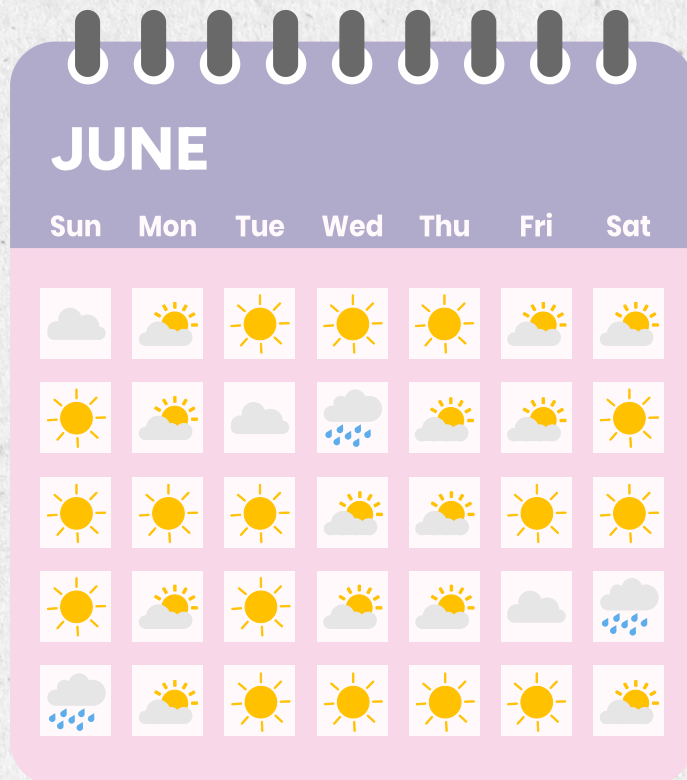


Seed Packets

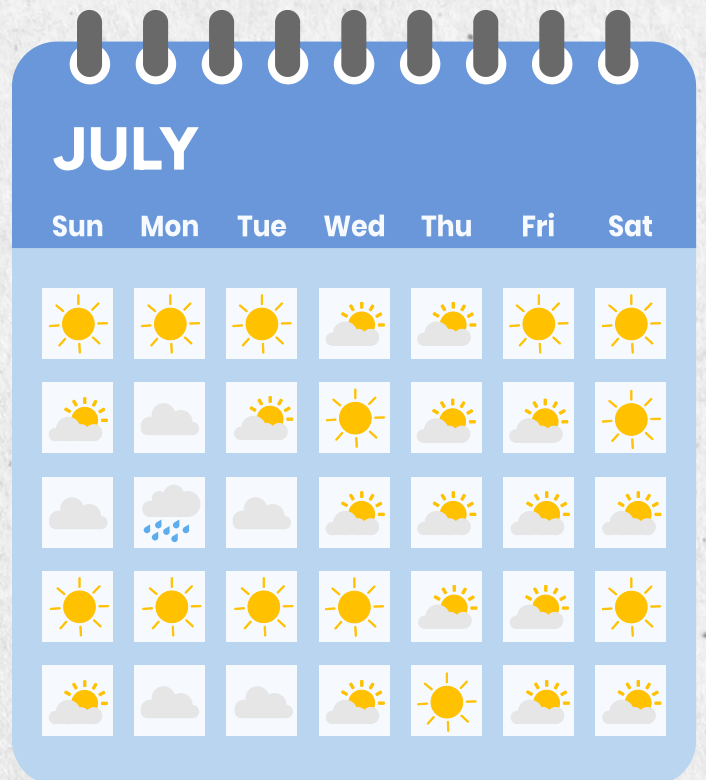




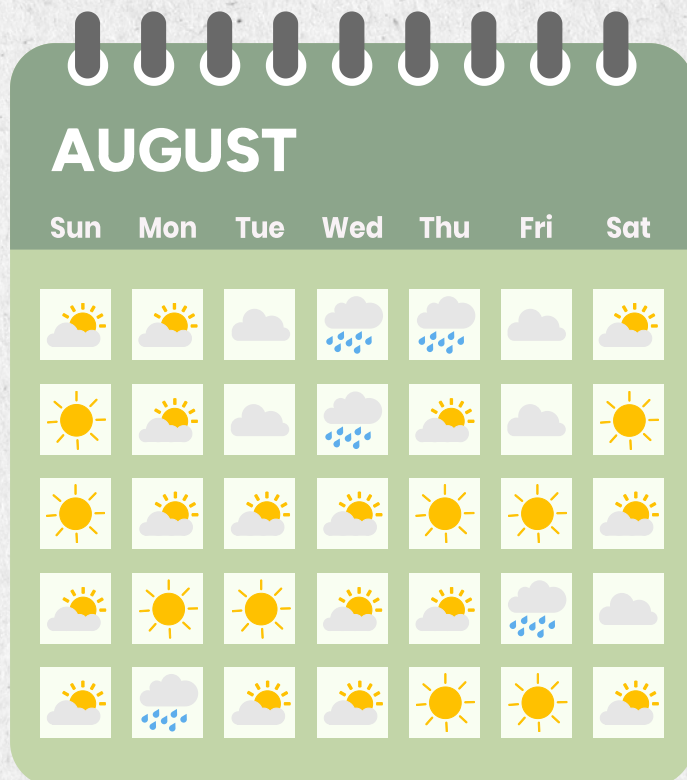
Growing Season Weather Report



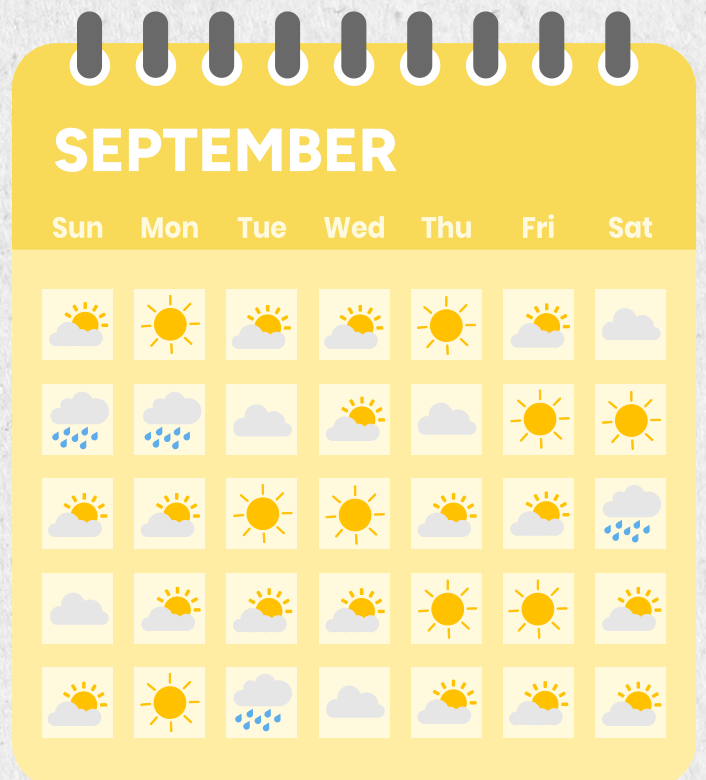
Average Monthly Temperature: 74°F
Total Rainfall: 2.4 inches



Average Monthly Temperature: 79°F
Total Rainfall: 0.9 inches



Average Monthly Temperature: 88°F
Total Rainfall: 3.1 inches



Average Monthly Temperature: 76°F
Total Rainfall: 1.7 inches



pH and Nutrient Test Results

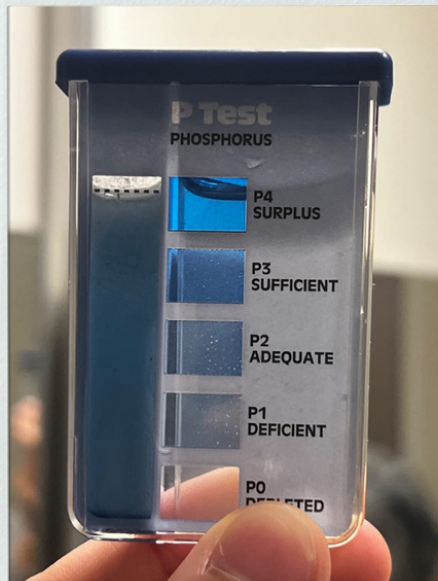


pH reading

to read nutrient
test results,
compare color of
water on left to
color chart on right



Nitrogen test reading



Phosphorus test reading



Potassium test reading



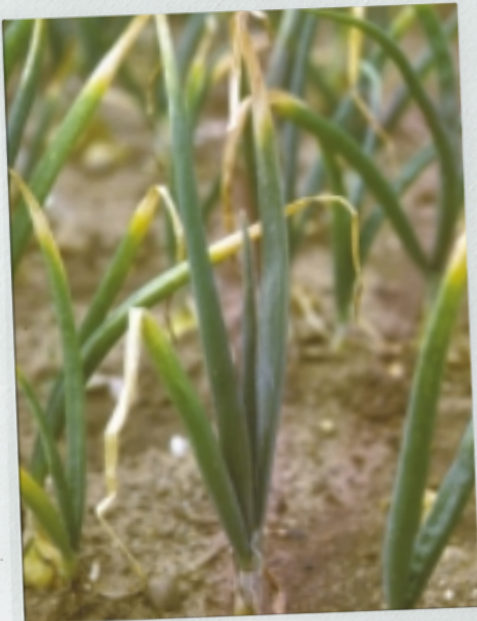
Plant Photos



Tomato plants



Pea plants



Onion plants



Broccoli plant



Catalog Clipping

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