LESSON 5: SIMULATING SUNSHINE

TEACHER GUIDE

LESSON OBJECTIVE

- To understand that the duration of light changes from season to season. Different plants require different amounts of light per day

- To know how many hours per day to run your grow lights in order to replicate a sunny, summer day.

- To understand that there are different types of visible light, and plants mostly require red and blue.

- To understand different types of grow lights have different intensities and abilities to penetrate the upper layer of leaves.

LESSON MATERIALS

- Paper
- Colored pencils and/or markers
- Old gardening magazines, seed catalogs
- Scissors
- Glue

LECTURE WITH BACKGROUND INFORMATION

In North America, there are not enough hours of light per day to grow "fruiting" plants during the Fall and Winter. And unless your plants are in a large, southern facing window where direct sun shines on them from sunrise to sunset, there probably isn't enough light to even grow lettuce. Consequently, you will need to add grow lights to supplement or replace the sunlight.

When using grow lights, there are 3 factors to consider: amount of red & blue light, number of hours lights should be on, and the intensity of the light.

LIGHT SPECTRUM

The visible light spectrum includes all of the colors recognizable by the human eye.

This spectrum includes red, orange, yellow, green, cyan, blue and violet.

Plants use their leaves to capture sunlight. Plants then use this sunlight to create sugar, which they use for their food source, through a process called photosynthesis.

Plants cannot use the entire light spectrum; they can only use red and blue light from the visible light spectrum to perform photosynthesis. Plants actually need more red light waves than blue, but they still require both to be fully healthy.

Natural sun light and artificial grow lights have an ample supply of red and blue light for plants to thrive.

Regular indoor lighting is not the best light source for plants. This is because it generally has insufficient red and/or blue light. For instance, incandescent light bulbs are lacking in blue light waves.

Hours Per Day

Plants grow differently in different seasons, based on temperature and the number of hours of light per day

All plants need light in order to make their food. However, not all plants have the same light requirements. For example, eggplant creates fruit only in the summer, when there is the most light, whereas kale grows in the fall just fine, when there is significantly less light.

Plants need dark, as well as light. Plants use this time in the dark to do most of their growing.

Some plants have greater energy requirements than others. They simply need more energy from the light in order to thrive. For example, tomato plants will not actually grow tomatoes until the days have reached sufficient light duration.

Fruiting plants (plants which produce a fruit like peppers and strawberries) tend to have greater light requirements than vegetative plants (like lettuce and herbs).

This differentiation in light requirements is a large part of why plants grow in different seasons. The plants that require more sunlight, and less dark, grow in the summer. Your aquaponics light timing recommendations are based off of this understanding. If you are growing a variety of plants in your aquaponics system, run your artificial lights for 17 hours on and 7 hours off

INTENSITY

Unlike sunlight which can travel over 90 million miles and still be strong enough to shine through the upper leaves and provide ample light for lower ones, grow lights (depending on the type) can lose their intensity in as little as 18 inches.

This is not a problem if you are growing short plants, such as lettuce and other greens. However, if you are growing an indeterminate tomato that can grow as tall as 15 feet high, you will need a stronger light.

Incandescent – Not recommended

Fluorescent – T12, T8, T5 are among those recommended, though they tend to lose their intensity within 18 inches. Okay for shorter crops. Inexpensive.

High-Intensity Discharge – a high intensity light. Good for taller plants

LEDs – New type of grow light, the jury is still out

High Pressure Sodium – a high intensity light. Good for taller plants

ASSESSMENT ANSWER KEY

1. Spectrum, duration (hours per day), intensity

2. **c.** - red & blue

3. **c.** – Summer

4. **c.** - 16-17

5. **c.** - A & C

STUDENT GUIDE – HOW CAN WE MIMIC THE SUN?

VOCABULARY

Light Spectrum – the range of different types of light

Visible Light – the light we can see

Season – a section of three months. The seasons are Spring, Summer, Autumn (Fall) and Winter

Photosynthesis – the process plants use to change light to food

Fruit – the part of the plant that contains the seeds

Plant Canopy – The dense, upper layer of leaves on a plant

Cruciferous – a plant that has flowers with four petals in the shape of a cross, and long narrow seed pods

LECTURE AND DISCUSSION

ASK: Does anyone know why plants need light?

Plants need light to make their food. They do it through a process called photosynthesis.

But, did you know that there are certain colors of light that are more important for this process than others? And, some plants need more hours of light per day than others.

The Sun and the Seasons naturally provide the right amount of light for the right amount of time for plants growing outdoors.

When growing plants indoors, however, we must recreate the Sun and Seasons, by keeping 3 factors of light in mind:

- Spectrum
- Duration
- Intensity

There are actually many different classifications (types) of light, but only one that we can see: visible light.

The visible light spectrum is made up of all of the colors we can see.

Plants, like the ones in our aquaponics system, are actually only able to use red and blue light to grow, i.e. to produce the food they need.

Plants need more red light than blue light, but they still need both of them in order to grow well.

A properly chosen grow light has enough red and blue light for plants to thrive.

Unfortunately, the normal lights in our classroom and houses are not as good for plants. They do not have enough of the red and blue light that plants need to grow and be healthy. So we must use artificial lights specifically made for this purpose.

DURATION

ASK: How many seasons are there? Name the seasons?

There are four seasons: Spring, Summer, Autumn (Fall) and Winter.

ASK: How are the seasons different from one another?

The seasons are mainly different in their temperature and the amount of sunlight per day.

Activity #1(a): Draw a sunlight diagram.

Summer has the most amount of sunlight, followed by Spring and Fall and finally Winter has the least amount of sunlight.

As mentioned earlier, plants use sunlight to make their food. Without light, plants would starve.

That said, not all plants need the same amount of light.

Plants that produce fruit tend to need more sunlight than those that do not. For example, strawberries require more sunlight than lettuce does.

ASK: How many hours of light per day do you think plants need to be healthy?

Fruiting plants grow best in Summer, and need as much as 18 hours of light per day to flower and produce fruit.

Cruciferous plants, like cauliflower and cabbages, on the other hand, grow well in late Fall, Winter and early Spring. They are happy with as little as 14 hours of light.

ASK: Name other plants the grow well in the Summer? Spring? Fall? Winter?

NOTE: Just because plants need light, doesn't mean they want it 24 hours a day. Darkness is important, too. Plants do most of their growing at night.

Our aquaponics system is designed to copy the sunlight; the timer is set so the plants can get the optimal amount of light.

When growing a mixture of Winter-loving and Summer-loving plants, set your timer for 16-17 hours of light per day. It's the ideal compromise.

Activity #1(b): Plants for Every Season

INTENSITY

Did you know that sunlight travels over 90 million miles and when it reaches the Earth it is still intense enough to penetrate the plant canopy (the dense, upper layer of leaves) to provide plenty of red and blue light for the lower leaves?

Some grow lights, however, can lose their intensity (strength) in as little as 18 inches.

This is not a problem for shorter plants, like lettuce, but for plants that can grow many feet tall, like tomatoes, stronger lights are necessary so that the red and clue light can reach lower leaves.

If the light is not strong enough plant stems will look long and string-like or the bottom leaves of the plant will fall off.

Therefore, once you know what type of plants you want to seed and how large they will grow, you can figure out what types of lights your aquaponics system will need.

ACTIVITIES

#1 - Draw a Sunlight Diagram:

1. Draw a circle.

2. At the top, write "Winter". At the bottom, write Summer. Then, write "Spring on the right side and "Fall" on the left side.

3. The amount of sunlight per day changes throughout the year. Which season has the most sunlight? Draw a large sun beneath that season.

4. Which season has the least amount of light per day? Draw a small sun above that season.

5. Which season starts out with shorter days and builds to longer days of light? Draw three suns to the right of this season: a small sun, a medium size sun and a large sun.

6. Which season begins with longer days and decreases to shorter day? Draw 3 suns to the left of this season: a large sun, a medium sun and a small sun.

#2 – Plants for Every Season:

1. Now add to your diagram. For each Season, draw pictures (paste images) of plants that grow best at each time.

CONCLUSION

Make sure children understand that plants need 2 types of visible light to grow: red and blue.

Review the each child's diagram, making sure they understand that Summer has the most hours of daylight, Winter has the least, Spring changes from shorter days to longer ones, and Fall changes from Longer days of light to shorter ones.

Also, make sure they know some plants prefer to grow in Summer (mainly those that produce fruit and vegetables), others in Spring and Fall, and Winter (mainly cruciferous vegetables). They should also be able to name one or two examples of these plants.

EXTENSIONS

Science: All light comes in waves. The different classifications of light are distinguished by their different wavelengths (the distance between two adjacent peaks in a wave).

Having a short wavelength means that the waves are close together. Having a long wavelength means that the waves are far apart.

Different wavelengths make-up different colors:

- The shortest wavelength we can see looks violet (purple).
- The longest wavelength we can see looks red.
- The middle of the spectrum (the medium wavelengths we can see) looks green to us.

ACTIVITY (You'll need jump ropes.)

1. Have students divide into groups of two.
2. Stretch out the jump ropes throughout the room so each has some space around it.
3. Send one group of two students to each jump rope, with one student on each end of the rope.
4. Have one student simply hold the rope to the floor.

5. Have the other student slide the rope back and forth on the floor to create a wave action in the rope.

6. Let the students take turns experimenting with the rope. Explain to the students that when they move the rope faster, it is like a violet wave. When they move the rope slower, it is like a red wave.

Different objects absorb and reflect different wavelengths, or colors, of light. The type of light that they reflect is what we see that object is. A stop sign is red because it reflects red light. A banana is yellow because it reflects yellow light.

Name_____ Date_____

ASSESSMENT 5 – SIMULATING SUNLIGHT

1. When simulating the sun indoors for plants, what 3 factors must be considered?

2. What 2 colors of visible light are most important for plants:
    a. Violet & orange
    b. Pink & green
    c. Red & blue
    d. Yellow & Ultramarine

3. Which Season do fruiting plants, such as tomatoes, grow best in:
    a. Winter
    b. Spring
    c. Summer
    d. Fall

4. When growing a mixture of Winter-loving and Summer-loving plants, how many hours a day should your grow lights be on:
    a. 5-6
    b. 12-13
    c. 16-17
    d. 23-24

5. Why is it important to know the intensity of your lights:
    a. To ensure that they will provide plenty of light for the entire plant to grow thick and healthy, top to bottom.
    b. To keep the clay media dry.
    c. To mimic the sun indoors.
    d. A & C