



Growing Bioenergy Activity

Objective

Students will understand the processes required to grow a hybrid poplar tree.

Skill Level: Middle school and high school

Prep time: Minimal

Class time:

- 30-minute period to plan planting.
- 30-minute period to plant tree
- Four to five 20-minute follow-up periods to take measurements.

Materials

- Hybrid poplar cuttings
- Deep pot (>20" deep) or garden plot
- Notebooks
- Measuring tape
- Scale
- Tags or popsicle sticks for identifying the cuttings
- Other tools depending on other activities

Next Generation Science Standards

Disciplinary Core Idea:

LS2.A: Interdependent Relationships in Ecosystems

Performance Expectations:

MS-LS2-1: Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

HS-LS2-2: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

Practices

- Asking questions / defining problems
- Developing / using models
- Planning / carrying out investigations

Crosscutting Concepts

- Patterns
- Cause and effect: Mechanism / explanation
- Scale, proportion, and quantity



<input checked="" type="checkbox"/> Analyzing / interpreting data <input type="checkbox"/> Math / computational thinking <input type="checkbox"/> Constructing explanations / design solutions <input type="checkbox"/> Engaging in argument from evidence <input type="checkbox"/> Obtaining / evaluate / communicate	<input type="checkbox"/> Systems and system models <input type="checkbox"/> Energy / matter: Flows, cycles, conservation <input checked="" type="checkbox"/> Structure and function <input type="checkbox"/> Stability and change
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Background Information

Hardwoods are used in many ways in the United States. From furniture to support beams, hardwoods are in great demand. Recently, scientists have explored their use as a source of biofuel. Hybrid poplars (*Populus deltoids* v. *Populus nigra*) are currently being researched and utilized as a source of biofuel in the state of Oregon. Unlike cottonwoods the species used is crossing North American poplars and aspens with European poplars create a hybrid poplar. The hybrid poplar grows quickly – anywhere between six to ten times faster than similar trees. This allows for a faster economic return, which is usually within 2 years. However, hybrid poplar trees are not without issues. In Oregon, these trees are planted in the eastern portion of the state, which is drier and thus requires more water.

Engage
<p>The need for less consumption of fossil fuels has driven research into new sources of bioenergy. Do new sources come at a greater expense than previous sources? Students will have the opportunity to grow hybrid poplar trees, monitor their growth, measure outputs, and discuss the benefits and issues associated with growing this alternative fuel source.</p>



Explore

Experiment Questions:

Is it possible to grow hybrid poplar trees in your classroom or backyard? Why is this tree a good possible bioenergy source? Based on student findings, which would be the best conditions and type of poplar to grow for the greatest biomass? Although these conditions produce the greatest amount of biomass, what are some of the disadvantages? eg. water usage, fertilizer seepage, land usage, etc.

Procedure:

Getting ready to plant the tree:

1. Have students watch [video](#). Have them focus on how the tree is planted. Ask them to write a planting procedure based on the video instructions.
2. Guide the students to design the experiment to answer the research questions. Older students will have a more complex design than younger students. Each experiment should have a control to make sure they know what affected height. Potential variable to test include: Amount of fertilizer, soil type used, drainage, spacing between plants, etc.
3. In groups, have students make a plan for what they will need in order to plant the tree. Guide them through what type of data they think they will collect and keep track of.

Planting the tree:

1. Remove all weeds and turf from within a 3-foot radius of the planting site. Hand-pull the weeds or use a hoe to dig them up. Keep this area free of all vegetation as the tree becomes established.
2. Till the planting site until the soil is loosened to a depth of 12 inches. Add a 3-inch layer of sand and till it to a depth of 8 inches. If planting in a pot, make sure pot is deep enough to accommodate long roots.
3. Dig a hole twice the depth and three times the width of the poplar cutting's base. Place the base on the bottom of the hole and pour a shovel-full of soil over them. Use your fingers to gently work the soil around and between the roots.
4. Backfill the hole, halfway, with soil. Fill the hole with water, allow it to drain and finish filling the hole with soil. Use your feet to lightly pack the soil around the base of the hybrid poplar to remove any air pockets that may remain.



5. Water the hybrid poplar until the water puddles at the base of the tree.
6. Place a 3-inch layer of mulch, 2 inches away from the hybrid poplar, but completely surrounding it. Spread the mulch over the weed-free area. Mulch will help insulate the roots from temperature extremes and also discourage weed growth.

Measuring tree growth:

1. Have students measure the initial tree measurements. Have them measure height, girth of trunk, number of branches, and the size of leaves. Notes should be taken in notebooks that can be used throughout the year to gather measurements. This data can be used to create tables and graphs communicating the results.
2. Take the same measurements at least once a month for at least five months.
3. After each measurement, have students compare their notes to prior months. Have them write notes about the main differences that they see. Poplar trees can be subject to fungal problems. Encourage students to write down if they witness any such issue and the methods they will go about to address this issue.

Explain

What are some issues students have had? Why? What do students think farmers will need to consider when planting a large crop of poplar trees? Are there economic considerations? Are there social issues that have come up that farmers would also need to contend with? Based on the experimental design, what factors affected the growth of the tree? What would you have done differently?

Elaborate

There is still a need to get more out of the tree with products such as lignin that inhibits the amount of ethanol produced. Have students watch this video <http://www.youtube.com/watch?v=xyaGeXUMtnE> and discuss why the work this scientist is doing is important or not. Why would scientists want to do this type of work?

Extensions

- In 2013, a study conducted in Europe showed that some of the crops grown for biofuels



emitted high levels of isoprene, a highly volatile organic compound (VOC) which when mixed with other air pollutants forms toxic ozone closer to the surface of the earth rather than in the stratosphere where it is more helpful in blocking ultraviolet radiation. The creation of ozone is not only harmful to soft tissues in humans and animals, but also reduces the biodiversity in crops. The issue of ozone creation and the impact it would have on human health, biodiversity, and crops. (See this link). Have students create their own homemade ozone detector known as a Schoenbein Paper by following these instructions. Have them discuss how ozone could be detrimental to crops and human health. How much should scientists be concerned with this by-product in the creation of new biofuels?

- Poplar trees have an ability to regenerate, once they are cut. Have students devise another experiment to examine what happens when the poplar trees are cut.

Resources

Additional Resources:

- Portions of activity adapted from [Garden Guides](#) (Click links)
- About Forestry [Website](#)
- [Study](#): Trees Grown for Biofuel Damage Ozone
- [Wisconsin's Grasslands Bioenergy Network](#)