Schoolyard Research on Winter Cover Crops

Grade Levels: Middle and High School

Length of Lesson Sequence: 1 hour in October, 1 hour in Late November, 2 hours in May

Brief Description:
Winter cover crops are planted between harvested crops (Fall - Spring) and provide many benefits to agricultural fields including reduction in nitrate leaching, nitrogen fixation, increased organic matter, weed suppression and others. However, few farmers currently use winter cover crops. The objective of this lesson is to engage middle or high school students in active research that identifies winter cover crop species and phenotypes that would be beneficial for local farmers. Students sow several cover crop species / phenotypes in the fall, measure ground cover in early winter and make plant measurements (biomass, height, root characteristics) in May of the following year. Research results may be reported to local farmers as an educational activity.

Content Statements/ Standards Covered:

B1.1C Conduct scientific investigations using appropriate tools and techniques (e.g., selecting an instrument that measures the desired quantity—length, volume, weight, time interval, temperature—with the appropriate level of precision).
B1.1h Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables.
B1.1g Use empirical evidence to explain and critique the reasoning used to draw a scientific conclusion or explanation.
B3.3b Describe environmental processes (e.g., the carbon and nitrogen cycles) and their role in processing matter crucial for sustaining life.
B3.5e Recognize that and describe how the physical or chemical environment may influence the rate, extent, and nature of population dynamics within ecosystems.

Objectives of Lesson:
At the conclusion of the lesson, students will be able to:
- Engage in constructive agroecology research activities
- Identify beneficial winter cover crop species or specific phenotypes of a species
- Create an educational brochure to inform farmers of their findings

Materials and Resources
- Two tillable locations, each 10 ft x 50 ft
- 50 grams of seed from five different cover crop species or varieties
- 20 medium size paper bags
- One 0.25 m$^2$ sampling quadrat
- Two Rulers
- Two pairs of scissors or garden clippers
- Two spades
- Ten plastic cups
- Tape Measure (>10ft)
- Two metal rakes

**Introduction/ Anticipatory Set**

Provide the students with the two page workshop attached at the end of this lesson plan. Students will research questions about agroecology and winter cover crops. They will then answer questions about specific cover crop species using the internet.

- The teacher or students may choose cover crop species that are different from the ones listed on the worksheet.

**Activities of the Session**

**Day 1 – Fall following typical grain or vegetable harvest (September or October in Michigan)**
- In each plastic cup, add 25 grams of each cover crop seed. Repeat so that each cover crop has two cups with 25 grams each.
- Till the soil at the two chosen locations to rid the area of weeds. If weeds are not a problem, direct seeding is preferred without tillage.
- Measure out five plots at each location that are 10 ft x 10 ft, for a total area of 10 ft x 50 ft at each location. Flag the corners to delineate plot boundaries. Randomly assign cover crops to one plot at each location.
- Evenly broadcast 25 grams of seed for the proper cover crop separately in each 10 ft x 10 ft plot. Gently rake the area to improve contact between the seed and the soil.

**Day 2 – Late Fall or Winter Ground Cover**
- Randomly toss the 0.25 m² quadrat into one of the ten plots
- Visually assess the percent of the ground that the cover crop is covering from above. A good way to be accurate is to average the assessments of multiple students.
- Repeat the percent cover measurements for the other 9 plots

**Day 3 – Spring Cover Crop Sampling (May in Michigan)**
- Collect above ground biomass from each plot using the 0.25 m² quadrat by randomly tossing the quadrat into each plot and clipping all of the plants off in the quadrat where the plant and soil meet. Place the biomass in a paper bag to dry.
- Measure the average height of the cover crops in each plot. Use a ruler to measure the height of five cover crop plants in each plot. Average the height of the five plants to acquire a plant height for each plot.
- Visually assess leaf characteristics (size, color, pubescence, etc.) for each cover crop
- Use the spades to dig up two entire plants (roots + shoots) from each plot. Separate some of the soil from the plants and place the two plants from each plot in the same paper bag. In the classroom, wash the remaining soil off of the roots to cleanse them. Analyze the roots of each species for architecture and the presence of nodules (legumes only).

**Day 4 – Laboratory and Data Analysis (Two weeks after sampling)**
- Record the dry mass for the above ground biomass from each of the ten plots
- Record the dry mass for each of the two whole plants (roots + shoots) from each of the ten plots
- Create a data table that includes the cover crop species and variety, price per pound, fall ground cover, May above ground biomass, May height, leaf and root characteristics and individual plant weight.

**Conclusion**

Make comparisons between the cover crop species or varieties for the different parameters measured. Some questions that can be asked include:

- Did the cover crops perform differently at the two locations?
- Which cover crop produced the most biomass?
- Did the cover crop with the most ground cover in the fall produce the most biomass?
- Was there a relationship between height and biomass?
- What plant traits did you notice that might be beneficial in a cover crop?
- If you were a farmer, which cover crop would you choose to plant before planting corn the following year?

**Assessment**

The students individually or collectively should prepare a scientific report including the introduction, methods, results, conclusions and literature cited. This can be done as a paper or a poster.

**Extensions (Optional)**

Prepare a brochure or handout for area farmers about the findings of the cover crop study.

**Post-lesson Comments and Reflection**

5.17.07

In 2006/2007 at Martin High School, this project proved to be a success. There were some challenges, such as having to work with two different classes, one in the spring and one in the fall. Another challenge was poor weather at the time of planting, making the students anxious to be back inside. However, the cover crops grew very well and we obtained some interesting results. I, the teacher, ended up making a two page handout that summarizes the entire project to give to the students or area farmers that might be interested.
What is agroecology?

What are the primary limiting resources for plant growth?

What is a winter cover crop?

Name four benefits of winter cover crops?

1.

2.

3.

4.

Name three challenges of growing winter cover crops?

1.

2.

3.

A farmer near Hickory Corners, MI has a field of soybeans, which will be harvested on September 25th. He would like to grow a cover crop over the winter and then plant corn in the field the following year on May 25th. What species should he consider growing? What types of plant traits would be most beneficial for a successful cover crop?
Which Cover Crop Species is the Most Beneficial?

Use the following websites to answer questions about four cover crop species that we will use in this experiment.

http://www.hort.purdue.edu/newcrop/afcm/canola.html (Canola)

Rye

Growth Season (Type):

Benefits (List 2):

Winter Wheat

Growth Season (Type):

Benefits (List 2):

Hairy Vetch

Growth Season (Type):

Benefits (List 2):

Canola

Growth Habits:

Environmental Requirements:

***Now that you have conducted your literature review, it’s time to make some hypotheses.
Which cover crop species will grow the most (highest biomass) by December? Why?

Which species will have the highest percent cover by December?

If we would decide to grow tomatoes next year, which species would most be most beneficial to the tomato crop?