Cover Crops
Grow Your Own Fertilizer

Overview

Cover crops have many potential benefits in agriculture. They can improve numerous soil physical, chemical, and biological characteristics, improve water retention and utilization, reduce erosion, control weeds, enhance biological control of pests and help manage crop nutrients, particularly nitrogen.

Nitrogen is a primary plant nutrient that is an important factor in determining a crop's health and productivity. However, it can also be a financially and environmentally costly farming/gardening input. Synthetic nitrogen fertilizers can play a significant role in polluting our water and air resources, while also consuming a great deal of fossil fuel energy in their production and transportation to the farm. Cover crops can play an effective role in reducing the need for synthetic nitrogen fertilizers.

The goal of this activity is to introduce the idea that nitrogen can be produced and conserved on a farm biologically through the use of cover crops. In order to make good use of a cover crop in a farm's nutrient management strategy, one needs to estimate how much nitrogen a mature cover crop contains. This estimate can then provide an approximate figure of how much nitrogen the cover crop will supply the soil reserve and next season's crop. The following reference resources are provided to improve your familiarity with the topic.

Resource References

Nitrogen Cycle. Kimball's Biology Pages, John W. Kimball
http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/N/NitrogenCycle.html

Cover Crop Resource Page. UC Sustainable Agriculture Research and Education Program (SAREP)
http://www.sarep.ucdavis.edu/ccrop/

Cover Crops for California Agriculture. Miller, P. R., W. L. Graves, et al. 1989. University of California, DANR Publication 21471, Oakland CA

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Introduction

Crops generally require more nitrogen than any other nutrient, usually between 80 and 200 lbs of nitrogen per acre. Encouraging nitrogen fixation via the mutualistic relationship between legumes and associated *Rhizobia* bacteria is one of the most important ways farmers can add nitrogen to the soil in sustainable farming systems. However, it is important for farmers to know the amount of nitrogen that such a cover crop contains and may supply to a subsequent crop. In this exercise, participants will estimate the nitrogen content of a legume cover crop. They will harvest and weigh all of the above ground biomass of a cover crop from a number of sample sites in the field. These weights will then be used to estimate the amount of nitrogen in the cover crop. Such information can be used by a farmer to help make decisions about when to mow and/or turn a cover crop into the soil or how much additional nitrogen may need to be supplied to the crop from other sources.

To Lead This Activity You Need to Know

Facilitators of this activity need to have basic understanding of the following concepts in order to effectively lead students through this activity:

- cover cropping
- the nitrogen cycle and its relationship to soil fertility management
- biological nitrogen fixation
- nitrogen requirements for common crops

Key Concepts

- nutrient cycles
- plant nutrition
- mutualism
- nitrogen fixation
- cover crop
- biomass

Objectives

- Engage participants in assessing the nitrogen contributing performance of a cover crop.
- Introduce the concept of mutualistic relationships in the context of agriculture.
- Demonstrate the economic and ecological benefits of biologically managed soil fertility.

Materials

- 3 ft x 3 ft (or for metric measurements, 1 meter x 1 meter) square quadrats, made from wood, PVC pipe or similar material (1 per team of 3 – 4 students)
- hedge shears (1 - 2 shears per team)
- burlap or woven fabric bags and a method to label them (2 – 3 per team)

One of each per class:

- a scale or balance with the ability to measure full bags weighing 20 - 30 lb (or10-15 kg) (note: if measuring a sample from an intercrop of legumes and grasses, and the primary scale can not make measurements less than 1 pound, a second, more sensitive scale is necessary)
- conversion factor chart (included below)
- calculator

Activity (45-50 minutes)
(The instructions and examples below use English units; however this exercise can be done using metric measurements; the appropriate information and conversion factors are provided in both English and metric units in the tables.)

1. Before starting the activity dig up some roots of the legume cover crop and show the participants the nodules on the roots. At this time discuss the nitrogen cycle, nitrogen fixation, and the concept of mutualism.
2. Arrange teams of 3-4 students per team.
3. Have them weigh and record the weights of their empty bags.
4. Demonstrate how to enter the cover crop field and place the quadrat so that you can sample all of the above ground plant material from the space being sampled. Demonstrate how to cut the cover crop.
5. Have each team choose a sample site in the field, place their quadrats at their sample sites and use their hedge shears to cut and remove all of the above-ground plant matter. Have the students place the cut biomass into their bags. The students can rotate cutting and bagging positions within teams every few minutes. Make sure all plant matter laying on soil is collected, but take care not to collect soil or other material. (10-15 min.)
6. Label the bag(s) with the name of the team taking the sample and the type of cover crop being sampled.
7. Have each team weigh their bags and record the weights on the student worksheet. Make sure all weights are corrected for the tare weight of the empty bags. (10-15 min.)
8. Use Table 1 of the Student Worksheet to determine the appropriate cover crop conversion factor based on type of cover crop being sampled. Multiply the cover crop sample weight by the conversion factor to arrive at the total amount of nitrogen in the cover crop.

If the cover crop is a legume/grass mixture

If a cover crop is a grass/legume mixture use the process below to first estimate the nitrogen contributions of the individual components of the mixture and then total nitrogen contribution.

1. Weigh and record the weight of the total biomass of the combined cover crop.

2. Take a representative sample of the cover crop biomass (at least 4 lbs) and physically separate the legumes from the grasses. Weigh and record the weight of each. Use these weights to calculate the percentage of the total biomass contributed by the legumes and the grasses. Then calculate the total legume weight in the sample and the total grass weight in the sample. (If the primary scale is not sensitive enough to measure less than a pound, a second, more sensitive scale may be necessary.)

3. Calculate the separate nitrogen contributions from the legume portion and the grass portion using these weights and the appropriate conversion factors from table 1. Add these together to get the total nitrogen content of the cover crop.

   Example: A cover crop comprised of a mixture of several legumes and several grasses is sampled from a 3 ft by 3 ft area. The total weight is 8 lbs. A 4 lb sub-sample is separated into legumes and grasses and is found to contain 3 lb of legume and 1 lb of grass.
   Calculations:
   % of mix that is legume = 3 lb out of 4 lb = 75%
   % of mix that is grass = 1 lb out of 4 lb = 25%

   Total legume in the sample = 8 lb x 75% = 6 lb
   Total grass in the sample = 8 lb x 25% = 2 lb

   N contribution from legumes = 6 lb x 23 = 138 lb N/acre
   N contribution from grasses = 2 lb x 11 = 22 lb N/acre

   Total N contribution from cover crop mix = 138 lb + 22 lb = 160 lb N/acre

Discussion and Reflection (10-15 minutes)

Students are encouraged to think about how the information generated in this field exercise can be used by farmers. Have students:
1. Select a common vegetable crop they would like to grow on the cover crop field in the next growing season (Table 3. of Student Worksheet).
2. From the table, identify the nitrogen needs of each selected vegetable crop.
3. Calculate how much nitrogen the cover crop could provide each selected crop as a percentage of that vegetable's nitrogen needs (Table 4. of Student Worksheet).

Based on the above, encourage the students to consider the broad economic value of the cover crop providing biologically generated on-site fertilizer.

This activity can lead to further investigations into the many different types of biological and synthetic nitrogen fertilizers used in agriculture. Questions can explore how different sources of nitrogen are produced, how nitrogen cycles, and the various costs and benefits of different nitrogen sources to our environment, economy, and society. Students can also investigate the many additional benefits cover crops provide beyond nitrogen fertilizer. Ask the students to suggest other possibly ways a farm, the environment, and society might benefit by the use of cover crops.

Student Worksheet

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Estimate the nitrogen contribution of a cover crop by using the weight of your biomass sample. Answer questions A,B,C,D, and E.

A. What is the weight of your cover crop biomass sample? ________ lb or kg (circle one)

B. What is the conversion factor for your particular cover crop? _______ (see Table 1.)

Table 1. Cover Crop Conversion Factors from Wet Weight to Nitrogen Content

Cover Crop	Conversion Factor (English lbs/acres)	Conversion Factor (Metric kg/hectares)
Vetch: Lana (Wooly Pod) or Purple	28	59
Bell Bean	18	37
Berseem Clover	23	48
Blackeyed pea (Cowpea)	21	44
Grass (average)	11	23
Legumes (average)	23	40

C. What is the estimated total amount of nitrogen contributed by the cover crop to the soil for the next season?

______________ X _____________ = _________________lbs/acre or kg/hectare

Cover Crop Sample Weight — Cover Crop Conversion Factor — Nitrogen Contribution by Cover Crop

If you were to plant your favorite vegetable in this field next season, what would it be? ________________________________

D. What is that vegetable's nitrogen need? _______ lbs/acre or kg/hectare (circle one)
(Select from table 2.)

Table 2. Typical Nitrogen (N), Needs of Vegetable Crops

Vegetable Crop	(lbs/acre)	(kg/ha)		Vegetable Crop	(lbs/acre)	(kg/ha)
Artichoke	50-100	55-110		Lettuce	120 - 180	135-200
Asparagus	80 - 150	90-165		Muskmelon	100 - 150	110-165
Bean	60 - 120	65-135		Onion	120 - 300	135-335
Broccoli	100 - 200	110-225		Pepper, Chili	80 - 150	90-165
Brussel Sprouts	100 - 200	110-225		Pepper, Sweet	120 - 240	135-270
Cabbage	100 - 200	110-225		Potato, Irish	150 – 300	165-335
Carrot	80 – 150	90-165		Potato, Sweet	80 - 120	90-135
Cauliflower	100 – 200	110-225		Spinach	80 - 150	90-165
Celery	200 – 300	225-335		Squash, Summer	80 – 150	90-165
Corn, Sweet	120 – 240	135-270		Tomato	100 – 200	110-225
Cucumber	80 – 150	90-165		Tomato, Cherry	100 - 200	110-225
Garlic	100 – 200	110-225		Watermelon	100 - 160	110-180

Source: FERTILIZER GUIDE FOR CALIFORNIA VEGETABLE CROPS
K. B. Tyler and 0. A. Lorenz, Department of Vegetable Crops, University of California, Davis, 1991
(Available at: http://vric.ucdavis.edu/veginfo/topics/fertilizer/fertguide.html)

E. What percentage of the vegetable crop's nitrogen need from the soil was potentially contributed by the cover crop? _________ %

________________ ÷ ______________ X 100 = ___________________

Cover Crop Nitrogen Contribution		Vegetable's Nitrogen Need		% Nitrogen Supplied to Soil by Cover Crop