Meredith Ward
meredith-ward@hotmail.com

Weed Seed Predation

Description: Investigate weed seed predation by ground beetles

Subject: Biological Weed Management

Duration: Setup - 40 min
Analysis – 60 min

Grade Level: Introduction to Advanced 10th grade classes.

Pennsylvania Academic Standards/Pennsylvania Ag Education: 4.5.10.B. 2
Analyze health benefits and risks associated with integrated pest management.

- Asses levels of control within different integrated pest management practices for weed control

Objectives:
1. Students will describe alternative weed management methods.
2. Students will identify four common invertebrate weeds seed predators.

AND/OR

3. Students will approximate weed seed predation by invertebrates and invertebrates+vertebrates.

Focus: Write the words agricultural weed management on the chalkboard. Discuss different forms of weed control used in agriculture. The most common answers are chemical herbicides and mechanical management such as tillage and mowing. Now write Integrated Pest Management on the board. Have student think and talk about different ways that insects may help control weeds in agricultural ecosystems. Discuss their answers and the feasibility of those answers.

Teach:
1. Discuss the many different ways of reducing weed infestations. List the positives and negatives of each.
2. Have students discuss and list the benefits and downfalls of using insects as a weed management method.
3. Discuss agricultural events and cropping systems that may increase a biocontrol agent's activity density.
4. Identify five common weed seed predators (rodents, birds, ants, crickets, and beetles).
5. Each group will average the activity density for their three pitfall traps according to seed predator and write it on the chalk board

AND/OR

Each group will find the average the % seed predation for each trap type and write it on the chalk board.

6. At the end of the period ask students the following questions:
    - What could a farmer do to increase invertebrate seed predator populations? (Reduce tillage, use cover crops, decrease pesticide use)
    - Why are organic and no-till farmers interested in weed seed predation? (organic can not use herbicides and no-till farmers use a lot of cover crops in their farming rotations)

Assessment:

1. Have students complete the Weed Seed Predation Activity Sheet.

2a. Have students determine the impact that invertebrates and vertebrates have on seed predation in the locations sampled.

AND/OR

2b. Have students determine the amount of predation occurring in the landscape.

3. Each group will pick one of the five weed seed predators discussed and do a presentation on that organism for the class.

Resources:

Liebman, M., C. L. Mohler. And C. P. Staver. 2001. Ecological Management of Agricultural Weeds. Cambridge University Press.

White, S. and D. Landis. 2004. Biocontrol Agent Profile *Harpalus pensylvanicus.* Technical Bulletin. Michigan Sate University. http://www.cips.msu.edu/biocontrol/fact_sheets/H.%20pen.htm

Zhang, J., F. Drummond, M. Liebman, and A. Hartke. 1997. Insect predation of seeds and plant population dynamics. Technical Bulletin 163. University of Maine. http://www.umaine.edu/mafes/elec_pubs/techbulletins/tb163.pdf

Tooley, J and G. E. Brust. 2002. The agroecology of carabid beetles. Intercrpt Limited. Andover, Hampshire, UK. 215-229.

Mortenson, D. A., L. Bastiaans and M. Sattin. 1999. The role of ecology in the development of weed management systems: an outlook. Weed Research. 40:49-62.

Teacher Sheet

Weed Seed Predator Identification and Activity Density

Name:

Date:

Class:

Introduction:

Weed seed predation is the removal of potentially viable seeds from the weed seedbank. Numerous organisms have been found to be weed seed predators. Some of the most common are rodents, birds, ants, crickets, and carabid beetles. The amount of seed predation occurring in a cropping system is directly related to the activity density of that seed predator. For the purpose of this demonstration activity density is the number of seed predators per pitfall; this number represents the number of seed predators that are searching for food on the soil surface. In this experiment you will be determining the activity density of two ground beetles *Harpalus pensylvanicus* and *Amara aenea*. This information will approximate the amount of seed predation that may be occurring by *Harpalus pensylvanicus* and *Amara aenea.*
Activity density can vary greatly between cropping systems. Annual cropping systems have unique characteristics because of the high frequency and intensity of both physical and chemical disturbances required to maintain them. Intensive management of agricultural landscapes such as frequent cultivation and pesticide application can negatively affect abundance, diversity and efficiency of ground beetles and other weed seed predators. Multiple studies have shown that seed predators have a higher activity density in cropping systems that require fewer soil disturbances and produce a denser canopy cover. Many seed predators live in the soil, frequent soil disturbances can cause habitat deterioration, emigrantion to more preferable habitats and in some cases can cause death. Cropping systems with dense canopy covers provide these biocontrol agents with much needed protection from other predators.

Materials Needed Per Group:

- 6- 2L soda bottles cut into two so that top forms a funnel
- 6- 24 oz deli containers or 6 2L soda bottle bottoms
- 6- 8 oz Styrofoam cups with lids
- Antifreeze
- 6 aluminum pie pans
- Tweezers
- Seed Predator Identification Guide

Procedure:

- Assign students to five groups.
- Pitfalls are made by cutting a 2-liter bottle in half. A Styrofoam cup is placed in the bottom of the 2-liter bottle and the nozzle is inverted to form a funnel.
- 3 pitfalls are randomly placed throughout a field for each of the five groups.

- Pitfalls are placed/buried in the field so that the lip of the 2-liter bottle is flush with the soil surface (See Photo 3).
- Once the pitfall traps are placed, pour one inch of antifreeze into the Styrofoam cup, this acts as the killing agent.
- Pitfalls are left out/open in the field for 72 hours.
- Samples can then be taken into the classroom and the contents of the cups are poured into aluminum pie pans and the common invertebrate seed predators are identified and counted (disregard other insects).
- Common invertebrate seed predators consist of *Harpalus pensylvanicus, Amara aenea,* ants and crickets.

Photo 1: Materials for pitfalls

Photo 2: Pitfall

Photo 3: Pitfall placement in field

Analyzing Data:

Data Table: Your Group's Results

Pitfall Number	Ants	Crickets	*Harpalus pensylvanicus*	*Amara aenea*
1				
2				
3				

Data Table: Averaged Results for Class

Group Number	Ants	Crickets	*Harpalus pensylvanicus*	*Amara aenea*
1				
2				
3				
4				
5				

1. Which seed predator had the highest activity density and which seed predator had the lowest activity density?

Based on student results

2. Did the seed predator's activity density vary according to location? If so, which seed predator activity density varied and why?

Based on student results

3. Do you think that they activity density of these seed predators will change throughout the summer? Explain.

Yes, seed predator activity density will change. Activity density will be the lowest in the beginning of summer until all eggs hatch and adults emergefrom hibernation, activity density will be lowest towards the end of the summer when generations start to die off.

4. What habits do you think these seed predators prefer in regards to soil disturbances and canopy cover and why?

Seed predators like habits with a dense canopy cover with provides protection from other predators such as birds. They also prefer habits with low numbers of soil disturbances (i.e. tillage); soil disturbances can cause mortality.

Student Sheet

Weed Seed Predator Identification and Activity Density

Name:

Date:

Class:

Introduction:

Weed seed predation is the removal of potentially viable seeds from the weed seedbank. Numerous organisms have been found to be weed seed predators. Some of the most common are rodents, birds, ants, crickets, and carabid beetles. The amount of seed predation occurring in a cropping system is directly related to the activity density of that seed predator. For the purpose of this demonstration activity density is the number of seed predators per pitfall; this number represents the number of seed predators that are searching for food on the soil surface. In this experiment you will be determining the activity density of two ground beetles *Harpalus pensylvanicus* and *Amara aenea*. This information will approximate the amount of seed predation that may be occurring by *Harpalus pensylvanicus* and *Amara aenea.*
Activity density can vary greatly between cropping systems. Annual cropping systems have unique characteristics because of the high frequency and intensity of both physical and chemical disturbances required to maintain them. Intensive management of agricultural landscapes such as frequent cultivation and pesticide application can negatively affect abundance, diversity and efficiency of ground beetles and other weed seed predators. Multiple studies have shown that seed predators have a higher activity density in cropping systems that require fewer soil disturbances and produce a denser canopy cover. Many seed predators live in the soil, frequent soil disturbances can cause habitat deterioration, emigrantion to more preferable habitats and in some cases can cause death. Cropping systems with dense canopy covers provide these biocontrol agents with much needed protection from other predators.

Materials Needed Per Group:

- 6- 2L soda bottles cut into two so that top forms a funnel
- 6- 24 oz deli containers or 6 2L soda bottle bottoms
- 6- 8 oz Styrofoam cups with lids
- Antifreeze
- 6 aluminum pie pans
- Tweezers
- Seed Predator Identification Guide

Procedure:

- Place 3 pitfalls randomly throughout the field burying them so that the lip of the 2-liter bottle is flush with the soil surface (See photo 3).
- Once the pitfall traps are in place pour one inch of antifreeze into the Styrofoam cup, this acts as the killing agent.

- Pitfalls are left out/open in the field for 72 hours.
- Collect samples and bring them into the classroom
- Pour pitfall contents into aluminum pie pans
- Separate contents into 5 piles, one for each of the weed seed predators mentioned earlier (*Harpalus pensylvanicus, Amara aenea,* ants and crickets) and another pile for other insects (disregard).
- Counted the number of each seed predator found for each pitfall and fill data table
- Find the average activity density for each of the seed predators over the three pitfalls for your group and write it on the chalk.
- Using the class results on the chalk board fill in data table 2.

Pl 

Analyzing Data:

Data Table 1. : Your Group's Results

Pitfall Number	Ants	Crickets	*Harpalus pensylvanicus*	*Amara aenea*
1				
2				
3				

Data Table 2. : Averaged Results for Class

Group Number	Ants	Crickets	*Harpalus pensylvanicus*	*Amara aenea*
1				
2				
3				
4				
5				

1. Which seed predator had the highest activity density and which seed predator had the lowest activity density?

2. Did the seed predator's activity density vary according to location? If so, which seed predator activity density varied and why?

3. Do you think that they activity density of these seed predators will change throughout the summer? Explain.

4. What habits do you think these seed predators prefer in regards to soil disturbances and canopy cover and why?

Weed Seed Predator Identification Guide

Meredith Murray

Harpalus pensylvanicus

- ½- 5/8 inch long
- Long black body
- Light brown appendages
- Actual size

University of Missouri

Crickets

- 2 3/10 inches long
- Brown or black body
- Large barbed hind legs
- Actual size

Wikipedia L'encyclopedia libre

Amara aenea

- 5/16-3/8 inch long
- Copperish metallic body
- Football shaped
- Relatively flat
- Actual size

Meredith Murray

Ants

- 1/20 to ½ inch
- Body color can be red, brown or black
- 6 legs
- 3 body segments
- Actual size

Teacher Sheet

Weed Seed Predation

Name:

Date:

Class:

Introduction:

Weed seed predation is the removal of potentially viable seeds from the weed seedbank. Numerous organisms have been found to be weed seed predators. Some of the most common are rodents, birds, ants, crickets, and ground beetles. Seed predation has been found to be responsible for up to80-90% of weed seed bank depletion. Seed predation can vary greatly between cropping systems. Annual cropping systems have unique characteristics because of the high frequency and intensity of both physical and chemical disturbances required to maintain them. Intensive management of agricultural landscapes such as frequent cultivation and pesticide application can negatively affect abundance, diversity and efficiency of ground beetles and other weed seed predators. Multiple studies have shown that seed predation is greater in cropping systems that require fewer soil disturbances and produce a denser canopy cover.

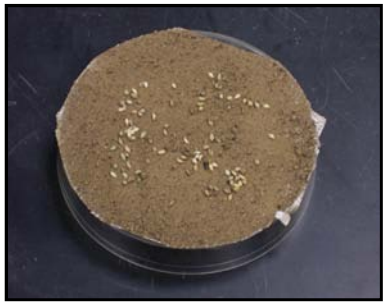
Materials per Group:

- 6 small Petri dishes
- 6 Large Petri dishes
- Double sided carpenter tape
- 0.5 in Medal wire mesh
- 18- 6 in bolts
- Sand
- 600 Giant Foxtail seeds or similar weed/crop seeds
- Duct Tape

Procedure:

1. Assign the students to 5 groups.
2. Have students remove paper off of six small Petri dishes with double sided tape, then sprinkle one packet of seeds (100 giant foxtail seeds) and sand onto the sticky surface. The seed cards will be used to determine the rates of predation [(subtract the number of remaining seeds on the seed card from 100)x100]= % seed predation. (Photo 1)
3. Each group selects a location in the landscape and randomly places three open traps and three closed traps. Open traps represents predation by invertebrates and vertebrates. This trap consists of three bolts being duct tapped to an inverted large Petri dish. The bolts are then pressed into the soil about an inch deep over top of the seed card. (Photo 2) The closed traps represents invertebrate feeding only. This trap consists of 0.5 inch metal wire mesh being cut and made into a cylinder with a large Petri dish fitting securely on top. (Photo 3) The trap bolts are pushed about an inch into the soil surface and has a seed card placed inside it.

4. The seed cards are placed so that they are flush with the soil surface directly under the large Petri dish that makes up the top of each of the traps.
5. The seed cards are left out in the field for up to 14 days at which time the seed cards are brought into the classroom, the number of remaining seeds counted and subtracted from 100 to get the percent predation occurring in the field.
6. Record and compare your results to the result of the class to determine the average amount of seed predation occurring in the field for invertebrates (closed trap) and invertebrates+vertebrates (open trap).



Analyzing Results:
Date Table
Your Group's Data

Trap Number	Number of Seeds Remaining Open Trap	% Seed Predation Open Trap	Number of Seeds Remaining Closed Trap	% Seed Predation Closed Trap
1				
2				
3				
Average				

Class Data Averaged Over Traps

Group Number	Number of Seeds Remaining Open Trap	% Seed Predation Open Trap	Number of Seeds Remaining Closed Trap	% Seed Predation Closed Trap
1				
2				
3				
4				
5				
Average				

1. Which trap had the greatest percent seed predation? Why do you think this occurred?

More predation may occur in the open traps because both invertebrates and vertebrates have access to the seed card.

2. Did seed predation rates vary according to location? Why or why not?

There may have been more predation in areas with more ground cover and less disturbance.

3. Do you think the rate of seed predation you saw occurring would have a large impact on next year's weed population in that location?

Seed predation rates may have been high however seed predation rates vary by

location. Seed predation alone may not significantly decrease crop yield loss; additional weed management methods such as crop rotation, selective herbicides and tillage are generally needed.

4. What weed control practices would you use in ADDITION to weed seed predation to help reduce weed population in that location?

Farmers can use crop rotation, intercropping, cover crops, tillage, low toxicity herbicides…..

Student Sheet

Weed Seed Predation

Name:

Date:

Class:

Introduction:

Weed seed predation is the removal of potentially viable seeds from the weed seedbank. Numerous organisms have been found to be weed seed predators. Some of the most common are rodents, birds, ants, crickets, and ground beetles. Seed predation has been found to be responsible for up to 80-90% of weed seed bank depletion. Seed predation can vary greatly between cropping systems. Annual cropping systems have unique characteristics because of the high frequency and intensity of both physical and chemical disturbances required to maintain them. Intensive management of agricultural landscapes such as frequent cultivation and pesticide application can negatively affect abundance, diversity and efficiency of ground beetles and other weed seed predators. Multiple studies have shown that seed predation is greater in cropping systems that require fewer soil disturbances and produce a denser canopy cover.

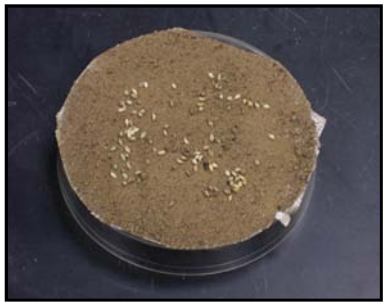
Materials per Group:

- 6 small Petri dishes
- 6 Large Petri dishes
- Double sided carpenter tape
- 0.5 in Medal wire mesh
- 18- 6 in bolts
- Sand
- 600 Giant Foxtail seeds or other similar weed/crop seeds
- Duct Tape

Procedure:

1. Remove paper off of 6 small Petri dishes with double sided tape, then sprinkle 1 packet of seeds (100 giant foxtail seeds) and sand onto the sticky surface. The seed cards will be used to determine the rates of predation [(subtract the number of remaining seeds on the seed card from 100) x 100]= % seed predation. (Photo 1)
2. Select a location in the landscape and randomly places three open traps and three closed traps. Open traps represents predation by invertebrates and vertebrates. This trap consists of three bolts being duct tapped to an inverted large Petri dish. Press the bolts into the soil about an inch deep. (Photo 2)
3. The closed traps represents invertebrate feeding only. This trap consists of 0.5 inch metal wire mesh being cut and made into a cylinder with a large Petri dish fitting snugly on top. Push the trap about an inch into the soil surface. (Photo 3)
4. Place a seed card so that it is flush with the soil surface directly under the large Petri dish that makes up the top of each of the traps.
5. Leave the seed cards out in the field for 14 days.

6. Bring seed cards back into the classroom and count the number of remaining seeds.
7. Subtract the number of remaining seeds from 100 to get the percent predation occurring in the field.
8. Record and compare your results to the result of the class to determine the average amount of seed predation occurring in the field for invertebrates (closed trap) and invertebrates+vertrebrates (open trap).



Analyzing Results:
Date Table
Your Group's Data

Trap Number	Number of Seeds Remaining Open Trap	% Seed Predation Open Trap	Number of Seeds Remaining Closed Trap	% Seed Predation Closed Trap
1				
2				
3				
Average				

Classes Data Averaged Over Traps

Group Number	Number of Seeds Remaining Open Trap	% Seed Predation Open Trap	Number of Seeds Remaining Closed Trap	% Seed Predation Closed Trap
1				
2				
3				
4				
5				
Average				

1. **Which trap had the greatest percent seed predation? Why do you think this occurred?**

2. **Did seed predation rates vary according to location? Why or why not?**

3. **Do you think the rate of seed predation you saw occurring would have a large impact on next year's weed population in that location?**

4. What weed control practices would you use in ADDITION to weed seed predation to help reduce weed population in that location?