Activity 21 Biological Warfare

by Dean Morris

Study Questions: What is biological pest control? How can it be used in an everyday situation?

Activity: Students will produce tobacco and observe and interpret the use of tobacco as a biological method of controlling plant pests.

Curriculum Fit:

Grade Eight - OP - Science

- Growing plants
- Biological methods of controlling plant pests
- Working with solutions
- Preparing solutions

Agriculture Concepts: Importance of enhancing plant growth through the use of biological methods of pest control.

Purpose:

- To acquaint students with alternative methods of pest control.
- To increase the student's responsibility and decision making competence in relation to the environment.
- To develop the students' knowledge and understanding of agricultural topics through direct application, experiment and analysis.

Materials Required:

- Tobacco plant solution in a spray bottle, plants, aphids, aquariums, native insects (bees, flies, caterpillars, etc.), plastic or wood top for aquarium, magnifying glass or microscope.

Time Required: Two to three class periods over an extended period of time (eg. 2-3 weeks).

Background — For the Teacher

The use of the biological pest control method is a safe way for any individual, whether a professional or a home owner to protect and beautify one's plant life. Most students having completed their work on the Plant Growth unit will have grown a tobacco plant and will have produced an insecticide solution. In this activity, students are to conduct an experiment to determine the impact of this type of insecticide on a house plant. Those that have never produced a tobacco solution, please refer to the included Teacher Resource Sheet for instruction.

NOTE:
This lesson would be an excellent following activity for an alternative method of Pest Control after Activity 12 (Don't Bug Me) from the Space Age Agriculture resource manual.

Procedure

Preparation

1. The students will need to be placed in groups of 3 or 4 (depending on class size). Each group can bring in a plant, either domestic or native to the environment. Two of the plants will need to be the same for control purposes.
2. The students can also bring in any insect native to the area for additional study purposes (the teacher will supply the aphids from a local greenhouse).

Introduction

3. Review the existing information on pesticides. Go over all the appropriate information covered in the included STUDENT/TEACHER Resource Sheets. Introduce and keep the students on topic by asking such questions as: What are pests? Is a pest always harmful to humans? How are pests controlled (3 ways — BIOLOGICAL, CHEMICAL and CULTURAL)? Explain how biological pest control works.

Activity

4. Have each group of students place their plant into the aquariums and cover with a plastic or wood top.
5. Mark one of the enclosures as the control unit with a felt pen.
6. Spray the plants in the experimental unit with the tobacco spray (see Teacher Resource #1).
7. Be very careful not to let the insects escape as you place them in both the experimental and the control units.
8. Have each student observe and record the data on Data Sheet One over a period of time, keeping track of the changes occurring in both the experimental and control units.

Conclusion

9. Have each group report their findings. Depending on the plants and insects used and on whether the findings come from the control or experimental group, the results may vary considerably.
10. Discuss the results of the experiment with the class.

Discussion Questions

1. Did different plants have any effect on the outcome of the experiment?
2. Were all the insects affected by the tobacco solution?
3. Are there any advantages to this type of biological pest control?
4. Any disadvantages to biological pest control?
5. How can the three types of pest control be integrated? How and why is such integration so important to the field of agriculture and crop production?

Evaluation Strategy

1. Group participation and cooperation.
2. Consistency in following through with the weekly routine of the experiment.
3. Evaluation of the final results, completed projects, and group presentation of results.

Related Activities

1. Hold a three-way classroom debate on the issue of biological, cultural and chemical pest control.
2. Develop a game board through research on pest control.
3. Interview farmers, scientists and consumers about their perceptions of pesticides.
4. Field trip to a local greenhouse or farming operation.

Resources

Alberta Agriculture, Food and Rural Development (Ag. in the Classroom),
Agricultural Education and Community Services Branch
2nd Floor, 7000 - 113 Street
Edmonton, AB
T6H 5T6
(427-2402)

Videos:Pesticides in Focus and Russian Wheat Aphids

Agriculture Canada
Supply and Service
Ottawa, ON
K1A 0S9

Alberta Environment
3rd Floor, Oxbridge Place
9820-106 Street
Edmonton, AB
T5K 2J6
(427-4147)

- local greenhouse
- local Alberta Pool
- Books: Insect Pests of the Prairies, H. Philip and E. Mengersen, U of A Printing, Edmonton, 1989.

Tobacco Spray

Solution Facts:

- Nicotine as a crude tobacco extract was used as an insecticide as early as 1763.
- The greatest concentration is found in the leaves with decreased amounts found in the stalks, pods and roots to only trace amounts in the seeds.
- The nicotine extracts have been used as contact insecticides, as fumigants and as stomach poisons.
- The material is especially effective against aphids and other soft-bodied insects.

Solution Production:

The nicotine is extracted from the plant by boiling 1 part plant to 2 parts water for a duration of 20 minutes. This solution is strained and then placed in a spray bottle with 1 ml of dish soap.

An ALTERNATIVE solution is to take 1 cigarette to 3 parts water and soak for 3 days. Strain the mixture and place in the spray bottle.

Symptoms of Poisoning:

1. Stupefaction
2. Hind legs paralyzed followed by wings and other legs
3. Staggered gait
4. Falls back
5. Twitching of antennae or abdomen

NOTE!!!
It is more important that the student make the observations than to be teacher directed and lead through the entire learning process.

Symptoms of Poisoning:

1.
2.
3.
4.
5.

TASK SHEET

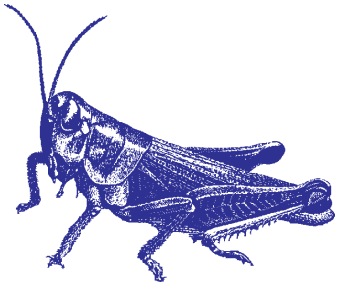
Date/Time	Types of Bugs	Types of Plants	Observations

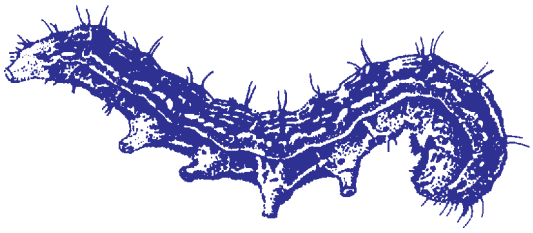
Symptoms of Poisoning

1. _____
2. _____
3. _____
4. _____
5. _____

What is a Pest?

A pest is any organism that adversely influences the welfare of humans by affecting their health, food or lodging. This can include anything from the tent caterpillar that consumes ornamental trees and strips the poplar of its leaves, to the mosquito that carries equine encephalitis (sleeping sickness) to horses and humans, the warble fly grub that feeds off livestock, the bacterial ring rot that destroys potatoes in storage or the wild oat plant that reduces the yield of wheat.





Helpful Insects

Many insects are helpful to man, either directly or indirectly. Insects can be valuable for commercial reasons or for the important roles they play in maintaining the balance of nature. Assistance from beneficial insects could be essential to our survival.

At least fifty of our important food crops depend on pollinating insects such as bees, for setting of fruit and resultant seed. Insect pests would ruin crops and vegetation but for predatory insects that capture and feed on them. Parasitic species also help to check insect pests. Scavenger insects aid in the decomposi- tion of organic matter while some insects help to aerate, fertilize and condition the soil There are insects that make shellac, dyes or pigments. The silkworm produces silk and bees make honey and beeswax. Insects also provide food for fish and animals, produce certain medicinal substances and aid in scientific research.

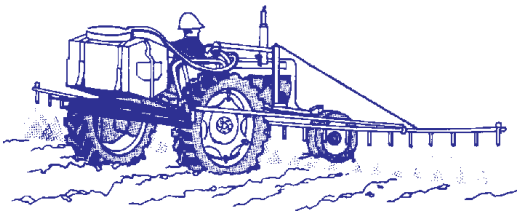
Knowing man's friends in the insect world can be important in controlling his enemies. Entomologists study the life cycles of the beneficial insects, learning how to use them to our fullest advantage.

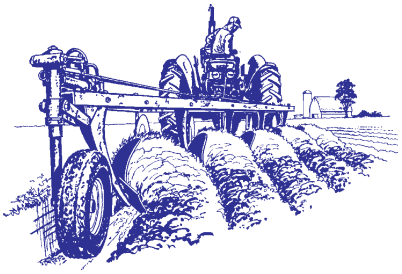
Insect Management Strategies

Certain weeds, insects and micro-organisms exploit the agricultural environment, using a significant portion of our yearly harvest if they are not controlled. Farmers use many methods to control this:

A. Chemical Methods of Pest Control

Chemical methods mainly include the use of pesticides such as herbicides, insecticides and fungicides. Pesticide-resistant organisms and examples of harmful side effects from chemicals have made it necessary to use different methods of controlling pests. The alternatives include cultural and biological control and integrated pest management.





C. Biological Control

Biological control of pests depends on the use of living organisms to keep pests from multiplying out of control. These control organisms may act on the pest through predation, parasitism or infection.

B. Cultural Methods of Pest Control

Cultural methods of pest control include using physical or mechanical means to prevents pests from getting established. Foremost among these are tillage, crop rotation, summerfallow and the use of weed-free seed.

D. Integrated Pest Management

If all the available methods of controlling pests are used in combination rather than individually, more effective pest control can be achieved. Cultural, biological and chemical methods can be integrated into a total package of pest control called integrated pest management. This strategy depends on a detailed knowledge of the life cycle and natural history of each pest species.

Chemical Methods of Pest Control

Once crop seeds begin to germinate in a field, physical or mechanical methods of controlling pests (tillage) are not practical. Destruction of crop seedling would occur should this method be attempted. Therefore chemical methods or pesticides are used. There are various types of pesticides:

a) **Herbicides** - kill weeds
b) **Fungicides** - control crop diseases
c) **Insecticides** - kill insects

Pesticides are ususally produced synthetically in a laboratory by chemists but a few can be obtained from natural sources like certain plant species. Three of these are pyrethrum, rotenone and nicotine.

Herbicides

Herbicides interfere with plant growth functions. For example, some herbicides attack the leaves of weeds to stop photosyntheseis, the energy-producing process in plants. The weeds die from lack of energy. Other herbicides act like hormones, speeding up the growth of plant cells beyond normal. When plants are exposed to these herbicides, their cells grow too rapidly, becoming deformed, and block the flow of nutrients throughout the plant.

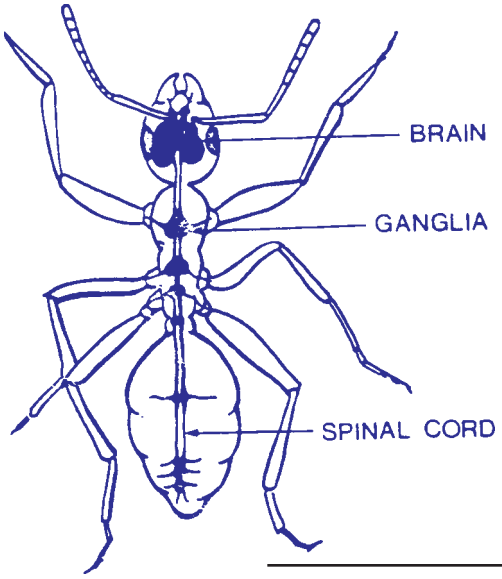
Since photosynthesis and plant growth hormones are peculiar to plants, herbicides do not affect animals. Some herbicides are non-specific in that they will kill any green plant. Other herbicides are fairly specific, for example, a herbicide designed to kill broad-leaved plants will not injure narrow-leaved or grassy plants. Similarily, broad-leaved plants are not killed by herbicides meant for grassy weeds. But herbidides meant to kill broad-leaved weeds will also kill broad-leaved crops such as beans, mustard and canola.

Fungicides

Crop diseases are caused by micro-organisms such as fungi. Fungi survive by carrying out many metabolic functions that are unique compared to those of the evolutionarily more advanced plants or animals. Fungicides act specifically to interrupt these metabolic pathways and usually do not affect plants or animals.

Insecticides

Many insecticides, whether they are synthetic or natural, affect the nervous system of insects. They block the passage of information along the nerves from one part of the body to the other causing uncoordinated body movement, twitching and death. Because the nervous system of man operates in a similar manner to the insect's nervous system, insecticides can affect man and other animals.



Nervous system of the ant

Resistance to Chemical Control

Certain pests can no longer be controlled by certain pesticides. In other words, the pests have become *resistant*.

The problems of resistance of pests to pesticides arose in the mid-50's. It was noticed that when a population (P1) of houseflies was exposed to a certain amount of an insecticide, most individuals would die but a few would survive. The survivors would then multiply to give another population (P2). If this second population is treated with the same amount of the insecticide as before, more individuals than before would survive. If this exposure is continued over several succeeding populations, eventually all the individuals would survive. These individuals have now become resistant to the insecticide.

Resistance is a natural phenonmenon in all living things. When an external selection pressure is applied on a population of an organism, most individuals die, but those that can withstand the pressure survive. For example, when a pesticide is applied to a population of houseflies, those that survive are said to be more "fit" than the susceptible ones. These survivors have inherited the ability to resist the effect of the insecticide; that is, the ability or trait to inactivate the insecticide faster than the susceptible individuals.

Resistance in insects was first noticed with respect to DDT. Since then, the phenonmenon has been observed with several insecticides, fungicides and to a lesser extent herbicides, and is a major concern in pest control today. Insects and diseases usually find ways to overcome any pressure that is applied against them. In the case of chemical pesticides the major way is through genetic adaptation, but insects can also adopt various behaviors to avoid being exposed to a pesticide, a predator, or a parasite. For example, some pests cover themselves with soil after a pesticide has been sprayed. When the pesticide disappears from the ground, the pest emerges to continue eating the crop.

Pest resistance seems to be more prevalent in the fruit and vegetable growing areas of the country and is, consequently, a relatively minor problem for agriculture in Alberta. Nonetheless, resistance is, and will continue to be a major problem in agriculture generally. This situation has been recognized and new methods of pest control are being considered to overcome it.

The housefly - a pest that quickly becomes resistant to pesticides

Cultural Methods of Pest Control

Cultural methods of pest control include using physical or mechanical means to prevent pests from getting established. Foremost among these are:

a) Tillage
b) Crop rotation
c) Summerfallow
d) Use of weed-free seed
e) Pest resistant species

Tillage

In tillage, the soil surface is disturbed in the fall after crop harvest or in the spring before seed planting. Weeds, insect eggs and disease organisms are disturbed and killed, or reduced in numbers.

Crop Rotation

The method of growing one crop one year and another crop the next year (crop rotation) also serves to control pests. For example, a certain disease may parasitize the crop grown one year, thrive and multiply. However, if the crop grown the next year is one the disease cannot attack, the disease organism has nothing to live on and dies off. The disease is not eradicated though, as it quickly reestablishes itself when the right conditions are presented in following years.

Summer Fallow

In summerfallow, the soil is tilled from two to six times during the summer to get rid of persistent weeds. This happens because the roots of the weeds are exposed to the sun and dry up. No crop is planted the year the field is under summerfallow - or seeding may be delayed until the fall, as for winter wheat.

Use of Weed-Free Seed

Another important method that farmers use to control weeds is to sow seed that is free of weed seeds. This process helps to prevent the proliferation or distribution of some troublesome weeds.

Pest Resistant Species

Genetic selection is used to breed a crop that is more resistant to pest organisms. For example, certain crops in the grass family are resistant to the wheat stem sawfly because crops with stronger stalks were bred that keep the fly from eating through.

Biological Control

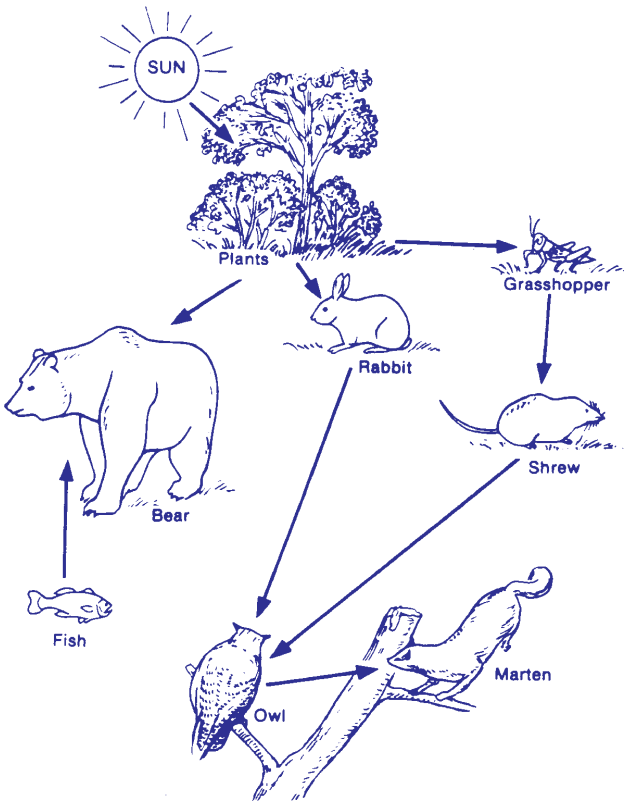
A natural wilderness environment consists of several species of plans, insect, animals, microorganism, etc., all of which interact with each other. Thus, each species has one or several others that keep it from multiplying out of control. Generally, one species (a predator) uses another (the prey) for food. Or one species (a parasite) may lay its eggs into another (a host).

This concept of using a predator or a parasite to feed on or infect an agricultural pest is an attractive idea being pursued vigorously by scientists. If a predator or parasite can be introduced into the agricultural environment to attack that pest, control of that pest is possible. This technique of controlling one organism with another is called *biological control.*

Despite the appeal of biological control, development of such a method is lengthy, time-consuming and costly. It requires considerable research to learn about the characteristics of the insect, its life cycle, its interaction in the environment and its predators. But although progress is slow in this area, some methods have already been developed and are being used.

For example, in green houses, several biological methods are being used with success. This enclosed environment is particularly suitable for such a method of pest contol since pest species are usually few, and little or no immigration of new pests occurs. Predators or parasites can be introduced into the greenhouse for each of the few pest species present.

Biological methods are especially desirable for pesticide-resistant pests. However, pests are also capable of developing resistance to biological control agents although this process develops much slower than pesticide resistance. (e.g. the disease "*Myxomatosis"* was introduced into Australia to suppress the out-of-control rabbit population. The biological agent worked initially but today, the rabbits are developing a resistance to the disease).



A natural environment showing the interaction of several species with each other.

The development of resistance is part of the endless process of evolutionary adaptation to a changing environment. It occurs in response to all categories of change, man-made or natural. Species that do not evolve as needed to retain their position in the ecological food chain may become extinct.

Integrated Pest Management

If all the available methods of controlling pests are used in combination rather than individually, more effective pest control can be achieved. Cultural, biological and chemical methods can be integrated into a total package of pest control called *integrated pest management*. This has been practised by farmers for many years.

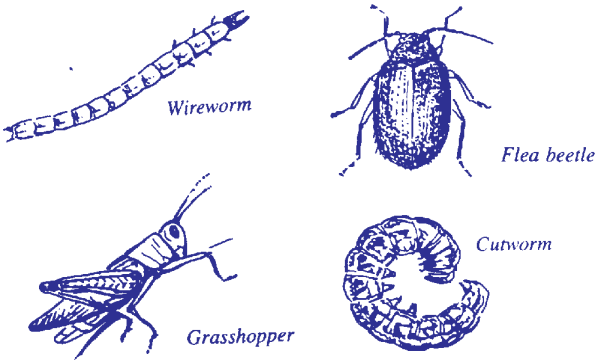
Tillage, crop rotation, summer fallow and the use of weed-free seed are the cultrual means employed to cut back on pest outbreaks. Predators or parasites are introduced when available and given maximum time to work. If pest populations are not reduced to an acceptable level, pesticides are then used.

The idea of an integrated scheme is to allow non-chemical means of pest control a maximum chance to reduce the pest population. When this fails, chemical means are then used. Integrated pest management therefore emphasizes reduced chemical use.

Farmers are now urged to seek the assistance of qualified pest managers in helping to manage their integrated programs.

These managers check closely for the presence of pest and predator, or parasite populations in crops and suggest if and when pesticides should be applied. This arrangement seems to be working well since in many instances, farmers save money by not having to apply chemicals unnecessarily. The practice of integrated pest mangement is being encouraged to cut back on pesticide use, thereby decreasing the problem of pest resistance to pesticides.

In Alberta, a few predators or parasites are known for the control of major pests such as grasshoppers, cutworms, bertha armyworms, etc.



Some major pests of Alberta

Testing these biological techniques is still in the laboratory stage and it will be several years before they are tested in the open environment. Therefore, the use of cultural and chemical methods of pest control predominate. However, populations of these pests are monitored every year and a forecast is provided to farmers to indicate whether or not pesticides will be required.