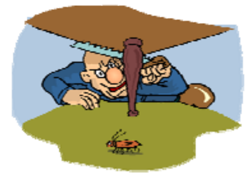
Insect Pest Management

Objectives

1. Define the term "Pest" and discuss how it is subjective.
2. Describe two categories of pests.
3. Differentiate between exponential and logistic growth.
4. Differentiate between K and r strategists.
5. Define EIL, ET and Characteristic Abundance.
6. Define Pest Resurgence and Secondary Pests and explain how they can be caused by pesticide use.



Introduction

Insects compete with humans for:
•Food (pre and postharvest)
•Clothing
•Shelter

Let’s start this unit by having you answer a seemingly straight forward question: "**What is a pest?**“

Bean weevil

What is a Pest?

Now that you have had a chance to think about what a pest is, let's look at the question more closely.

The answers students often give when asked what an insect pest is usually an answer like:
"A pest is something that damages crops."
or
"A pest is something that bothers us.“

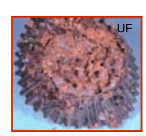
These are both correct answers. A good definition of a pest that includes both of these thoughts is "**a species that interferes with human welfare or aesthetics**.“

Subjectivity

What is unacceptable to one person may be of no consequence to another. For example, some people may feel a single ant walking through their kitchen is unacceptable and take action while others may assume that their is no problem until their pizza is being carried out the door by a colony of ants . This subjectiveness regarding pests can even extend to pests that are causing real damage. Some people are willing to put up with a worm hole in their apple in order to have food that is produced without pesticides. However, most people in our society feel that if a tiny blemish on any fresh fruit or vegetable is unacceptable and refuse to buy otherwise perfectly good produce.

Why are there so few pests?

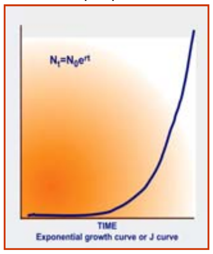
There have been approximately one million insect species named. Half of those, or 500,000, are herbivores that eat plants and compete with us for food. But out of that 500,000, only 3500 (0.7% of herbivores) cause us any problems. On top of that, only 200 insect species are serious pests in the U.S. That's approximately only 0.04% of all herbivores. If we have 500,000 species of insects eating plants why aren't there more insect pests?



Yes, even cigarette beetles like chocolate.

Population Growth and Regulation

Malthus figured out a formula we call the **exponential growth curve** or the **J curve** because it looks like a 'J'. As you look at the graph, you can see that the population at the beginning is not very high, but soon skyrockets and grows indefinitely at a very fast rate. Malthus got the British aristocracy all upset because they thought they were going to have all kinds of problems and that the masses of people would rise up and overpower them.



Modified from Daly *et al*. 1998, p175

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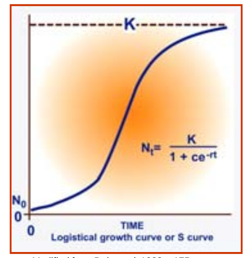
Logistic Growth Curve

Malthus didn't factor in an important element to his equation. Has the world population been growing indefinitely since 1803 as his graph shows? Not really. He didn't consider factors that keep the human population in check such as diseases, earthquakes, famines, pestilences and so on.

As it levels out, the 'J' growth curve looks more like an 'S' or **'S' growth curve,** also known as the **logistic growth curve.** The point at which the population levels or is no longer growing is called the **carrying capacity (or K)**. Carrying capacity refers to how many numbers of one species the habitat can support.



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Reproductive Strategy

Organisms that are **r strategists** produce a lot of offspring and have relatively little parental care. Examples of animals that are r strategists are frogs, fish and mice. Insects that tend to be r strategists are grasshoppers or aphids. When trying to decide if an organism is an r strategist or a K strategist you have to consider:

1. Its reproductive rate.
2. Survival rate.
3. Parental care.
4. How many generations the organism will have during a season.

aphids

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K Strategist

If numbers one and four are high, then it is an **r strategist**. If the organism tends to have few young and high parental care with few generations a year, then it is a **K strategist**.

K strategists put a great deal of resources and effort into relatively few young and these young are most likely to survive and reproduce. Some animal examples of K strategists are humans, whales, elephants, bears and horses. Horses can have one foal a season, and that foal stays with the mother to nurse for a few months. This is unlike frogs who lay several eggs in a pond and then leave the eggs to hatch and survive on their own.

The term r strategist comes from the equation used to calculate the logistic growth curve. The variable 'r' is the growth rate of the population. An r strategist has a high growth rate and thus its name. The term K strategist comes from the letter 'K' that represents the carrying capacity in the equation. K strategists are adapted to reproducing at the K level or the carrying capacity of the environment and don't reproduce at an exponential rate.

r r r r r r
r r r r r r **r** or **K** K K K
r r r r r r

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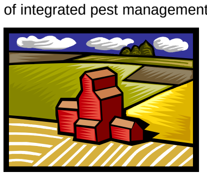
Growth Factors

With these terms in mind, which type of insect would you expect to be a pest of a large monoculture grain field, an r or a K strategist? (Monoculture means that there is only one type of crop on the field).

It's going to have to be an r strategist. Suddenly we go from bare ground to a crop that will last only a short season. The insect will have to reproduce quickly in order to take advantage of such a food resource. This doesn't mean all pests are r strategists. It depends on the kind of crop. A fruit fly will search for one apple to lay its egg on. It takes only one egg to ruin the apple. The fruit fly is more of a K strategist because it will only lay one egg rather than a ton of eggs on that apple. Factors that affect growth in a population are **density-dependent** and **density-independent growth factors**. These are a couple of terms used relative to pest control and the whole idea of integrated pest management (IPM).



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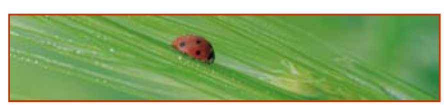
Density Factors

Density-dependent factors deal with how much population is present. They intensify as the population increases. These factors reduce the population growth rate by decreasing reproduction and by increasing the death rate in crowded situations. Available food, predation, parasites and diseases are common factors of this type. As a population grows, less food becomes available and soon the habitat may run out and the population may start to die off. A disease may not be able to spread from organism to organism if you only have a few of the insects in a field. But once the insect population starts to become crowded, the disease can be quickly spread and kill the entire population.

Density-independent factors include things like the weather and the physical environment and are unrelated to the population size. If there's a sudden frost, it doesn't matter if there are two aphids or fifty aphids on a plant, they will all be wiped out. Spraying insecticides is a man-made density-independent growth factor.



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Evaluating Pests and Pest Impact

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Now that we have looked at some aspects of insect populations, different reproductive strategies, and some general categories of control factors it's time to begin looking at how we humans control insects. One important tool that farmers and researchers have used for several years are the **Economic Injury Level (EIL)** and the **Economic Threshold (ET)** or **action level**.

The EIL is the point at which the damage caused by the insect equals the cost of preventing that damage. If it's going to cost you more to kill the insect pest than the money you would receive for the crop, then it's not worth trying to kill the pest. The EIL is calculated with the following equation: EIL = C/VDK

You don't need to memorize the equation, but just know what it means. The EIL is calculated with the variables C, V, D, and K. Variable C represents the costs of controlling the insect. For example, how much is it going to cost to spray an insecticide on your crop? Variable V represents the value of your crop, or how much you would get paid for it at the market. The variable D, equals the yield loss per pest. Yield refers to how much crop you get, such as if you got 1000 kg of wheat per square foot of land. And say one grasshopper destroys 10 kg of that. Then D would be 10 kg wheat/insect. Variable K equals the fraction of the pest controlled by your insecticide. (i.e. what percentage of the population will be killed if you apply the insecticide?) All of these four factors, 'C,V, D, and K,' go into figuring out the EIL.

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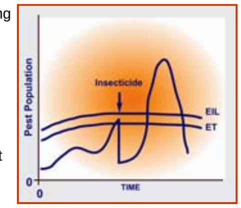
Economic Threshold

ET, or the **economic threshold** or **action level**, is usually set below the EIL. It is the point on the graph in which you take *action,* thus the name. When the pest population reaches a certain number that is calculated to be the ET, then you know you should do something so that the pest population doesn't get higher than the EIL. If you don't act before your pest population reaches EIL, then you are going to lose money. By the time you actually kill the insects and sell your crop, the amount you get for your crop will be below what it cost you to apply the insecticide. But if you act before you reach EIL, then you will save yourself money.

You have to monitor your pest population by taking samples so that if it starts reaching the ET, then you know you need to apply the insecticide or release your biological control agent. It is difficult to determine the economic threshold and economic injury level because you have to understand how much damage one pest is doing to a plant, and you have to make sure you take accurate samples. What if you took a sample that was really smaller than what the actual pest population was? Then you would wait longer thinking you had enough time, only to find out in the end your crop was destroyed.



Modified from Daly *et al*. 1998, p278

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Characteristic Abundance

Characteristic abundance, abbreviated CA is the organism's long-term average population size in a given area. If you were to walk into a forest, how many deer would you probably see? Probably one or two per acre. That one or two per acre is the deer's CA in that forest. How many sparrows would you expect to see in the forest? A lot of them per acre. You would also see lots of insects per acre. Knowing an insect's CA is important because it will help you determine when you need to apply insecticide or other control methods. If it's a pest where the CA doesn't reach the EIL, then you won't need to treat for it . This would be classified as a non-economic pest because it is still causing damage, but not enough where it would be cost effective for you to try and get rid of it. Surprisingly, many insects fall within this non-economic category. An example is the alfalfa caterpillar in central Iowa. It defoliates the alfalfa but densities are low enough that it doesn't cause enough economic damage to treat. Sometimes if there are multiple non-economic pests attacking a crop, together they are doing enough damage that the farmer ought to find a control measure that will be effective against all of them.

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Economic Pests

When it's an **economic pest**, the CA can get above the EIL at various times during the year. When this happens, you need to monitor this pest in your crop throughout the year. When it reaches the economic threshold you treat for it . The green cloverworm defoliates soybeans in the midwestern United States. This insect is present each year in nearly all soybean fields. In early spring it is a problem. However, it isn't a pest during the late season because a fungus attacks and kills it. The fungus keeps the cloverworm population below the EIL. A farmer would take this information and keep a closer eye on the population level in the early season rather than later. When he saw that the worm's population reached the ET, he would treat.

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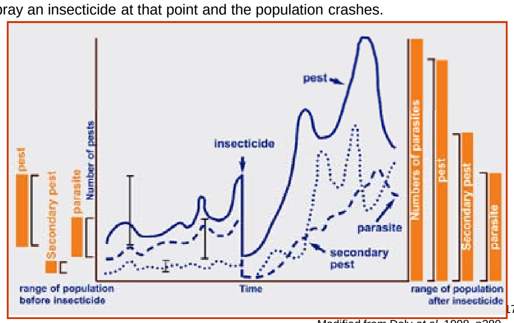
Secondary Pests and Pest Resurgence

The last thing we need to talk about is **secondary pest** and **pest resurgence**. Look at the figure below. The dark line is a pest. Its population at first is fluctuating over time. Notice that the level gets too high; say say you decide to spray an insecticide at that point and the population crashes.



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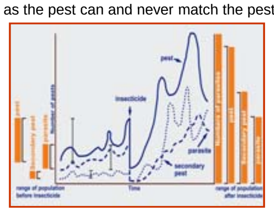
Modified from Daly *et al*. 1998, p280

Secondary Pests and Pest Resurgence Continued

The long dashed line is a parasite of the pest. Its numbers fluctuate with the pest population. But notice when the insecticide is sprayed the parasite population crashes also. The pest numbers the shoot up way past EIL after application and above what its population was before the insecticide was sprayed. This means the insecticide was more effective in killing off the parasite than it was in killing off the pest. Since the parasite numbers are so low, it doesn't keep the pest population down. This large jump in the pest population after the insecticide is sprayed is called **pest resurgence**. This often happens because you wiped off the pest's natural enemies while you were trying to control it. The parasite is not able to reproduce as quickly as the pest can and never match the pest population again.



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Modified from Daly *et al*. 1998, p280

Pest Question

Think about this for a moment, in the previous example, is the *parasite* going to be an r strategist, or a k strategist?

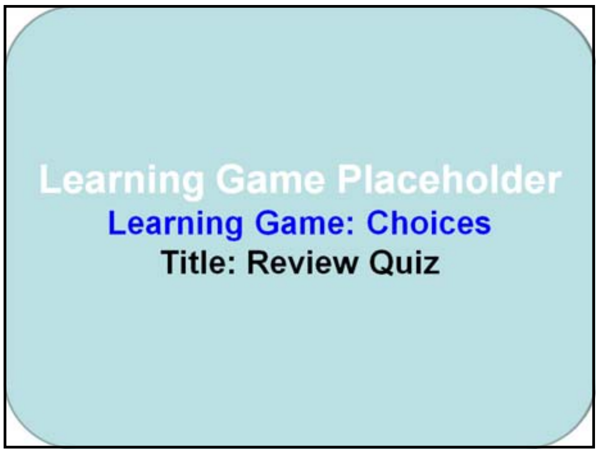
The parasite would more of a K strategist because it tends to be something like a wasp that is a parasitoid. The wasp only lays a single egg in the caterpillar. But what kind of strategist is the *pest* in this figure? It's an r strategist because notice how it is able to reproduce very quickly, even if there are only a few of the population left. This pest can reproduce a lot after the insecticide application since it doesn't have its enemy keeping its numbers low.

?

Secondary Pests

A **secondary pest** was in such small numbers previous to pesticide application that it was never a significant pest and causing many problems. It became an economic pest after the insecticide application. After application, this secondary pest's population numbers shoot up (if needed, refer back to the graph). This can be for various reasons, but it's probably because you eliminated its natural enemies, just as you did with the pest's parasites. This is common in an apple orchard system. You might spray to control codling moths, which are common apple tree pests. A small number of spider mites may have lived on the trees before you sprayed. Let's say the insecticide got rid of the moth AND the mites as well as the parasite or predator keeping the mite population down. Then after spraying, the mite population takes off and becomes a pest along with the codling moth!

In the mid-1960's, there were attempts made to eradicate the pink bollworm on California cotton. After insecticides were sprayed the bollworm was effectively reduced, but so were the natural enemies of the secondary pests called the cotton leaf perforator and spider mites. Soon after pesticide application their populations rose drastically and the outbreaks of these two secondary pests proved costly.



Conclusion

Society has to be careful when applying insecticides especially in view of secondary pest and pest resurgence. A well intended insect control program could turn out to be hazardous not only for the environment but for the farmer as well. He may have to spend huge sums of money to try and save a crop and not even make a profit in the end. The competition for food between insects and humans continues. Hopefully we all come out winners in the end. Remember to review the unit objectives and see that you know each one.