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What do bugs do in winter?

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There are several well-known insect pests of corn and soybeans that can be affected by winter weather dramatically. The initial infestation levels, and the early damage that results, is a direct result of how and where these insects survive the winter in combination with the actual weather that they experience.

Insects can be categorized by various winter survival techniques, each unique in their own way. We must remember that insects, unlike mammals, are cold blooded, which means there body temperatures are regulated by external environments; whereas the body temperatures of mammals is manufactured and maintained by their own internal life processes. Therefore insects needed to devise strategies to avoid being frozen during the winter months.

Over time, insects have evolved three distinct methods to overcome and/or deal with the cold temperatures. These are called **migration**, **freeze avoidance** and **freeze tolerance**.

Migration:

Birds are animals that migrate in huge numbers from north to south in the colder months. How far south and the distances they fly vary on species and habitat. In many cases the same birds that fly south, fly north again in the spring. But with insects, having a much shorter life span, the individuals who fly south, are not the same individuals that fly north. Usually, a new generation of individuals makes the flight north. A classic example of migration is the Monarch Butterfly, where the entire population flies from the northern United States and Canada to southern California and Mexico.

Mass migration is not the way that most agricultural pest overwinter, the major pests of corn and soybeans use a combination of freeze avoidance, freeze tolerance and immigration (as opposed to migration) to survive the winter and infest crops in the mid-west.

Freeze avoidance:

Insect will die if their body fluids freeze and cell walls burst. Many insects have developed methods of survival that results in them avoiding colder temperatures. Most insects in the Corn Belt have evolved to use freeze avoidance very effectively. There are several methods by which an insect can avoid freezing: some alter their physiological processes, while others have biochemical changes within their cells.

Locating a dry hibernation home for the winter, where freezing is less likely to occur is a common method of survival by some. Examples of this would be the stink bugs and Asian soybean beetles that have become unwelcome home visitors in the fall. Another example would be the laying of eggs deep in the soil by corn rootworm beetles, and thus avoiding the hard freezes at the soil surface. Some insects have also developed a waxy cuticle, which prevents ice from forming on the cuticle.

When an insect has developed the strategy of freeze avoidance, it cannot tolerate ice crystals being formed in their body fluids. Therefore other freeze avoidance insects have adapted to the cold by processes that allow their body fluid to super chill below the freezing point. Water can remain fluid, and not freeze, to -42^{o}C if there are no particles to crystalize onto. The removal of food, dust and bacteria from the gut occurs as the insect conditions itself for overwintering, reducing the possibility that ice crystals can form.

Still other insects have evolved to manufacture cryoprotectants such as polyols and sugars, creating an environment not unlike putting anti-freeze in vehicles during the cold winter. Polyols are distributed throughout the body of an insect, and the higher concentrations of these alcohols prevent freezing of body fluids.

All insect that hibernate in the winter synthesize anti-freezing compounds in their bodies. This is usually triggered by a photoperiod response to shorter days and longer nights. The compounds synthesized are not alcohols, but rather proteins that can attach to the ice crystals as they form, and restrict their size, thereby reducing the likelihood of the cells bursting and death occurring.

Freeze tolerance:

Some insect have evolved to survive the formation of ice within their bodies. These insects actually initiate the freezing of their tissues, but control potential freeze damage by controlling the ice formation. An example of this would be the wooly bear caterpillar, which is a common sight in the fall. Such controlling of ice formation is akin to hardening. Over time, the insect conditions its tissue to adjust slowly to the formation of ice, moderation the rate of freezing and avoid the pressures that would normally explode cells as ice crystals form. Oftimes this is accomplished with the help of symbiotic microorganisms with the insect that produce proteins that function as the source of ice crystal formation. It is reported that many insects that initiate this freezing, also have high concentrations of glycerol, which can decrease the amount of ice formation outside of the cells.

Hibernation:

Over wintering insects utilize the above freeze strategies, along with various hibernation techniques, to survive the winter. Some cluster in large groups, and conserve heat. Others survive underground, either as adults, or pupae, or eggs. Still others inhabit on the south side of trees and shrubs, having more potential exposure to the warming effects of the sun. Galls, cysts, cocoons are all methods of hibernation.

A few well-known insect pests and their overwintering habits:

Corn Rootworms:

Corn rootworms overwinter as eggs buried in the soil by adult female corn rootworm beetles. Research has shown that corn rootworm eggs (Western and Northern species) can survive to -27^{o}F, although most eggs do not hatch if supercooled to -21.5^{o}F. Depth of egg laying is critical for survival. Most Northern corn rootworm eggs are found closer to the soil surface, while Western corn rootworm eggs are found much deeper in the soil, and therefore better “insulated” from the cold temperatures. Snow cover, plant residue, tillage, soil moisture all interact to modify how deep impact of freezing temperatures will have on rootworm egg survival. It is suggested that the winter of 2013-14 may have significantly reduced the number of rootworm eggs that survived to hatch in the spring.

Corn Earworms:

Corn earworms can survive as pupae in areas south of I-70, but the bulk of the summer populations die each fall. The infestation that occurs in the central and northern Corn Belt is a result of adult moths flying in on weather fronts, and laying eggs in susceptible crops.

Cutworms:

Black cutworms overwinter as pupae only in southern states. They have not evolved or adapted to survival in the more frigid winter climes. Other cutworm species can survive as pupae or partially grown larvae, in the soil, except in times of extremely cold weather. Since black cutworms do not survive in the Corn Belt, spring infestation is totally dependent on immigration of the adult moths from the south.

European corn borer:

European corn borer overwinters in corn residue as a fully grown 5th instar larvae after hatching from eggs laid in late summer/fall after the 2nd, or 3rd, generation of adult moths.

Soybean aphids:
Soybean aphids survive the winter as eggs laid on buckhorn. These eggs have been shown to have a supercooling point of -29°F. Soybean aphid eggs are adapted to survive most cold winters. Survivability of eggs is directly correlates to how severe the soybean crop will be affected the next year.

Bean Leaf Beetle:
Bean leaf beetles survive the winter as adults under crop residue near soybean fields. Mild winters will favor higher spring populations, while harsh cold winters will reduce bean leaf beetle populations.

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