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Integrated Pest Management: What Are Economic Thresholds, and How Are They Developed?

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An insect control action (such as spraying an insecticide or planting a corn hybrid that incorporates a Bt trait) is only justified once the population of an insect pest reaches a certain level. This makes sense if you consider how foolish it would be to spray an entire soybean field because you found a single bean leaf beetle. However, determining the critical level of pest activity where a control action is needed can be challenging. Management guidelines for a particular insect pest include a population density, usually referred to as the "action threshold," that is used to determine if a control tactic is justified. As long as the pest density remains below this threshold no action is needed, but if the insect population density exceeds this level, a control action is recommended. How high or low this level is depends on how much damage can be tolerated, which in turn varies depending on the situation; for example, in the case of a medically important insect such as a mosquito that spreads malaria, there is no level of infection that we could reasonably tolerate. However, in agriculture we can easily determine the value of the product that we are trying to produce, and can set an action threshold based on this value. This is referred to as an **economic threshold**, and is the basis of integrated pest management recommendations in crop production.

The goal of the economic threshold is to prevent a pest population from reaching the point where its damage causes monetary losses that are equal to the cost of control. This "break-even" point is referred to as an **economic injury level**, and is computed using the following formula:

$EIL = C/VIDK$, where

C = cost of control

V = value of the commodity

I = injury (e.g. defoliation or damaged fruit) based on a given density of insects

D = economic damage (e.g. bushels lost or quality discount) caused by a given level of injury

K = proportion of reduction in injury resulting from a control measure (usually the proportion of the insect population that is killed, or “percent control”)

These variables are discussed in detail in a variety of research papers, including a thorough review (Pedigo, 1986). The cost of control and the value of the commodity are (usually) pretty straightforward, while the remaining values must be determined for individual pest species through applied research. Let’s consider a hypothetical example: an imaginary species of beetle that feeds directly on apples. In this case, you can expect 5 apples to have feeding injury for every beetle that you find per tree (*I* = 5 damaged apples per beetle). Each injured fruit means a loss of 0.5 pounds of apples (*D* = 0.5 pounds per damaged apple). You can sell a pound of apples for $1.50 (*V* = $1.50 per pound) at the local farmer’s market. An insecticide that costs $20 to apply to a tree (C = $20 per tree) will reduce the damage by 90% (*K* = 0.9). In this scenario, you would calculate the EIL as:

$$\boldsymbol{EIL} = \frac{20}{(1.50\ ) \times (5\ ) \times (0.5) \times (0.9)} = \mathbf{5.9\ beetles\ per\ tree}$$

Most people reading this article will never need to calculate the economic injury level formula (except maybe in an entomology class). However, reviewing the factors that are used to compute the formula illustrates the fact that economic injury levels are dynamic. Commodity prices, the cost of control, the efficacy of control, and even the relationship between insect feeding and yield loss can all change over time. The economic injury level increases or decreases as these values change depending on their position within the formula. As the cost of control (*C*) increases, it takes more insect damage to justify an application, and the economic injury level increases. In contrast, if the value of the commodity (*V*) increases, it takes fewer lost bushels to justify the cost of control and the economic injury level decreases. (Unfortunately, right now we are more familiar with the opposite situation: as commodity values decrease, it takes greater reductions in yield to justify a control action, and the economic injury level increases). Similarly, the economic injury level will be lower for insect species that cause a greater amount of feeding damage per individual (*I* in the formula), or for varieties that are more sensitive to this injury and suffer more economic damage (*D*) per unit injury. (Note that in many cases, *I* and *D* are combined into a single measure that relates the amount of yield lost directly to the insect population density).

This brings us back to the economic threshold, which is always set lower than the economic injury level to provide a “lead time” before the break-even point is reached and an economic loss occurs. The economic threshold is the level that is published in Extension recommendations and other sources to determine when an insect control measure is justified (some examples are provided in **Table 1**). How much of a lead time is needed depends on the situation, including characteristics such as the growth rate of the pest population. In the case of the soybean aphid, entomologists have been able to base this threshold on the population growth of the aphid; an economic threshold of 250 aphids per plant (rounded down from 273 for convenience’s sake) is recommended to give a roughly 1-week lead time before the economic injury level of 674 aphids per plant is reached (Ragsdale, 2007). Unfortunately, population growth is not always predictable, especially for insect pests that move readily within and among fields; in these cases, the economic threshold is usually set at some arbitrary percentage of the economic injury level (75% is a common rule of thumb). For many insects, sporadic populations make it difficult or impossible to conduct the research necessary to determine the relationship between insect density and yield loss; in these cases, a threshold is estimated based on previous experience.

Table 1. Economic Threshold Recommendations for Some Common Agronomic Pests in Illinois

Crop	Pest	Sampling Method	Economic Threshold
Corn	Corn rootworm (continuous corn)	Sticky card traps	2 beetles per trap per day
	Corn rootworm (rotated corn)	Sticky card traps	1.5 beetles per trap per day
	Western bean cutworm	Direct counts	8% of plants with egg masses or small larvae
Soybean	Defoliators (combined defoliation after bloom)	Visual estimation	20% defoliation
	Soybean aphid (prior to R6)	Direct counts	250 aphids per plant
Alfalfa	Alfalfa weevil	Direct counts	3 larvae per stem with 25% of leaf tips damaged

Like any other input, the goal of an insect control measure should be to provide a positive return on investment, in this case by preserving enough yield to justify its cost. Using the economic threshold concept to guide these decisions helps to ensure that pest control actions will “pencil out” on the operation’s balance sheet. In addition, by using these tools only when they are truly needed, the additional costs of pest control (especially the development of resistance to tactics and the potential non-target effects of insecticides) can be minimized.

References

Pedigo, L., S. Hutchins, and L. Higley. “Economic injury levels in theory and practice.” *Annual Review of Entomology* (31)1986:341-68.

Ragsdale, D., B. McCornack, R. Venette, B. Potter, I. MacRae, E. Hodgson, et al. “Economic threshold for soybean aphid (Hemiptera: Aphididae).” *Journal of Economic Entomology* 100(2007):1258-1267.