Agriculture & Pesticides Facts

WHAT HAPPENS TO PESTICIDES THAT ARE APPLIED TO CROPS?

Because pesticides are designed to kill one or more types of living organisms, there is always concern about the risk that they pose to other, non-target, organisms. The extent of the risk that a pesticide poses to the environment and human health depends, in large measure, on what happens to that pesticide after application. Two key factors are the length of time the pesticide remains in an active form in the environment, and the likelihood of the pesticide to move from the point of application.

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An ideal pesticide would be one that would remain in the environment just long enough to accomplish its intended purpose, and then quickly break down into harmless compounds. In reality, pesticides vary greatly in their potential for causing damage. Some pose little risk to either the environment or to human health. Others can represent a significant hazard if they are not managed carefully.

THE ENVIRONMENTAL PROCESSES AFFECTING PESTICIDES

After application in a field or orchard, pesticides are subjected to three main types of processes:

- **adsorption -** pesticides can become attached to particles of soil or organic matter
- **transfer -** they can be moved from the point to which they were applied
- **degradation -** they can be broken down into less complex compounds.

The extent to which each of these processes act upon a pesticide varies depending on the properties of the pesticide, the soil, the weather and the crop.

1. ADSORPTION

Some pesticides are strongly attracted to soil particles and are held tightly by them. Pesticide held in this way is no longer active for controlling pests or causing damage to the environment. Adsorbed pesticides are also not prone to leaching, and therefore pose a low risk of groundwater contamination. (The commonly used pesticide Roundup, or glyphosate, is an example of a pesticide that is strongly adsorbed and made ineffective as soon as it contacts the soil. It can be deactivated, for example, just by being mixed with slightly muddy water.)

2. TRANSFER

Pesticides can be moved from the point to which they were applied in a variety of ways:

- **volatilization** (evaporation)
- **runoff -** movement in water across the surface of land
- **leaching -** movement through the soil towards groundwater
- **plant uptake**

Volatilization is the conversion of a solid or liquid into a gas and movement into the atmosphere. Once in the air, pesticide vapours move wherever they are taken by the wind and other air currents. Clearly, this is not desirable either for effective pest control or for environmental protection. Many pesticides are not volatile and thus are no cause for concern in this regard. Those that are prone to volatilization are formulated to minimize their volatility as much as possible, and are applied in ways designed to reduce the risk. For example, some highly volatile pesticides are worked into the soil at application to minimize their exposure to the atmosphere. It is important, however, that all pesticides be applied in ways that will reduce this risk (e.g., during the cool of the day and when there is little wind).

Runoff is the movement of water over the soil surface when rain falls faster than it can be absorbed by the soil. Pesticides can move from a field in runoff water (also called surface water), either dissolved in the water itself or attached to soil particles being eroded from the field. The amount of runoff depends on many factors:

- the type of soil (greater on clay than on sand)
- the slope of the land (the steeper the slope, the greater the potential for runoff)
- the condition of the soil surface (more runoff from bare soil than

from fields covered with living crops or crop residues)
- the amount and intensity of rainfall following application
- the moisture content of the soil (the wetter the soil to begin with, the less rain it can absorb)
- the length of time after application before rain (the greater the time between application and rainfall, the less pesticide there will be in the runoff).

Leaching refers to the movement of materials down through the soil with water. The risk of a product being leached depends on its solubility in water, its tendency to be bound to soil particles and its persistence. To be leached, a pesticide must first be dissolved in the soil water. The longer the pesticide remains in its active form in the soil water, the greater the risk of it leaching into the groundwater. Most pesticides are either adsorbed by the soil or degraded before they can be leached. Few pesticides have the combination of properties that make them prone to leaching in quantities that pose a significant risk to groundwater quality.

Leaching also depends on the characteristics of the field: it is more likely to occur in sandy or gravelly soils, in soils that are low in organic matter, and on flat rather than sloping land.

Plant uptake

Pesticides are applied either to the soil or to the foliage. In either case, some pesticide is likely to taken into the plant through either the roots or leaves. Pesticide taken up by plants is protected against runoff or leaching. Once within crop plants, pesticides are degraded through chemical reactions. (In the case of plants that are killed by a herbicide, pesticide residues will be broken down microbially as described below.)

3. DEGRADATION

With the possible exception of pesticides that have leached into the groundwater, all pesticides are eventually degraded into harmless components in a variety of ways:
- Microbial breakdown: the pesticide is broken down (i.e., 'eaten') by fungi, bacteria or other micro-organisms living in the soil, on the surface of plants or in surface water.
- Chemical degradation: the pesticide reacts with other compounds in the soil, especially water, to form non-toxic compounds.
- Photo-decomposition: some pesticides are broken down by sunlight.

Some of the first insecticides introduced following World War II (DDT is the best known example) became very popular because they provided long-term control against a wide range of insects. However, these insecticides were so persistent that they accumulated in the environment and led to serious environmental problems. Pesticides exhibiting these characteristics were banned 25 to 30 years ago.

More modern pesticides are much less persistent. Whereas the half-life of DDT could be measured in years, the half-life of the pesticides in use today can be measured in days or weeks. (Half-life is the length of time required after application for the concentration of the active form of a pesticide in the field to be reduced by half.) Thus, modern pesticides generally pose less long-term risk to the environment than did products like DDT.

INTERNET RESOURCES:

Pesticides and Groundwater Contamination (Ohio State University Bulletin 820)
http://www.ag.ohio-state.edu/~ohioline/b820/index.html

Pesticides and Their Behavior in Soil and Water (University of Florida)
http://pmep.cce.cornell.edu/facts-slides-self/facts/gen-pubre-soil-water.html