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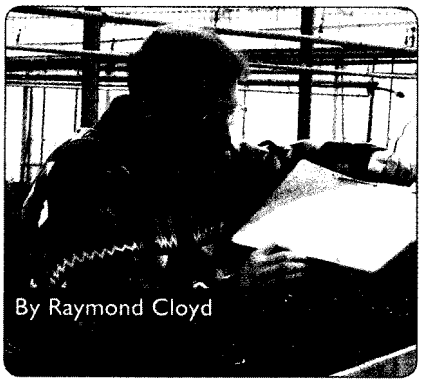



# Factors affect efficacy of systemic insecticides

SYSTEMIC INSECTICIDES ARE WIDELY USED to manage phloem-feeding and certain chewing insect pests. Systemic insecticides are commonly applied to the growing medium as drench applications for uptake through the roots and distribution throughout the plant via its vascular system (xylem and phloem). During feeding, phloem-feeding insects such as aphids, whiteflies, mealybugs and soft scales imbibe the insecticide active ingredient and are killed if concentrations are high enough.

Systemic insecticides available for use in greenhouses and labeled for drench applications include: neonicotinoid-based insecticides imidacloprid (Marathon), thiamethoxam (Flagship), dinotefuran (Safari), and clothianidin (Celero); and the organophosphate insecticide, acephate (Orthene/Precise).

The uptake, movement, distribution and accumulation of systemic insecticide active ingredients in plant tissue may be influenced by water solubility and two physical estimated properties: acid dissociation constant (p*K*a) and octanol-water partition coefficient (log $P_{oct}$).

## Water solubility

Water solubility is a function of an active ingredient's physical ability to associate (or dissolve) in water, which may affect the uptake and distribution of the active ingredient within plant tissue. Systemic insecticides with greater water solubility tend to be more mobile in the plant. However, this is dependent on plant species and age. Furthermore, plant affinity (or binding potential) may also influence uptake and accumulation of the active ingredient, and the ability of the active ingredient to be distributed throughout plant tissues.

Transpiration rate (movement of water through the xylem tissue) impacts uptake and accumulation of active ingredient concentration, which may affect control of insect pests. In research at Kansas State University, we have shown that light intensity, which affects transpiration rate, influences the accumulation of the systemic insecticides, imidacloprid (Marathon) and dinotefuran (Safari) in poinsettia and Lantana camara. In general, dinotefuran was consistently detected at higher concentrations in both poinsettia and lantana compared to imidacloprid, which may be correlated with water solubility of the active ingredient. The neonicotinoid-based insecticides vary in water solubility. The water solubility (parts per million and grams per liter) of all the neonicotinoid-based

### Properties of neonicotinoid-based insecticides applied to greenhouse crops

| Active ingredient | Trade name | Application type | Water Solubility (ppm) | Water Solubility (g/L) | p*K*a | log $P_{oct}$ |
|---|---|---|---|---|---|---|
| Imidacloprid | Marathon | Foliar and drench | 500 ppm | 0.51 g/L | ---- | 0.57 |
| Thiamethoxam | Flagship | Foliar and drench | 4,100 ppm | 4.1 g/L | N/A | -0.13 |
| Acetamiprid | TriStar | Foliar | 2,950 ppm | 2.9 g/L | 0.7 | 0.8 |
| Dinotefuran | Safari | Foliar and drench | 39,830 ppm | 39.8 g/L | 12.6 | -0.64 |
| Clothianidin | Celero | Foliar and drench | 327 ppm | 0.32 g/L | 11.1 | 0.7 |

Water solubility (ppm and g/L); acid dissociation constant (p*K*a) and octanol-water partition coefficient (log $P_{oct}$) of the neonicotinoid-based insecticides available for use in greenhouses that may be applied to either the foliage or the growing medium (drench).

insecticides labeled for use in greenhouses are in the table below.

## Acid dissociation constant

p*Ka* is the acid dissociation constant and indicates the strength of an acid. The larger the p*Ka* value the weaker the acid. Greenhouse growers should at least have a working knowledge of the p*Ka* value in order to understand the behavior of acids and bases in solution, which may affect how systemic insecticides enter plant roots.

## Octanol-water partition coefficient

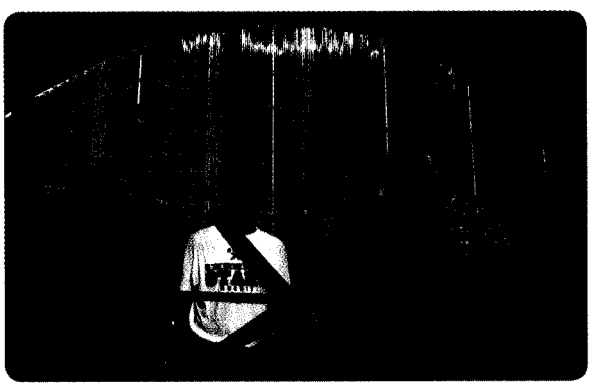
Log $P_{oct}$ stands for the octanol-water partition coefficient and is related to the lipophilic nature or lipophilicity of compounds. Lipophilicity refers to the ability of a chemical compound to dissolve in fats, oils, and lipids

# Scouting Notes

**Research greenhouse tests biologicals.** A new greenhouse at the Texas AgriLife Research and Extension Center in Overton, Texas, will help researchers investigate ways to reduce chemical use and increase biological control of insects and other pests. The experimental greenhouse was largely funded by the Texas nursery industry.

"As the public demand for organic and sustainable-produced plants increases, it is important that growers have the know-how to meet the needs of the market," said Scott Ludwig, extension entomologist and IPM specialist. "This facility will enable AgriLife extension to conduct research that will aid growers to produce healthier plants for landscapes and homes."

**For more:** Scott Ludwig, Texas AgriLife Research and Extension Center, (903) 834-6191; http://agnews.tamu.edu/showstory.php?id=571.



**A ribbon-cutting ceremony honors a new greenhouse dedicated to integrated pest management research.**

**Dow stops sales of insecticides in some Florida counties.** Dow AgroSciences voluntarily suspended the sale and use of multiple spinosyn insecticides in Broward County and a portion of Palm Beach County in Florida. This action was taken in response to evidence that western flower thrips have developed resistance to a product with the active ingredient spinosad. Products affected are: Conserve SC, Delegate WG, Entrust Naturalyte, Radiant SC and SpinTor Naturalyte. This is a temporary suspension for a minimum of 12 months.

**For more:** Dow AgroSciences, (800) 255-3726; www.cdms.net/ldat/ld24P007.pdf.


**Female adult cabbage loopers have two black spots on their wings, but males have only one spot.**

**Scout for cabbage looper.** Cabbage looper caterpillars are commonly found on ornamental cabbage and kale in both production and retail settings. Leanne Pundt, University of Connecticut Extension horticulture and greenhouse IPM specialist, said growers should look for the familiar adult white butterflies tinged with yellow on the underside of their wings flying above the plants. Female adults have two black spots on their wings; males have only one spot.

Examine the upper leaf surface for bullet-shaped eggs with fine parallel lines. The velvety-green larvae are easily missed because they blend in with the leaf color. Larger caterpillars have a delicate yellow line that runs lengthwise down the center of their bodies. Larvae signs include irregular holes in the leaves and dark green fecal droppings.

Controls include various formulations of *Bacillus thuringiensis* and Conserve.

**For more:** Leanne Pundt, University of Connecticut, (860) 626-6240; leanne.pundt@uconn.edu; www.negreenhouseupdate.info.

**Online training available for new chemicals.** BASF Turf & Ornamentals launched an online interactive educational training module for its new Pageant fungicide and FreeHand 1.75G herbicide. Users can select training for either product and walk through an interactive program led by BASF technical specialists. A quiz gives users a chance to challenge their retention skills.

**For more:** BASF Turf & Ornamentals, (800) 6690-1770; www.betterplants.com.

Compounds that are lipophilic (log $P_{oct}$>4) are generally not systemic whereas those compounds that are considered moderately or intermediately lipophilic have a log Poct between 0.5 and 3.5.

Uptake by the roots is greater when compounds are more lipophilic. Entry and uptake of the active ingredient by roots is primarily due to passive diffusion with the passage of the active ingredient across cell membranes. The ability of compounds to cross cell membranes is a function of their lipophilicity. Systemic insecticides with intermediate lipophilicity are able to cross membranes. The p*K*a and log $P_{oct}$ values for the neonicotinoid-based insecticides are presented in Table 1.

## Long-distance transport

Long-distance transport of systemic insecticides typically involves the xylem or phloem portions of the vascular system. Non-ionized compounds (those not converted into ions) are primarily translocated through the xylem with the transpiration stream directionally from the roots to the shoots. However, some polar compounds (those generally able to dissolve in water) may be moved into the phloem with photosynthesates from leaves to growing points such as the shoots and roots.

## Impact of water pH, growing media

The pH of the water or nutrient solution may influence the uptake and movement of systemic insecticides.

Additionally, absorption by growing media may contribute to lower systemic activity, especially media that contain bark and peat. Fine textured growing media, particularly those with high organic matter, tend to "strongly" adhere to the active ingredients of certain systemic insecticides. Media containing less than 30 percent bark and other organic constituents may irreversibly adhere to systemic insecticide active ingredients such as imidacloprid thus preventing uptake of sufficient concentrations of the active ingredient required for protection from plant-feeding insects.

There may also be interactions between water solubility and the $K_{oc}$ (soil adhesion) depending on the growing medium and watering practices used after drench applications. For example, the active ingredient in some products may be both water soluble and very mobile in plants leading to a higher leaching potential. The active ingredient in other products may adhere to higher organic matter growing medium, which could reduce uptake by plants. There may also be interactions among plant age, water solubility and log $P_{oct}$, which may

affect product movement of the active ingredient in the plant. For example, the active ingredient may move in the xylem and reside or "get stuck" near the top of the plant because of lipid attraction or it may relocate by being transported back down the phloem.

Furthermore, systemic activity or uptake may be directly associated with the cation exchange capacity of different growing media. The pH or acidity of the medium may be responsible for the lack of systemic activity among or between different media. For example, peat has a pH between 5.0 and 6.5. A lower pH may influence lipophilic properties and uptake by partitioning the active ingredient prior to root uptake.

## Insecticide distribution

Allocation of systemic insecticide active ingredients within a plant may not be uniformly distributed among leaves and stems. For example, certain systemic insecticides have been documented to accumulate in leaf margins. More recently, clothianidin (Celero), a neonicotinoid-based systemic insecticide, tends to be more evenly distributed across the entire leaf lamina (the leaf blade or expanded part of the leaf) than other neonicotinoids labeled for drench applications, including imidacloprid (Marathon), thiamethoxam (Flagship) and dinotefuran (Safari), which tend to accumulate in leaf margins.

Systemic insecticides are not "created equal" and it is important to understand the physical and chemical properties that may influence their ability to provide control of plant-feeding insects. Be sure to evaluate these factors before concluding that the systemic insecticide you applied failed to control a designated insect pest.

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**CONTACT INFORMATION**

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