Welcome to the 2nd issue of Ornamentals Online!

This is a very busy time of the year for the Green Industry, and we hope this edition will deliver useful and timely information that will help in making your operation more successful, profitable, and sustainable. As always, feedback is welcome by contacting Roberto Lopez or Kyle Daniel at rglopez@purdue.edu or daniel38@purdue.edu. Thanks for reading. Enjoy!

NEW e-GRO University

In May of 2013, e-GRO.org the same website that has brought e-GRO Alerts to the industry launched its latest addition, e-GRO University.

e-GRO University is not your traditional university; but a collaborative virtual university with lectures. Raymond Cloyd, Kansas State University; Margery Daughtrey, Cornell University; Brian Krug, University of New Hampshire; Roberto Lopez, Purdue University; Brian Whipker, North Carolina State University; and Kimberly Williams, Kansas State University developed a greenhouse course curriculum that covers topics from plant nutrition, light and temperature management, plant growth regulators (PGRs), insects, diseases, plant growth, and structures.

Growers are busy so e-GRO University was created with growers in mind. These lectures average 15 minutes in length and cover specific topic in each lecture. e-GRO University brings some of the top Extension Specialists to the convenience of your office or conference room. Because e-GRO University lectures are relatively short and categorized for easy browsing you can easily find the topic you are interested in, or complete the entire course. The goal of e-GRO University is to make educational opportunities available to everyone in the greenhouse industry in a convenient and enjoyable format. One of the best things about e-GRO University is that it is FREE because of the generous support of the Fred C. Gloeckner Foundation.

You can watch the lectures by browsing to www.e-GRO.org and click on “e-GRO University” on the top menu.

Tree risk assessment: What you should know, now

Lindsey Purcell
Urban Forestry Specialist, Purdue University

One of the more critical tasks of an arborist or property manager is risk assessment of trees. It is the responsibility of a tree owner to maintain and manage this important green asset and protecting the safety of others is the highest priority (Figure 1).

Tree Risk Assessment (TRA) is a relatively recent development and it is difficult to find much in the literature regarding the assessment protocol. Prior to the 80’s and even the early 90’s, little discussion exists on this practice; however, there have been recent developments with drastic improvements in
procedure. Trees have not become more dangerous or a greater risk; the more likely causes of this heightened awareness is perhaps the “litigious society” in which we live, increasing demands from insurance companies and increasing claims against property owners.

In response to increased concern with risk management, a great deal of research and development has been applied to the assessment process. Specifically, the release of the long awaited standards and best management practices for TRA. Recently, ANSI (Approved American National Standards) has released ANSI A300 Part 9, Tree Risk Assessment. This set of standards focuses on the specific aspect of tree structure assessment. In addition, the International Society of Arboriculture (ISA) has released a companion publication, Tree Risk Assessment BMP’s as an aid in the interpretation of these professional standards and to help guide TRA process based on current science and technology.

This set of documents is intended to serve as a guide for tree managers and arborists with assessment consistently and accurately and to recommend the proper mitigation to achieve an acceptable level of risk. What the literature doesn’t do is provide specific tactics or measures for hazard conditions, but provides help in the decision-making process. Additionally, it is critical for the property manager or owner to consult a qualified arborist in the process.

The new ANSI standards on TRA and the best management practices provided by the ISA is a great step forward in formalization of this task. The information can help protect the tree owner and manager by providing consistency in the procedures that emphasizes the needs of the client. Now, the TRA process is finally moving closer to a standardized technique which will help the arborist evaluate risk and recommend the necessary action to reduce threats in the urban landscape (Figure 2). If risk assessment is part of the job description a visit the ISA website to purchase these two publications is highly recommended.

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**Online Ornamentals e-Bulletin**

is an electronic e-bulletin for commercial greenhouse, floriculture, landscape, nursery, and related businesses. It provides timely information on pest control, production practices, and other topics of interest to these industries. All green industry and interested persons are welcome to subscribe. Subscription is free of charge.

To subscribe, send your name, company name and email address to Roberto or Kyle:

Greenhouse growers contact Roberto Lopez at: rglopez@purdue.edu
Nursery and Landscape, and associated businesses contact Kyle Daniel at: daniel38@purdue.edu
Subject line: Online Ornamentals

This e-bulletin can be accessed free at
http://flowers.hort.purdue.edu or https://ag.purdue.edu/hla/extension/nle/
Online Ornamentals

The Purdue Plant and Pest Diagnostic Lab (PPDL) - Ready to serve you

Gail Ruhl and Dr. Tom Creswell
Senior Plant Disease Diagnostician, and Director of the PPDL

The Purdue University Plant and Pest Diagnostic Laboratory (PPDL) specializes in the identification of plant diseases, insects and plants, as well as in the diagnosis of plant-health related problems. The lab is a central facility for receiving both physical samples and digital images. The PPDL is a partner in the national Plant Diagnostic Network (NPDN) (http://www.npdn.org), a national consortium of diagnostic laboratories that enhance agricultural security by rapidly detecting and monitoring pest and pathogens introduced into a new region of the United States.

Using a number of diagnostic procedures including microscopic examinations, laboratory culturing and virus assays we strive to provide accurate and rapid identification of:

- Fungal, bacterial and viral plant diseases
- Insects and other arthropods
- Unknown plants, including terrestrial and aquatic weeds
- Vertebrate pests
- Environmental or cultural injury to plants

We serve as a source of unbiased information regarding pest management strategies and provide training for diagnosis of plant and pest related problems.

Sample handling fees for routine diagnosis: $11 for Indiana samples and $22 for samples originating outside of Indiana. An additional $25 fee is charged for ELISA, Immunostrip or PCR testing. For more information on our fees and services, to download forms, and to submit digital images for diagnosis, see our website at: http://www.ppdl.purdue.edu/PPDL/digital.html

Ten Tips for Collecting and Submitting Samples:

1. Time is money: Don't wait until the problem is widespread to send a sample. Many diseases and insects are manageable if caught early.

2. Dead plants tell no tales: Plants which are totally dead, dry or rotten are useless for diagnosis. Collect declining but not completely dead ones.

3. What's bugging you? Collect several examples of insects for ID, just in case some get damaged in shipping or if both males and females are needed. Many can be shipped in vials with 70% alcohol. More details at: http://www.ppdl.purdue.edu/ppdl/physical.html#insect_ID

4. More is better: The main concern may be overlooked if you send only one plant, one insect or a single branch. Send plenty of material or whole plants if practical (Figure 3). Make sure samples are representative of what you are seeing. Digital images of the site and patterns of occurrence can help too!

5. Get to the root of the problem: Many plant problems are related to the roots and soil. Dig plants in the landscape rather than pulling them up to keep roots intact. Include plenty of the small roots and at least a cup of soil. For problem plants in containers or plug trays, if possible, submit entire pots and plug trays to help maintain the integrity of the plants. (Complete soil nutrient analysis is available from commercial labs. See: http://www.apsnet.org/members/directories/Documents/SoilLabsandPlantClinics.pdf for details)

6. A place for everything: If soil gets on the leaves during shipment it can mask symptoms or even create a “disease” that wasn't there at shipment. Keep soil around roots so they don't dry out (Figure 4). Bag the roots and soil and tie at the main stem or secure roots and soil within aluminum foil. Wrap foliage in newspaper lightly then pull the bag over the rest of the plant and tie the top loosely to keep foliage from drying out. Make sure foliage isn't wet before packaging.

7. The devil is in the details: The more you tell the diagnostic lab about the situation the better. Please give complete information; including name of plant, location, percent affected, symptoms of concern, distribution, soil type and drainage, and fertilizers or pesticides used recently. For Plant or Weed ID please give full details requested on submission form.

8. Fresher is better: Mail or deliver samples as soon as you can. Store samples in a cooler on hot days until you can deliver or ship them. Avoid mailing samples on Fridays since most plants will start to rot after being in transit over a weekend. A next day delivery service is needed for urgent samples or those that may rot quickly in shipment (Figure 4).

9. Fragile, handle with care: Padded mailing envelopes may be used for samples that are not fragile, such as ears of corn, but crush proof boxes with crumpled newspaper for padding are preferred in most cases (essential for young and tender plant material) (Figure 5).
Stressing out about plant stress: Part deux

Kyle Daniel
Nursery and Landscape Extension Specialist, Purdue University

Welcome back! Since our last correspondence the weather has certainly improved. The grip of winter has subsided and the spring is now upon us; this means a renewed growing season, both for plants and your respective businesses. In part one of this two-part series we discussed the drought of 2012 and the stresses associated with the water deficits. What a difference a few months can make, as most of the rivers have surpassed or are currently lapping at the muddy banks of waterways across most of Indiana, as of this writing, with more rain in the long-range forecasts. Groundwater levels are closer to normal as well. Instead of customers asking you about planting cacti for the ‘new’ Mojave desert last year, you will likely be asked questions such as, “Due to all of this rain, how would cypress trees and cattails look in my new landscaping?”, such is life in the Green Industry.

As a refresher, the last edition of this Online Ornamentals article focused on temperature, light, and water stresses. It examined both excess and deficits of each type of abiotic stress. Many times a plant will exhibit multiple stresses occurring simultaneously, in which symptoms will be compounded. Long-term stress, for example the drought of 2012, will continue to affect plants for several years after the initial stress occurs. This has been evident this spring, as many landscape plants around the state exhibited dieback during bud break, most likely due to the drought, as well as probable cold hardiness deficiencies.

Below is a list of the remaining common abiotic stresses that plants may incur and ways that they overcome the stress, as well as tips to correct the issue. To determine abiotic versus biotic stress, abiotic stress tends to be uniform over many plants, while biotic stress typically demonstrates sporadic damage. It goes without saying a healthy plant is going to survive these types of stress more effectively than an unhealthy one. This list is not all-inclusive or exhaustive, as there are many types of stress and many processes that occur to combat stress.

**Fertility**

**Deficiency**

There are 17 elements that are essential for plant nutrition; three of these (C, H, and O) are derived from the air, while the others are absorbed primarily in the soil solution. Essential elements fall into two categories: macronutrients and micronutrients. This only indicates the amount of a particular element, not the importance, as each of these is needed for the plant to complete their life cycle. Most essential elements are abundant in most natural soil types, so addition of nutrients may not be needed in large quantities, which should be determined via a soil analysis by a certified laboratory. Many times an artificial landscape (i.e. landscape islands) contains soils that are deficient of certain elements, as well as organic material. Plants exhibit various symptoms depending on the type of nutrient that is deficient, including chlorosis, growth stunting, wilting, and others. There are several commonly used species of landscape plants that usually exhibit symptoms due to the high pH in many areas of Indiana, with examples of iron chlorosis of most plants in the Ericaceae family, as well as iron and/or manganese in maples (Figure 7). The pH of the soil is a limiting factor for these species, which we will not discuss in this article. Some symptoms of fertility deficiency will appear similar, in which a foliar tissue test for nutrients should be sent to a certified laboratory.

To correct: Follow soil and tissue analyses instructions for adding fertilizers.

**Toxicity**

The old saying, ‘Too much of a good thing…’ can be used in many occasions, and plant fertility is no exception. Plants utilize nutrients to complete normal processes, but...
when an abundance of nutrients in the soil solution, the plants will exhibit adverse symptoms, and possibly death. There are some types of plants that exhibit luxury consumption, where more nutrients are taken up and stored in quantities above the requirements to complete basic functions, but at times, too much can be stored. Many times toxicities occur with additions of micronutrients.

To correct: Obtain a soil and foliar test to determine the nutrients in excess and follow recommendations to correct the problem.

**Other Types**

**Herbicide**

The word herbicide literally means ‘the killing of plants’, so damage to off-target plants via drift, volatization, etc. occurs frequently, especially with growth regulators (i.e. 2,4-D, dicamba, Imprelis, and others) (Figure 8), as most landscape plants are susceptible to damage from this class of herbicides.

![Figure 8. Imprelis damage to pine indicated by twisting of apical needles.](image)

Depending on the type of herbicide and species affected, the damage can have a wide array of damage, ranging from a small amount of necrosis, to stunting, to death. Glyphosate (Roundup) damage is also a common herbicide injury due to the widespread use of this chemical. Glyphosate can exhibit many symptoms, which may be confused with other types of abiotic injury (Figure 9). Most systemic herbicides do not break down quickly in the plant, so long-term damage could gradually occur.

![Figure 9. Roundup (glyphosate) damage to spirea indicated by dieback and witches broom during the following year after damage.](image)

To correct: Depending on the species and class of herbicide, the damage may correct itself naturally, but significant damage could lead to death. For some types of herbicide damage, pruning the affected parts could help prevent spreading throughout the entire plant.

**Mechanical**

Mechanical damage can occur via wind, machines, animals, etc. (Figure 10). Plants are able to partition off most types of damage, which help protect the plant through a process similar to human's blood clotting process, using a product in the phloem, called a P-protein. This process prevents attacks from insects and disease. Plants in the nursery and landscape usually have significant mechanical damage due to pruning, poor branching, weed eater/mower damage, etc. It is very common to have splitting or cracking occur longitudinally from mechanical damage during the winter due to the freeze/thaw cycle.

![Figure 10. Wind damage to silver maple.](image)

To correct: Depending on the severity of the mechanical damage, the plant may compartmentalize the damage without intervention, though pruning may be required to prevent further damage.

**Salt**

Salt damage of plants is very common in those areas that experience snow and/or ice. Many common landscape plants are prone to salt damage, especially arborvitae. The symptoms of salt damage are similar to drought stress such as scorched leaves, wilting, etc. (Figure 11). Many times, salt damages accompany an abundance of fertilizer applications. Salt damage can occur with most types of consumer and commercial applications of calcium chloride and sodium chloride.

To correct: Limit the amount of salt applied to sidewalks and driveways, and use salt tolerant plants in areas that receive a lot of salt.

![Figure 11. Salt damage on hackberry indicated by the scorched edges.](image)

**Impatiens downy mildew in the landscape**

Nora Catlin and Margery Daughtrey
Floriculture Specialist and Senior Plant Pathology Extension Associate, Cornell University

Downy mildew, caused by *Plasmopara obducens*, is a new threat to *Impatiens walleriana* landscape plantings. In the fall of 2011, downy mildew was seen in landscapes in CA, CT, FL, IL, IN, NY, MA, MN, OH, and WI. Since then, cases of impatiens downy mildew have been reported in nearly every state from the east coast to the mid-west and the western coast states. In some areas, particularly in drought stricken parts of the country, the disease was not widespread in 2012, though in many others the effects were devastating, resulting in numerous landscape failures and replanting. All cultivars of
Impatiens walleriana (standard garden impatiens, including double impatiens and mini-impatiens) as well as any *I. walleriana* interspecific hybrids (such as Fusion® and Butterfly® impatiens) are susceptible. *I. balsamina* (balsam impatiens or garden balsam) are also susceptible.

New Guinea impatiens, *Impatiens hawkeri*, as well as hybrids such as SunPatiens® are not susceptible to impatiens downy mildew, nor are other garden plants. Other plants can be susceptible to different downy mildew pathogens, but are not susceptible to the impatiens downy mildew caused by *P. obducens*. In host range trials conducted at the Long Island Horticultural Research & Extension Center, heavy downy mildew sporulation was seen on *Impatiens hochstetteri* and sporulation was also seen associated with small leaf spots on *I. flanaganiae, I. capensis, I. auricoma*, and *I. arguta*. Leaf samples have been sent to USDA-ARS for molecular analysis to see if the downy mildew affecting these other impatiens is genetically identical to the strains troubling *I. walleriana*.

Early symptoms on *I. walleriana* can be very subtle (Figure 12). Look for a slight stippling or chlorosis (yellowing) of the leaves. These symptoms might appear similar to a nutritional deficiency or spider mite injury. Leaves can flag or curl downward, sometimes giving the appearance that the plants need to be watered (Figure 13).

Under humid conditions, you will see a coating of white-colored sporulation on the undersurfaces of some leaves (Figure 14).

Sporulation may not always be present or easy to find: look closely at any chlorotic or downward curled leaves. If infected when young, plants will appear stunted; in advanced stages, plants will drop their leaves and flowers and the stems will collapse (Figure 15). Symptoms on *I. balsamina* appear as discrete leaf spots with corresponding sporulation on the leaf undersides.

Downy mildew thrives in moist or humid conditions. New infections will occur when there are long periods of leaf wetness. Overhead irrigation (especially night-time irrigation), crowded plant spacing, shading, or

Information about impatiens downy mildew in the landscape and considerations for management:

Downy mildew can spread to healthy impatiens plants via water splash from nearby infected plants, windborne spores from infected plants in nearby landscapes, or from oospores that have survived overwinter in the soil.

It is not yet definitively known how far the windblown downy mildew spores can spread; at a minimum the spores can spread hundreds of yards, though it is possible that the spores can spread many miles. It is also not yet known exactly how long oospores of *Plasmopara obducens* will survive in the soil. Oospores of other species of *Plasmopara* are known to be viable for 5-10 years.

Impatiens should not be planted in a landscape in which impatiens downy mildew has been previously found. Due to how widespread and destructive impatiens downy mildew was in our local landscapes last season, it should be considered very risky to plant large plantings of impatiens – consider planting plants other than garden impatiens. Remember that New Guinea impatiens and other garden plants are not susceptible to impatiens downy mildew. See [http://ccesuffolk.org/floriculture-program](http://ccesuffolk.org/floriculture-program) for some suggestions for other shade plants.

If garden impatiens are planted in a landscape, watch carefully for symptoms of yellowing foliage or stunting, look for the diagnostic white sporulation on the undersurface of leaves. Sporulation can often be found when there are no other obvious symptoms. If found, entirely remove and dispose of infected plants—it is not recommended to compost the infected plant material.

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any condition that results in long periods of leaf wetness will increase the risk of infection and the rate of disease development and spread. Plants with limited exposure to these conditions will have a better chance of remaining healthy, but are not completely free of risk.

Once an impatiens plant is infected it will not recover, though speed of disease progression will depend on environmental conditions. Fungicides with activity for downy mildew might offer protection for healthy plants, but would need reaplication for season-long management. Plants treated with certain fungicides before leaving the production greenhouse will be protected, but only for as long as the fungicide activity lasts.

For additional pictures of symptoms and more information on Downy Mildew visit: http://ccesuffolk.org/floriculture-program (scroll down to Fact Sheets and Information). Also visit the resources posted by the American Floral Endowment at www.endowment.org/afe-news/press-releases/221-controlling-downy-mildew-on-impatiens.html.

Systemic insecticides and western flower thrips

Raymond Cloyd
Professor and Extension Specialist in Horticultural Entomology/Integrated Pest Management
Kansas State University

Systemic insecticides are compounds that when applied to plants are absorbed and translocated into other parts through the vascular system (xylem and/or phloem), which renders plant parts insecticidal or toxic to specific insect pests. They are primarily active on insects that feed in the xylem or phloem tissues including aphids, whiteflies, mealybugs, soft scales, planthoppers, and some leafhoppers because these insect pests feed exclusively within the xylem vessels or phloem sieve tubes, which increases their exposure to the active ingredient of systemic insecticides. The use of systemic insecticides prevents insect pest populations from building-up and reaching outbreak proportions thus avoiding the need to make frequent spray applications. Systemic insecticides may be applied as a foliar spray or to the soil/growing medium. The active ingredient is then translocated through the vascular tissues (xylem and/or phloem) to areas throughout the plant where insect pests feed.

Systemic insecticides must be water-soluble to some degree in order to allow the dissolved active ingredient to be absorbed by plant roots, for soil/growing medium applications, and then translocated throughout the plant. Water solubility determines how rapidly the active ingredient is absorbed by roots and translocated throughout plant parts such as leaves and stems. A highly water-soluble systemic insecticide may kill insect pests quickly; however, it may not provide long-term or sufficient residual activity compared to a less water-soluble systemic insecticide. A less water-soluble systemic insecticide may persist longer, but may not be as effective unless the rate is adjusted to compensate for the slower mobility. Table 1 presents the systemic insecticides labeled for use in greenhouse production systems that can be applied to the soil/growing medium, and their corresponding water solubilities.

One common question asked by greenhouse producers is associated with the effectiveness of systemic insecticides against the western flower thrips, Frankliniella occidentalis. Western flower thrips is the most important insect pest of horticultural greenhouse-grown crops world-wide. As such, it is essential to understand the feeding behavior of western flower thrips. Western flower thrips has piercing-sucking mouthparts but they do not feed exclusively in the phloem sieve tubes. Instead, they feed within the mesophyll and epidermal cells of leaf tissues. More specifically, western flower thrips feed on plants by inserting their tubular-like styles into cells and withdrawing the cellular contents. This feeding behavior may inhibit the effectiveness of systemic insecticides against western flower thrips; however, this is dependent on whether they are feeding on leaves or flowers. In addition, the anthophilic (inhabiting flowers) nature of western flower thrips limits their exposure to systemic insecticides because the active ingredient is not readily transported into flower tissues (petals and sepals) and the concentration of active ingredient that is translocated into flower parts may not be sufficient enough to directly kill western flower thrips. Furthermore, the active ingredient may degrade faster in flower parts or differences in the transpiration rates between flowers and leaves may result in flowers being less efficient sinks for the active ingredient of systemic insecticides. In addition, flowers are more ephemeral (don’t last as long as leaves) and there is less time for systemic insecticides to accumulate compared to the foliage. They may also not provide fast knockdown to prevent western flower thrips feeding damage to flowers when abundant populations are present. However, this may depend on the systemic insecticide and the associated water solubility because systemic insecticides with greater water solubility may accumulate in flower parts at concentrations sufficient to kill western flower thrips.

Again, the water solubility influences the level of uptake and relative effectiveness of systemic insecticides. For example, imidacloprid (Marathon™), which has a water solubility of 0.51 g/L or 500 ppm, tends to be less effective against flower and pollen feeding insect pests including the western flower thrips. Research has shown that acephate (when commercially available as Pinpoint™; however, the product was discontinued due to phytotoxicity issues), which has a water solubility of 790 g/L or approximately 79,000 ppm, and is converted into the metabolite—methamidiphos, actually moves into flowers and protects them.
translaminar insecticides will be required to regulate populations of the western flower thrips.

Western flower thrips feeding on leaves such as the nymphs and adults tend to be more susceptible to systemic insecticides than when feeding in flowers as leaf-feeding by western flower thrips may result in them imbibing toxic concentrations of the active ingredient of systemic insecticides. For example, it has been reported that thrips feeding on plant leaves are “suppressed” by thiamethoxam (Flagship™) when applied to the soil/growing medium. The water solubility of thiamethoxam is 4.1 g/L or 4100 ppm. However, it is possible that the metabolite—clothianidin is actually responsible for killing the thrips because although the water solubility of clothianidin is 0.32 g/L or 327 ppm, the material translocates throughout the entire leaf tissues thus potentially exposing thrips to lethal concentrations of the active ingredient.

Spray applications of systemic insecticides tend to be more effective than soil/growing medium applications because they are being primarily used as contact or translaminar, and not so much for any systemic activity. For example, sprays of acetamiprid (TriStar®)* and thiamethoxam (Flagship™) have been shown to be effective against western flower thrips nymphs and adults. In our research efficacy trials, we have found that the systemic insecticide dinotefuran (Safari®) provides sufficient (>80%) mortality of western flower thrips when applied as a foliar spray.

In summary, due to the feeding behavior of the western flower thrips, systemic insecticides, when applied to the soil/growing medium, in general, may be less effective than when applied as foliar sprays. Therefore, it is important to understand that when using systemic insecticides for regulation of xylem and phloem-feeding insect pests that the use of spray applications of contact or translaminar insecticides will be required to regulate populations of the western flower thrips.

New web-based supplemental light calculator (DLICALC)

Roberto Lopez, Brian Krug and Christopher Currey
Assoc. Prof. and Floriculture Extension Specialist, Purdue University; Floriculture Extension Specialist, Univ. of New Hampshire and Assist. Prof. Iowa State University

If you measure light in your greenhouse, you probably use instantaneous values such as foot candles (f.c.) or lux. Unfortunately, these two units are only a measure of light visible to the human eye. As greenhouse growers we are interested in measuring photosynthetically active radiation (PAR), the light our plants utilize for photosynthesis, in micromoles (µmol·m⁻²·s⁻¹). But, this is still an instantaneous reading and, as we all know, light levels are constantly changing. Research at Purdue and other universities is showing the economic benefits of monitoring and managing the cumulative amount of photosynthetic light that is received in a greenhouse over the course of a 24 hour period, which is known as the daily light integral (DLI). For example, this greenhouse operation has placed an excessive amount of

Table 1. Insecticides with systemic activity, when applied as a drench or granule to soil/growing medium that are commercially available for use in greenhouse production systems including common name (=active ingredient), trade name, and corresponding water solubility.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Trade Name</th>
<th>Water Solubility (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acephate</td>
<td>Orthene</td>
<td>79,000</td>
</tr>
<tr>
<td>Azadirachtin</td>
<td>Azatrol, Aza-Direct, and Molt-X</td>
<td>0.50</td>
</tr>
<tr>
<td>Dinotefuran</td>
<td>Safari</td>
<td>39,000</td>
</tr>
<tr>
<td>Imidacloprid</td>
<td>Marathon</td>
<td>510</td>
</tr>
<tr>
<td>Spirotetramat</td>
<td>Kontos</td>
<td>29</td>
</tr>
<tr>
<td>Thiamethoxam</td>
<td>Flagship</td>
<td>4,100</td>
</tr>
</tbody>
</table>

*Acetamiprid (TriStar®) is not labeled for soil/growing medium applications. It is only registered for use as foliar or sprech applications. This is why acetamiprid is not included in Table 1.

The author would like to acknowledge Joe Chamberlin (Valent U.S.A Corporation; Snellville, GA) for reviewing an initial draft of the article.
fern hanging baskets above their bench top crops resulting in a sub-optimal DLI at bench height (Figure 18). One question we are often asked is: “How do we calculate DLI?” Calculating DLI can be a daunting task.

Figure 18. A greenhouse with excessive hanging baskets suspended above other crops often results in a sub-optimal daily light integral at bench height.

We created a decision support tool, DLICALC (http://extension.unh.edu/Agric/AGGHFL/dlicalc/dlicalc_home.cfm) as a tool to help growers manage the photosynthetic light environment. You may already be familiar with the GROCALC suite of electronic grower decision support tools that include ALKCALC, FERTCALC, and PGRCALC (Figure 19).

Figure 19. DLICALC is the newest calculator in the GROCALC family of electronic decision-support tools for greenhouse growers interested in managing the daily light integral in their greenhouses.

These programs are useful for making calculations related to greenhouse crop culture including water acidification requirements, fertilizer solution, and plant growth retardant (PGR) mixing. However, there are few or no tools available to help make calculations related to the greenhouse environment.

**DLICALC functions**

The main function of DLICALC is to calculate the answer to two different questions:

1) “I currently have supplemental lights [high pressure sodium (HPS) or metal halide (MH)] in my greenhouse. How long do I need to run them to achieve a target supplemental DLI?” For example, a young plant grower has HPS lamps that provide 60 µmol·m⁻²·s⁻¹ (554 f.c.) at plant height. They would like to increase their DLI by approximately 4.5 mol·m⁻²·d⁻¹, but are unsure how long to operate the lamps for.

2) “I am currently operating supplemental lights, what is my supplemental DLI?” For example, a bedding plant grower has MH lamps operating from 6 to 10 am and from 4 pm to 12 am (12 total hours of operation) providing 55 µmol·m⁻²·s⁻¹, but would like to know how much of their total DLI is from supplemental light.

To answer these questions, DLICALC is designed to: 1) estimate a supplemental DLI from your supplemental light source; and 2) estimate hours of lamp operation to achieve a target supplemental DLI (Figure 20).

In order to determine how long to operate supplemental lights each day to achieve a target DLI, the target supplemental DLI, lamp type (i.e. HPS, MH, etc.), supplemental light intensity value and the corresponding unit of measurement (i.e. f.c., µmol·m⁻²·s⁻¹) must be entered into the program. Note that converting f.c. to µmol·m⁻²·s⁻¹ and vice versa requires a specific conversion factor that DLICALC integrates into its calculations for different light sources. From this information, the number of hours needed to operate supplemental lights is calculated. So for our young plant grower in the example above, the HPS lamps would need to operate for approximately 21 hours to provide 4.5 supplemental mol·m⁻²·d⁻¹. Alternatively, to determine the amount of supplemental light provided by an existing supplemental lighting program, the lamp type, supplemental light intensity and the corresponding unit of measurement, and hours of operation must be entered and, from this, the supplemental DLI is calculated. Again, for our bedding plant grower above, when they operate their MH lamps for 12 hours they provide 2.4 mol·m⁻²·d⁻¹ of supplemental light.

Figure 20. The central feature of the DLICALC is to calculate either the amount of supplemental photosynthetic light provided by an existing program or the amount of time required to operate an existing supplemental light source to achieve a target supplemental daily light integral.
Other DLICALC functions

While the main function of DLICALC is to help manage supplemental lighting, there are several other factors that contribute to the greenhouse light environment. In addition to calculating supplemental DLI and hours of lamp operation, DLICALC contains information on measuring light in the greenhouse and estimating the natural DLI, as well as tips for using shade in the greenhouse.

One of the most important aspects of photosynthetic light management is successfully measuring the light in your greenhouse. However, there are several things to consider in order to record accurate light measurements. For instance, type of measurement (instantaneous versus cumulative), sensor type and calibration, and sensor placement and cleanliness all impact light measurements. In DLICALC, we provide some basic guidelines, resources, and supplemental materials to assist growers in measuring photosynthetic light in the greenhouse.

Measuring photosynthetic light in a greenhouse is the only way to accurately know what the environment in your greenhouse is. We provide a description of light units and terminology and present several publications dedicated toward better understanding measuring and quantifying the light environment in greenhouses. However, we know that not everybody will have access to some of the tools necessary to measure ambient light. Therefore, we discuss the nature of light transmission of outdoor light into a greenhouse and present monthly outdoor DLI maps developed at Clemson University.

Although many growers are concerned about increasing the DLI in greenhouses, it is also common to reduce the DLI when ambient light is high or when low-light crops such as phalaenopsis orchids are being produced. One of the features of DLICALC is a page dedicated to best management practices and shading.

Conclusions and Future Directions

The ultimate goal of DLICALC is to enable growers to better manage supplemental lighting and greenhouse light in general. We hope that DLICALC will be a useful tool for growers to help manage the photosynthetic light in the greenhouse, as well as other aspects of managing the light environment. While DLICALC will not have the ability to tell a grower exactly what the total DLI (ambient solar + supplemental) is, we hope that it will be a step in the right direction of having greenhouse growers make informed decisions when managing photosynthetic light.

Retail garden center workshop

The Horticulture and Landscape Architecture Department at Purdue University is in the planning stages to host Retail Garden Center Workshops, which will be an amazing learning opportunity to an underserved market. This program is intended to educate those ‘on the front line’, who typically deal with many of the consumer’s questions. Since many home owners derive much of their information from the garden center employees, it is very important for them to be educated about various aspects of plants. To develop a top-notch program, we ask those of you in the Retail Garden Center Industry to please take a quick survey to determine topics, best time of the year, etc. The survey will take less than five minutes of your time.

To access the survey, please visit: https://purdue.qualtrics.com/SE/?SID=SV_ahIf61rud-vUoU8l

Two new websites for the ornamental industry!

Visit Roberto Lopez’s website for greenhouse and floriculture at:
https://ag.purdue.edu/hla/lopezlab/Pages/default.aspx

Visit Kyle Daniel’s website for nursery and landscape at:
https://ag.purdue.edu/hla/extension/nle/Pages/default.aspx
### Online Ornamentals

**Upcoming 2013 Industry and University Events**

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<tr>
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<th>Location</th>
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<td>Purdue Turf and Landscape Field Day</td>
<td>West Lafayette, IN</td>
<td>Education</td>
<td><a href="http://www.agry.purdue.edu/turf/field-day.html">http://www.agry.purdue.edu/turf/field-day.html</a></td>
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<td>July 13-16</td>
<td>OFA Short Course</td>
<td>Columbus, OH</td>
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<td>Aug. 1</td>
<td>INLA Shooting for Scholarships and Summer Tour</td>
<td>Fishers, IN</td>
<td>Fundraiser and Tour of Local Operations and Jobsites</td>
<td><a href="https://www.inla1.org">https://www.inla1.org</a></td>
</tr>
<tr>
<td>Aug. 6</td>
<td>Michigan State University Plant Trial Field Day</td>
<td>E. Lansing, MI</td>
<td>Tour</td>
<td><a href="http://planttour.hrt.msu.edu/">http://planttour.hrt.msu.edu/</a></td>
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<tr>
<td>Jan. 8-10, 2014</td>
<td>Indiana Green Expo</td>
<td>Indianapolis, IN</td>
<td>Education and Trade Show</td>
<td><a href="http://www.indianagreenexpo.com">http://www.indianagreenexpo.com</a></td>
</tr>
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**Online Ornamentals**

**Purdue Turf and Landscape Field Day**

Tuesday July 9, 2013  
W.H. Daniel Turf Center, West Lafayette  
Great educational value! ONLY $40 when you pre-register by Wednesday, June 29  
includes lunch!

Register on-line, US mail, Fax, or Call  
Up to 4.0 category 3a/3b/RT CCH’s, 3.0 category 6 CCH’s, 2.0 category 2 CCH’s, and 1.0 category 7a CCH’s requested  
If you have any questions, please contact Jennifer Biehl at 765.494.8039 or biehlj@purdue.edu

**Landscape Tour Highlights**

- Diagnoses of virus
- Hidden diseases of trees and shrubs
- Tree assessment
- Conifer ID
- Planting depth
- Dealing with pests
- Emerald Ash Borer solutions

An afternoon tour of the Purdue Horticulture Gardens and Growing Facilities
Reference to products in this publication is not intended to be an endorsement to the exclusion of others that may be similar. Persons using such products assume responsibility for their use in accordance with current directions of the manufacturer.