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Landscape, Floriculture, and Ornamentals News

A Newsletter for the Professional Landscape, Floriculture, and Ornamentals Industries

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Contents

Laughlin and Hensley Leave UH

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The college and the state recently lost two more very visible and productive faculty and their families to higher paying positions on the Mainland.

Dr. Charles Laughlin, dean of the College of Tropical Agriculture and Human Resources, resigned his position in mid-June and has assumed the duties as administrator of the Cooperative States Research, Education and Extension Services in the U.S. Department of Agriculture in Washington, D.C. The program headed by Dr. Laughlin administers nearly a billion dollars in base funding for extension and research activities under federal/state partnerships. In his new position, Dr. Laughlin will hopefully be able to continue helping Hawaii's agriculture industry while supporting the entire Land Grant system.

During his tenure as dean of CTAHR, Laughlin guided the college through the initial stages of reorganization in which the number of departments will be reduced from 11 to 6 through a major redistribution and consolidation of academic programs and faculty assignments. The University Board of Regents officially accepted Phase One of the two-part reorganization just prior to Laughlin's resignation. Phase Two is expected to pass in the coming months and with it a brand-new look for CTAHR.

Laughlin said that despite the continuing budget cuts, which have particularly affected research and extension activities, CTAHR has a "very good reputation" among agriculture colleges. "The image and reputation of the college within the university is also much higher than it was three years ago, and I attribute that to the accomplishments of the faculty," he said.

Most of us in CTAHR came to know him simply as Chuck. He always wore a big smile and had an open, friendly manner about him that naturally encouraged one to greet him with a "How'z it?" **Barbara Laughlin** was also a very familiar face in CTAHR, serving on the faculty of Human Resources. Chuck and Barbara are real people, the kind you hope to know for a lifetime. All of us at UH, and especially CTAHR, will miss them. A selection committee for the recruitment of a new dean is presently being formed. Dr. H. Michael Harrington has been appointed interim dean and Ms. Catherine Cavaletto has filled Dr. Harrington's former position as interim associate dean for research.

A national recruitment is under way to permanently fill the three interim positions of associate dean for research, associate dean for academic affairs, and associ-

ate dean for extension.

And then a few weeks later, just to show that lightning does strike twice, **Dr. David Hensley** tendered his resignation effective July 15, 1999. Most of our local readers know that Dave was chair of Horticulture and acting chair of the newly formed Tropical Plant and Soil Science Dept. He also acted as advisor to the Landscape Industry Council of Hawaii (LICH) and was active in many other industry organizations. He has been credited with reviving LICH and for getting the *Hawaii Landscape* magazine back on its feet and making a profit. And, of course, Dave has been co-editor of this newsletter for the past three years.

Glenda Hensley served as administrative officer for the Joint Institute for Marine and Atmospheric Research (JIMAR) in the School of Ocean and Earth Science and Technology on the Manoa campus. More importantly, Glenda is the one who has to look after Dave.

Dr. Hensley's new position is chair of the Department of Landscape Architecture and Horticulture at Temple University, Ambler campus, located just outside of Philadelphia, Pennsylvania. (Yes, you read it correctly. Dave was never one to heed the words of a wise man like W.C. Fields!)

It is not likely that Dr. Hensley's Landscape Specialist position will be filled in the near future. Vacancies created by the retirements of specialists in the areas of turf and nursery have gone unfilled for the past several years. The departure of Hensley creates an even greater void in the support of agricultural programs in all three of these areas. There are now 10 unfilled positions in the Department of Horticulture alone.

Until one or more of these vacancies is filled, the landscape, turf, and nursery programs will be without specific faculty leadership. In the interim (that's becoming a very familiar term in CTAHR) Paul Murakami and I will do our best to fill in. Paul will be teaching classes in nursery and landscape in the up-coming academic year as well as consulting in those areas. I will continue to serve as co-editor of this newsletter along with Dr. Ken Leonhardt, and to write Extension publications in the general areas of turf and landscape. I also hope that I can fill in for Dave in many of the industry programs he was involved with, and I'll do my best to consult with the general public in those areas. If I don't know the answer, I know who to ask!

As was the case with the Laughlins, Dave and Glenda are, in Dave's words,"real down-home folks." He could have embellished it a bit more. The Hensleys were involved with many different groups and are genuinely loved and admired by all. The combination of Dave's wacky, off-the-wall sense of humor and Glenda's calm and warm demeanor is enough to win over anyone they meet—even in Philadelphia. Once again, Hawaii is losing some of its best.

Turf Fertilizers: Making the Best Choices

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Fertilizers for turf use include an ever-growing and widely varied selection of products. As a turf manager, you can quickly become overwhelmed with information about the many different formulations, analyses and grades of products available for purchase. However, among the many choices, formulation (fluid or granular) is one of the more important factors to consider in deciding which is the right product for your needs.

Fluid fertilizers are formulated and packaged as a liquid. This includes fertilizers that are clear liquids (solutions) or liquids that contain suspended solids (suspension fertilizers). Turf managers use fertilizers packaged and sold as fluids less frequently than solids (granules), although liquid products are more common in agricultural applications. In fact, fluid fertilizers account for about 40 percent of total U.S. fertilizer sales. Examples of fluid fertilizers include anhydrous ammonia (which is transported as a fluid and injected into soil in gaseous form), nitrogen (N) solutions (usually made from a mixture of urea and ammonium nitrate), ammonium polyphosphate and triazones.

Applicators often apply solid water-soluble fertilizers as liquids. They mix the dry fertilizer with water to form a solution and apply it to the turf as a liquid or foliar feed. Liquid application of fertilizer uses a high spray volume (3–6 gallons per 1000 square feet) to move nutrients into the soil, a common application method for many commercial lawn-care companies. Foliar feeding uses a lower spray volume to apply a small amount of fertilizer (for example, iron commonly is applied this way) directly to the foliage, providing rapid uptake of nutrients and quick correction of a nutrient deficiency. Typically, applicators use foliar feeding to supply a small amount of a deficient nutrient or as part of a fungicide application, not to supply all the needed fertilizer for

turf growth.

Benefits from using soluble solids as liquid fertilizers include the ability to apply nutrients through irrigation (fertigation), possible use as a carrier for post-emergence herbicides and flexibility of application as a foliar feed. Liquid application of a soluble-solid fertilizer can reduce the risk of foliar burn, provide even coverage and allow simultaneous application of fertilizers and pesticides. You can apply liquid fertilizers at low rates on a frequent basis to spoon-feed turf, promoting even greening and consistent growth. Application of small amounts of fertilizer at regular intervals can prevent over-application, lessening environmental risk.

Negatives may include the cost of new or specialized application equipment and the issues of handling a heavy, bulky, liquid material. Plus, it can be difficult to apply higher rates of nutrients in an appropriate spray volume to avoid burning the turf, in which case frequent application becomes the key. However, the need for frequent application can be a problem, especially if labor is in short supply.

Solid fertilizers are dry particles that manufacturers size between an upper and lower limit of screen sizes. They may be finely crushed, granular, crystalline, powder or processed into uniform prills. These fertilizers, by themselves, are usually water-soluble for quick release, but often are coated as controlled-release products. Controlled-release products also are called slow-release, slow-acting, metered-release or controlled-availability fertilizers. Although easy to apply, care is necessary with granular fertilizers. We have all seen the all-too-visible effects of an incorrectly calibrated spreader or incorrect application by an inattentive employee!

Soluble materials

Water-soluble fertilizers are rapidly available for turf growth. Examples of common water-soluble turf products include ammonium nitrate (34-0-0), potassium nitrate (13-0-44), ammonium sulfate (21-0-0), potassium sulfate (0-0-50) and urea (45-0-0). Some water-soluble fertilizers are homogeneous products (every particle has the same composition). These have a uniform appearance and are made from blends of raw fertilizer materials such as superphosphate, ammonium solutions, monoammonium phosphate (MAP), diammonium phosphate (DAP), urea, potassium chloride or potassium sulfate (not all phosphate fertilizers are completely water-soluble). Fertilizer bags always list which raw materials the manufacturer used and the specific fertilizer grade in the bag.

Other solid fertilizers are non-homogeneous blends (you can see the individual granules of different fertilizer materials), where the manufacturer simply has mixed particles together to produce a desired overall composition. Non-homogeneous products may not spread as uniformly as homogeneous products, especially if the particles are different sizes. Some products are a mix of soluble and slow-release fertilizers; the bag should list the percentage of each in the product.

Water-soluble fertilizers produce rapid greening, have a low cost per unit of nutrient, are easy to apply, and are readily available from a wide range of dealers. The rapid greening from these fertilizers is due to N, and perhaps sulfur or iron in the fertilizer as well. These products are usually easy to handle and do not take expensive equipment or intensive training to ensure correct application. Regular application of these products may also offer a business bonus—your clients see you at their site frequently.

A soluble nitrogen source provides a readily available supply of nitrogen to the turf. The growth rate increases sharply about 2 days after application, reaches a peak in 7–10 days after application and, depending on the rate of application, tapers off to the original growth rate in 4–6 weeks. A uniform growth rate could be produced if very small amounts of soluble nitrogen are applied on a daily schedule. However, the only practical method of applying nitrogen on a daily schedule would require fertigation, a method of applying fertilizer through the irrigation system. Fertigation may prove economical for high maintenance golf courses and parks.

The "peaks" and "valleys" in growth rate observed between applications of soluble nitrogen fertilizers may not be obvious on frequently mowed turf areas, but they can have a detrimental effect on the grass. Short bursts of growth after fertilizer application followed by a period of slow growth can deplete carbohydrate reserves in the grass, reduce root development and eventually thin a turf. These effects are not readily apparent by observing growth rate and color responses to fertilization. Long term observations and responses to stress will more accurately establish the effect of soluble nitrogen sources on turf.

At rates of application above 0.5 pound of N per 1000 sq ft, soluble sources may desiccate or burn the foliage if not watered into the turf shortly after application. A commercial lawn service organization cannot depend on the homeowner to water the lawn as needed and may find that lower rates with more frequent applications are best suited to their needs. Also, at rates above

0.5 pound of N per 1000 sq ft, soluble N fertilizers produce a burst of growth for a short period after application. This is not desirable from the standpoint of mowing, watering and other maintenance requirements. In addition, excessive leaf growth depletes the grass of energy reserves, retards root growth and increases the susceptibility of the grass to insects and diseases.

In their favor, soluble N sources are the lowest cost per pound of N, produce a rapid greening response, are effective at all temperature extremes, and are suited to either liquid or dry programs. Where N can be applied at 0.5 pound per 1000 sq ft at monthly intervals, the soluble products are the choice of most applicators. However, the need for frequent applications limits their use in most lawn service operations.

A relatively new product called Formolene (methylol urea) overcomes several of the shortcomings of the soluble N sources, but does not have a long residual. The methylol urea has a greatly reduced burn potential and 1.0–1.5 pounds of N per 1000 sq ft can be applied in a single application without burning the foliage. Also, the product does not produce the rapid burst of growth produced by other soluble N fertilizers. However, the residual is only slightly greater than soluble N fertilizers. A further disadvantage is that the product is tightly bound to the foliage and clipping removal after application can remove significant amounts of nitrogen. Formolene is a liquid concentration with 25–30% nitrogen. It mixes readily with other fertilizer nutrients and pesticides and is well suited to liquid applications. The user should be advised not to remove the grass clippings for at least two mowings after application.

Slow-Release Nitrogen Sources.

A low, uniform supply of available nitrogen and other essential minerals during the growing season is the objective of most turfgrass fertilizer programs. Such a program is difficult to accomplish without the use of slow release sources of nitrogen. Residual soil nitrogen, that which becomes available to the grass over a relatively long period of time, cannot be rapidly built up with soluble materials. Slow-release nitrogen sources build up residual soil nitrogen that is made available to the grass at varying rates. The rate at which residual nitrogen is made available (released) may vary with nitrogen source, temperature, moisture, pH, particle size, microbial activity and time of application. Knowledge of a particular nitrogen source and of conditions favorable for nitrogen release is necessary for a turf manager to determine the timing and rates of application of slow-release fertilizers.

Urea-formaldehydes (UF) are products of reacting urea with formaldehyde under carefully controlled temperatures, pH and reaction times. The nitrogen release characteristics of the materials produced are determined by the ratio of urea to formaldehyde in the product. Methylene urea has a ratio of 1.9 to 1 and is ⅔ water-soluble and ⅓ water-insoluble. Other UF products such as Nitroform® and Fluf® have a ratio of urea to formaldehyde of 1.3 to 1 and are ⅓ water-soluble and ⅔ water-insoluble. The rate of nitrogen release of these products is closely related to the solubility of the UF. Methylene urea has a faster nitrogen release and greening response than Nitroform; but the "residual" nitrogen is much greater for Nitroform.

All of the nitrogen in UF is dependent on soil microorganisms to breakdown the methylene urea chains to urea before nitrogen can be released. But, the short chain (water-soluble) methylene urea polymers are broken down much faster than the long chain (water-insoluble) polymers. The water-insoluble fraction of UF may not be completely broken down in the first year, and, with relatively short growing seasons, significant carryover (residual) can be expected into the second and third seasons. Where normal rates of UF are applied, 2 or 3 years may be required to build up residual nitrogen to a level that annual applications of UF release an adequate amount of nitrogen. To overcome this lag in nitrogen availability, higher initial rates of UF can be applied or supplemental soluble nitrogen can be used. Higher rates and supplemental sources are commonly applied to Hawaii's turf in order to compensate for our longer growing season.

Since microorganisms are required to breakdown UF, environmental conditions (high temperatures, neutral soils, and an adequate supply of moisture and oxygen) that favor microbial activity also promote nitrogen release from UF. Conversely, low temperatures and acid soils inhibit the release of nitrogen from UF.

Losses of nitrogen due to leaching and volatilization are less from UF than from soluble nitrogen sources. Therefore, over a period of several years, UF sources are at least equal to soluble sources in terms of nitrogen use efficiency. In addition, under conditions that favor leaching and volatilization UF sources are more efficient.

Nitrogen losses due to removal of fertilizer granules with grass clippings can be significant on closely mowed turf. Losses may be as high as 20% on golf greens. For the first several days after application, the grass should be allowed to dry before mowing. Urea-

formaldehyde has little effect on soil pH or salinity. Thus, even at high rates of application, UF does not burn the grass.

Isobutylidene diurea (IBDU) a condensation product of urea and isobutyaldehyde with slow-release characteristics, is a nitrogen fertilizer. Contrary to UF, IBDU does not depend on soil microorganisms for release of nitrogen. In the presence of water, IBDU is hydrolyzed to urea. The rate of hydrolysis varies with soil pH, temperature, particle size and moisture. IBDU is effective as a controlled release nitrogen source for turfgrasses between pH 5 and 8. Below pH 5, the rate of hydrolysis is very rapid and above pH 8 the rate of hydrolysis is quite slow.

Temperature does not influence the release of nitrogen from IBDU to the degree that it does for UF and organic nitrogen sources. But, high temperatures favor the hydrolysis of IBDU and significantly increase nitrogen release. The rate of nitrogen release from IBDU is 2 to 3 times as fast at 75°F than at 50°F; whereas, for UF and organic sources the same temperature difference may result in a 10-fold increase in nitrogen release rates. Particle size of IBDU granules has a significant influence on hydrolysis rates and nitrogen release. The finer the particle, the greater the surface area and the faster is the rate of hydrolysis. By varying the size of the IBDU granules, nitrogen release can be distributed over a longer period of time. A material with a range of particle sizes between 8 and 24 mesh is recommended for turfgrasses. Particle size does not influence the rate of nitrogen release from UF,

Soil moisture levels also influence the release of nitrogen from IBDU. Wet soil conditions favor the release of nitrogen from IBDU. Soil moisture levels of 40– 70% of field capacity are favorable for a controlled release rate of nitrogen from IBDU. Above these levels nitrogen release is very rapid, and below these levels, nitrogen release is very slow. IBDU would not provide a uniform level of available nitrogen where turf is exposed to prolonged wet and dry cycles. Nitrogen losses due to leaching and volatilization are quite low from IBDU. And, efficiency, in terms of nitrogen recovery, is similar to other slow-release nitrogen sources. Nitrogen losses due to mower pick-up of the IBDU granules are similar to those that occur with UF sources,

Unlike UF sources, IBDU does not require a build up of residual nitrogen to provide adequate levels of available nitrogen. Unless particle sizes of IBDU granules are quite large, greater than 2 mm in diameter, most of the nitrogen is hydrolyzed within 60 days after application. However, where particles are much over 2 mm in diameter, mowers will pick-up significant quantities of IBDU granules on closely mowed turf.

IBDU has little effect on soil pH, although a temporary increase in pH may occur following a high rate of application. Also, IBDU does not damage turfgrasses at normal rates of application. However, temporary chlorosis has developed 3–4 weeks after the application of very high rates of IBDU (above 6 lb N/1000 sq ft). This chlorosis has been attributed to excessive absorption of ammonia by the grass.

Sulfur-coated urea (SCU) is produced by spraying pre-heated urea with molten sulfur in a rotating drum. A wax coating may be applied on top of the sulfur coating to seal the pinholes and cracks in the sulfur coating. Finally, the product is cooled and a clay conditioner applied to reduce cracking. The product is screened to remove any oversize granules.

Sulfur-coated urea granules have been shown to provide a slow-release nitrogen source. The rate of release of nitrogen from SCU depends on the time required for microorganisms to break down the sulfur coating. Thus, the nitrogen release rate can be decreased by heavier sulfur coating and by inclusion of a microbial inhibitor in the coating. However, a problem occurs with heavy sulfur coatings for turfgrass fertilizers because the mower crushes or picks-up the larger fertilizer granules.

Factors that influence the release of nitrogen from UF (temperature, pH and moisture) also affect nitrogen release from SCU. High temperatures, neutral pH and moist soils favor the release of nitrogen from SCU.

Sulfur-coated urea is the least uniform of the slow-release nitrogen sources discussed. Imperfections exist in the coatings of SCU because of irregularities on the surface of urea. Also, the sulfur coating may not be uniformly applied to the urea granule. These defects together with incompletely covered granules and cracks in the coatings provide the sites for urea to be released when SCU is exposed to water. Thus, each SCU granule will have a slightly different rate of nitrogen release depending on the extent of the "imperfections", whereas UF and IBDU granules are homogenous and are not affected by "imperfections" in the coating. Sulfur-coated urea granules are also subject to being crushed by the fertilizer distributor during application or by the mower reel, roller or wheel during mowing.

Solubility rates for SCU are expressed as the percent urea released when the product is placed in water at 100°F for seven days. Commercial products usually have a dissolution rate between 20 and 30%. Below 20%

the product is considered too slowly available; while much above 30% the product would not be considered a slow-release nitrogen source.

Nitrogen losses from SCU due to leaching and volatilization are intermediate between urea and UF or IBDU. Perhaps the greatest losses of nitrogen from SCU occur when the sulfur coating is broken and urea is readily released or when the SCU granules are picked-up with the grass clippings by the mower. SCU has little affect on salinity, but may reduce soil pH. The sulfur released by SCU after the coating is broken down tends to reduce soil pH. Where sulfur is deficient in soils, SCU provides an additional benefit with the release of sulfur that eventually becomes available to the grass.

Nitrogen recovery for SCU is greater than for urea and other soluble nitrogen sources. However, recovery would need to be measured over a longer period of time for SCU than for soluble sources.

Polymer-coated nitrogen sources such as Grace Sierra's Once® and Pursell Industries Polygon® provide controlled release of nitrogen by diffusion through a polymer membrane (coating). These products are usually a coated potassium nitrate, urea, or potassium sulfate. Release rates are dependent on moisture and temperature and by the composition and thickness of the coating. Such products are very uniform and provide predictable release rates of nitrogen.

Liquid slow-release products also are available, such as the triazones. These products combine the advantages of using a liquid (such as low burn potential and tank-mixing) with the benefits of a slow-release source of N. However, like all liquid applications, they require the appropriate equipment and the ability to store and handle liquids.

Organic Nitrogen Sources

The oldest sources of nitrogen used for turfgrass fertilization are the natural organic materials: manure, composted crop residues, sludges and humus. These materials are quite low in nitrogen content, difficult to store and apply, expensive and, in some cases, contain undesirable substances such as salts, heavy metals and weed seeds.

Nevertheless, organic nitrogen sources can be effectively used in most turf maintenance programs. Nitrogen release from organic sources is dependent on microorganisms; thus, factors that favor microbial activity increase the rate of nitrogen release from these materials. Organic materials are not considered good nitrogen sources during the cooler months because of the low activity of microbes. During most of the year in Hawaii, organic sources are very effective.

Organic sources should not be considered slow-release sources. When conditions favor nitrogen release from organic sources, the nitrogen usually becomes available to the grass within 4–6 weeks. A significant amount of the nitrogen from organic sources may remain tied-up in the organic form for years.

Organic sources have the advantage that they will not "burn" the grass, have little effect on pH, contain nutrients other than nitrogen and may raise soil temperatures during cool periods. Also, some of these materials such as manures, sludges and composts may improve the physical condition of soils.

Milorganite®, a product of the Milwaukee Sewage Commission, is an activated sewage sludge that contains 6% nitrogen. The product is granulated, screened and packaged for application to fine turf. It is, perhaps, the most widely recognized nitrogen source for golf green turf and is commonly used on Hawaii's golf courses for that purpose.

Advantages of Milorganite for putting green turf include a uniform nitrogen release rate over a period of 3–4 weeks, a very low burning potential, the addition of phosphorus and iron, and a minimum effect on soil pH and salinity. Leaching and volatilization losses of nitrogen from Milorganite are also very small.

Disadvantages of Milorganite include a low nitrogen content, a short nitrogen residual, a relatively high cost per pound of nitrogen and a poor winter response. The limited availability of the product might also be considered a disadvantage.

Turf response to Milorganite in terms of growth rate and color are excellent during the spring, summer and fall. Additionally, turf researchers have reported less thatch accumulation where Milorganite was used in place of soluble nitrogen sources.

Combinations of Nitrogen Sources for Turfgrass

In low maintenance areas a single source of nitrogen may meet the needs of the turf. But where demands are greater as for lawns, golf courses and athletic fields, combinations of nitrogen sources provide the most uniform level of nitrogen to the turf.

The objectives of the fertilization program have a significant influence on the source of nitrogen needed. If the objective of fertilization is to simply maintain a grass cover, a single application of a slow-release fertilizer, or perhaps, two applications of a soluble fertilizer will meet the requirement of the grass. But, where a con-

tinuous supply of nitrogen is needed to maintain growth, to recover from wear or to maintain good color, a combination of nitrogen sources will best meet the needs. For lawns, fairways, athletic fields and other intensively maintained turf areas mowed at a 1-inch height or greater, coated products, UF, or IBDU can provide the "residual" nitrogen while soluble sources can be used to produce rapid green-up. For closely mowed turf areas such as golf greens, tennis courts and bowling greens, UF and IBDU should be used for residual nitrogen and Milorganite or similar organic sources should be used for rapid green-up. During cooler periods, IBDU or soluble sources must be used to produce a fast greening response.

Other factors that must be considered include the acidifying potential of SCU or ammonium sulfate, the salinity hazard of ammonium nitrate and ammonium sulfate and the cost of the slow-release and organic nitrogen sources.

On a cost per pound of nitrogen basis relative to urea, SCU is about 2 times greater, UF and IBDU are 3 to 4 times greater and organic sources are 5–6 times greater than urea. Thus, for larger turf areas where soluble sources can be safely used, they may be the logical choice for nitrogen fertilization. The most important factors when using soluble sources include the rate and timing of applications. Single applications should not exceed one pound of nitrogen per 1000 sq ft and should not be made prior to or during a period of rapid growth.

Sources:
Liquid vs. Granular: Which fertilizer works for you?, Beth Guertal (Grounds Maintenance, Aug 1998)
Turfgrass Fertilization, Richard L. Duble (Texas Agricultural Extension Service)
Turfgrass Management-Master Gardener Training (1995), Tony Koski, (CSU Cooperative Extension).

Minimizing the Environmental Effects of Fertilizer

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Environmental awareness concerns from both the private and government agencies are placing a high priority on the issue of fertilizer run-off and ground water contamination. Numerous studies conducted address concerns with identifying possible sources of pollution in the environment.

Sources of pollution are termed either "point source" or "non-point" source pollution. Point source refers to known sources such as factory out-falls and sewage treatment plants. These are fairly obvious in terms of what effects their wastes may have on the environment. The other type is "non-point source" which is best described as sources that have no immediate effects and are not easily identified until later in time. These sources are of great concern for Agriculture because government studies attribute 65% of all pollution to non-point sources. Minimizing the risk of polluting both soil and ground water is paramount in developing any type of agricultural endeavor whether it is vegetable growing to landscape maintenance. Hawaii is most concerned with this issue as "non-point" source contamination of well water with pesticide residues have been directly traced to the intensive farming of sugar cane and pineapple. These contaminants have taken years to leach down into the water tables and are now detectable.

Years of research and developments in the maintenance and growing of plants has led to ever increasing amounts of fertilizer application. Most of these fertilizers are products of the technical revolution producing inorganic sources of fertilizer, which are at higher concentrations and cheaper than organic sources. As a consequence the use of fertilizers at higher and higher rates has reached all time highs.

This increased use of fertilizer to increase plant growth has been directly correlated with groundwater increases of fertilizer elements. As more fertilizer is applied for plant growth an ever-increasing amount of fertilizer is lost to the environment. This is because plants are not that efficient in nutrient uptake; a great majority of fertilizer is leached past the root zone and is no longer usable by the plant.

Why do elements leach away? Soils are negatively charged and as such will not attract elements that are

also negatively charged. This is a rather simplistic look at soil chemistry interactions but is the basis for why large amounts of anions can end up in ground water.

Nitrogen run-off is the most major problem encountered. There are two reasons for this. The first is that in most cases, nitrogen can be the most limiting factor in plant growth. This is the reason that an application of nitrogen is the standard we use to feed plants. The second reason is that the most readily available form of nitrogen to the plant is nitrate nitrogen. Nitrate nitrogen is negatively charged (NO_3^-). Nitrate nitrogen is readily moved past the root zone in soil and released to the environment.

Other forms of nitrogen such as ammonia (NH_4^+) are the least likely to leach from the soil because they are positively charged. Urea is another form that is likely to leach from soil, however if it is held in place for two days it will convert to ammonia and then become less likely to leach.

Nitrate nitrogen is a known health hazard. The amount of nitrate nitrogen in water cannot exceed 10 parts per million otherwise by federal law the water is contaminated. Nitrate nitrogen is poisonous to humans at levels higher than 10 parts per million and current studies indicate that some birth defects, cancer and nervous system damage can result from high nitrate levels.

This presents dilemmas for plant growers in that plants need to have much higher amounts of nitrate nitrogen in order to grow correctly. Studies done with run-off water collected from agricultural areas had levels of nitrate nitrogen from 2 to 81 parts per million. The reason for the run-off is that plants are not that efficient in recovering all the nutrients used for fertilizing them. It is estimated that in general the plants take up less than 70% of the nutrients applied to them. This number may be even lower if one considers the actual nutrient used by the plant. This suggests that a lot of plant food is lost after application.

The state of California has taken a very firm stand on fertilizer pollution in the environment with its "zero tolerance" policies. Several agriculture sites were fined for fertilizer run-off in recent years and the environmental lobby is pushing for state legislation to redefine the existing rules for the state's agricultural pesticide applicator's licensing to include fertilizer and soil amendments. In loose terms, the definition would become "any chemical which is applied to the ground or soil" would be treated as a pesticide or herbicide. All agricultural workers would be required to have certification to apply such chemicals. This could be interpreted to imply that a supplier or distributor would be liable for environmental pollution fines if they provided the recommendation for the chemical. The environmental lobby is hoping that if such legislation is passed in California, it could be used as a model for federal regulations. This type of legislation would effect Hawaii in the future and bears watching.

So how does one minimize movement of fertilizer off the site? First, take a good look at the type of fertilizer you are using. Highly soluble forms of fertilizer that are readily dissolved in water will move quite rapidly with heavy rain or irrigation. Quick release and more inexpensive forms of fertilizer tend to be highly water-soluble and also of non-uniform particle sizes. These make it difficult to control the release of the product. You can use these products but in order not to create a problem situation one should make sure to use a light rather than heavy application. This will probably have to be done more often to keep the plants healthy.

A much more efficient way and less polluting method is to use one of the new "High Tech" controlled release fertilizers. In general, these fertilizers will be more expensive than quick release forms, however they will in the long term save labor costs and reduce the pollution aspect considerably. You will have to choose a fertilizer based on your plants growing cycle. If you coordinate your release timing and your plant growth, you will have an adequately feed plant without excessive loss.

It goes without saying that improper use of fertilizer will result in damaging the environment. Here are some steps that will help to minimize the loss of fertilizer from your landscape site or growing areas:

Use grass buffer strips where run off occurs from your location. Grass is one of the most efficient fertilizer users and will remove excess fertilizer from water and soil.

- Avoid use of fast release or cheap blends of non-uniform particle sizes. It is harder to control amounts and release with these products.
- Use controlled release fertilizer products.
- Do not apply fertilizers through overhead sprinklers as the fertilizer is not applied properly and is wasted.
- Use a drip or controlled irrigation system around the plant base to prevent run-off.
- Use a thick layer of compost around plantings to prevent weeds and save moisture. It is crucial for everyone to use fertilizers carefully to avoid providing "overzealous watchdogs" with reasons to criticize.

Turf Performance of Seeded Bermudagrass and Zoysiagrass Cultivars

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New seeded cultivars of bermudagrass and zoysiagrass offer improvements in turf density, leaf texture and turf quality. However, many of the top turf performers have not yet produced enough seed to meet demand.

The number of seeded turf bermudagrass cultivars has increased enormously in the past decade and seeded zoysiagrass cultivars are beginning to make their mark as well. Several field trials have recently been completed on both species.

Turf Evaluations for Seeded Bermudagrass

In 1995, researchers at Mississippi State University initiated a variety test that included 16 seeded bermudagrass cultivars grown under simulated fairway conditions with mowing scheduled three times per week at 3/4-inch height using a reel mower. Also presently under way at the same site is the 1997 national bermudagrass test, which includes 20 seeded and 10 vegetative cultivars. From these two trials and from previous tests that were conducted cooperatively with other agencies, these researchers have developed significant insights into seeded bermudagrasses.

Tifway for comparison

Tifway, a hybrid of *Cynodon dactylon* and *C. transvaalensis*, is the most widely used bermudagrass cultivar on fairways and tees. It's a sterile vegetative cultivar that produces high-density, fine-textured, wear-resistant turf. The goal of breeders is to achieve the performance of Tifway with a seeded bermudagrass cultivar. The Mississippi State evaluations of seeded cultivars have included plots of vegetatively planted Tifway for comparison. In each experiment, they used the format for rating adapted by the National Tzgrass Evaluation Program, including the randomized complete block design with three replications of each cultivar.

Seedling Vigor

Seedling vigor ratings include germination and seedling growth. In three years of seeding (1995-1997) this feature was evaluated two to three weeks after seeding and prior to the first mowing. Due to their rapid upright growth, Arizona Common, NuMex Sahara and Bluemuda displayed high seedling vigor in each planting. However, after mowing was initiated, these cultivars were ranked near the bottom in turf performance ratings. Low-growing cultivars, including Princess, Sundance, Savannah (4), and PST-R6YC, displayed lower seedling vigor but higher performance after initiation of mowing. Seeded bermudagrass has been well known for easy establishment because of rapid germination and growth. Compared with other warm-season species, none of the cultivars evaluated had unacceptable seedling vigor.

Turf Quality

Turf quality ratings are the most used tool for evaluating turfgrasses. In this evaluation of bermudagrasses several components were considered in arriving at quality scores. These components were uniformity, density, leaf texture, color and the presence or absence of seedheads. Quality ratings were made twice monthly during each growing season.

The seeded cultivars that maintained the highest quality scores included Princess, Sundance and Savannah. Most cultivars achieved quality that was significantly higher than Arizona Common, including NuMex Sahara.

Princess, Sundance, Savannah, Sultan, Sunstar, Del Sol, ED1, Mirage, Sundevil II, MD2, Sonesta, PST-R69C, SWI-11, J-1224, J-540 and OKS 95-1 all displayed significantly higher turf quality than NuMex Sahara for at least one growing season in one or more experiments. None of the seeded cultivars achieved the turf quality of Tifway.

Several other recently published field trials rate Princess, Sundance, Savannah, SWI-11, and Panama among the top performers in over-all turf quality

Leaf Texture

Leaf texture (blade width) and turf density have improved more than any other aspect of turf quality as a result of breeders' work with seeded bermudagrass. These traits are usually linked - the finer the leaf blades, the higher the turf density. In the Mississippi State evaluations, Princess, Sundance and Savannah displayed the finest leaf texture among seeded cultivars. Sultan, Sundevil II, Del Sol, Sunstar and Mirage were also significantly finer than NuMex Sahara and Arizona Common. Tifway was significantly finer than any seeded cultivar. Guymon bermudagrass had the coarsest leaf texture in these experiments, followed by ED5.

Turf Density
Seeded cultivars receiving the highest density ratings (number of shoots per unit area) were Princess, Sundance and Savannah. Other cultivars with significantly higher density than NuMex Sahara included Sultan, Sunstar, Sundevil II, Mirage and ED1. Density of Tifway was significantly greater than any seeded cultivars.

Color
No great differences were observed in genetic color among seeded bermudagrass cultivars. Most differences among plots on any date of ratings could be attributed to injury or defoliation. Cultivars that grow more upright, such as Arizona Common, have a greater tendency to scalp, which affects color. When comparing healthy leaves, differences among seeded cultivars appear to be subtle and all are different from the color of Tifway.

Rhizome Density
Bermudagrasses have stolons (aboveground stems) and rhizomes (belowground). Rhizomes can aid in recovery when the turf surface is removed or injured. Rhizomes contribute to winter survival and sod strength.

To evaluate the quantity of rhizomes in each cultivar, plugs of rhizome stem material were dried and weighed. The rhizome density was calculated by dividing the dry weights by the volume of the sample. The results showed that rhizome density enhanced winter survival but did not always correlate with shoot density. Guymon, for example, received the lowest turf-density rating, but ranked consistently highest among seeded cultivars in rhizome density. Princess, one of the denser cultivars, had few rhizomes on some dates of measurement. Other cultivars with high rhizome density were Sundance and ED1. Most cultivars were not significantly different from Arizona Common. Tifway produced more rhizomes than any seeded cultivar.

Spring Green-up
Spring green-up of bermudagrass should not be confused with winter survival. The spring green-up rating was applied in years when temperatures had been mild and there was no significant winterkill. These results would therefore apply more to conditions that we experience here in Hawaii.

Spring green-up indicates the rate at which the cultivars break winter dormancy and begin spring growth. In the test that was seeded in 1996, all plots survived the two winters that followed, but cultivars responded differently to the two different winters. In 1997, Guymon displayed the earliest green-up, while Tifway and Arizona Common ranked among the latest. In 1998, Tifway was early, while Guymon ranked among the latest, with Arizona Common. Savannah displayed improved spring green-up over NuMex Sahara and Arizona Common in both years of rating. Several years of evaluation are needed to properly rank the spring green-up of these cultivars.

Availability
Seed production is often traded away as breeders strive to improve the turf qualities of cultivars. That means it is often hardest to obtain seed for the best grasses. The Mississippi State researchers contacted the sources of the top three seeded bermudagrasses Princess, Sundance and Savannah and found that the initial seed production of Princess (Seeds West Inc.) was low and the seed was not widely available in 1998. Better availability is expected in 1999. Seed yield of Sundance (Lesco) has been unacceptable. Sundance II has been selected for improved seed yield. Evaluation of Sundance II's turf quality will begin in 1999. Supply of Savannah (Turf-Seed, Inc.) is now available for purchase in adequate supply.

Summary on Seeded Bermudagrass
New seeded bermudagrass cultivars offer improvements in turf density, leaf texture and turf quality. Lower and more prostrate growth habit enables these new cultivars to perform at lower mowing heights than Arizona Common. Late seeding combined with low mowing height may result in poor winter survival in cooler locations during the establishment year. Although most of the top turf performers have not yet produced enough seed to meet demand, the future looks bright for seeded bermudagrass. And although seeded cultivars have not met the performance of Tifway, this goal is much nearer than it was just a decade ago.

Turf Evaluations for Seeded Zoysiagrass
There have been significant improvements in seeded zoysiagrass cultivars during the past five or six years. Many of these improved cultivars are selections from 'Meyer' zoysia, an improved strain of *Z. japonica*, which until recently has only been propagated vegetatively. The most recent data I could find on zoysiagrass field trials is the 1997 variety list of the National Turfgrass Evaluation Program (NTEP).

'Meyer' and 'Emerald' for Comparison
The 1997 NTEP zoysiagrass evaluation involved 11 vegetative varieties, including 'Meyer' and 'Emerald',

hybrids of *Z. japonica* and *Z. tenuifolia.* Both of these hybrids are widely utilized in the industry and are used as a standard for comparison to the seeded cultivars in this report. The study also included the following 9 seeded cultivars: J-37, J-36, J-14, Chinese common, Zenith, Zen-500, Zen-400, Z-18, and Korean common.

Establishment Rate

Zoysiagrass hybrids must be propagated vegetatively and are very slow to establish. The main advantage of the seeded cultivars is in the drastically shorter time to reach100% cover. Except for Korean common, all of the seeded zoysia cultivars tested were significantly faster to establish than 'Meyer' and 'Emerald', or any of the other hybrids for that matter. J-37, J-36 and Chinese common were roughly 3 1/2 times faster than 'Meyer' or 'Emerald' and the others were about 2 1/2 times faster. Korean common was the same as 'Meyer' and 'Emerald'.

Turf Quality

The components used to determine turf quality in zoysiagrass are essentially the same as those used for bermudagrass. When compared to 'Meyer' all seeded cultivars except Z-18 and Korean common ranked significantly higher. J-37 also ranked significantly higher than 'Emerald', while Zenith, Zen-400, J-36, and Chinese common were not significantly different from 'Emerald'. In addition, the ranking for J-37 was not significantly different from that of the hybrid 'El Toro', which received the highest quality ranking of all those tested. Over all, the new seeded zoysiagrasses compare quite well to the hybrids in turf quality

Leaf Texture

Seeded zoysia cultivars do not show the impressive improvements in leaf texture and turf density, as do the seeded bermudagrasses. All seeded zoysia cultivars have very significantly lower leaf texture ratings than 'Emerald', and only Z-18 has a leaf texture significantly higher than 'Meyer', which is considered to have a medium leaf texture. Interestingly, most of the zoysiagrasses that have a high turf quality rating also have a low leaf texture rating. The hybrid 'El Toro' and seeded J-37 have the highest turf quality ratings of those tested and both are also at the bottom of the leaf texture rating. This is probably related to the tendency of the finer bladed zoysiagrasses to scalp easily when mowed.

Turf Density

All of the seeded zoysia cultivars tested have very significantly lower turf densities than 'Emerald'. Zen-400 is the only seeded cultivar with a turf density not significantly lower than 'Meyer'. Generally, all of the seeded cultivars have a lower turf density than any of the hybrid zoysiagrasses tested. The seeded cultivars with the lowest turf density are Z-18 and Korean common.

Color

As a group, the seeded zoysias ranked higher than the hybrids in genetic color (dark green is the highest rating). The two hybrids 'Meyer' and 'El Toro' had the highest ranking but not significantly better than seeded Zenith. All of the other seeded cultivars except Z-18 ranked higher in color than 'Emerald' as well as the rest of the hybrids tested

Turf quality as affected by mowing height

The recommended mowing height for most if not all zoysiagrasses is 1 inch or below. Many types of zoysia get puffy, develop a thick thatch, and scalp easily at mowing heights above 1 inch. It is therefore important to compare the quality of the turf at increasing mowing heights. All of the seeded cultivars tested have higher turf quality ratings at a mowing height of 0.5 to 1.0 inch, as compared to a height of above 1.1 inches. On the other hand, the hybrid zoysiagrasses all have a much lower turf quality rating at mowing heights of 0.5 to 1.0 inch, as compared to above 1.1 inches.

Turf quality as Affected by Water Stress

Resistance to drought and acceptable turf appearance under water stress conditions are very important qualities of a superior turfgrass. In the 1997 NTEP trials, the new seeded zoysia cultivars performed much better than the hybrids under moderate and severe water stress. All of the seeded cultivars had significantly higher turf quality ratings under moderate to severe water stress as compared to watering conditions that would prevent stress. The best seeded performer was Zenith, with a turf quality rating of 6.7 under severe water stress as compared to 4.8 under adequate water conditions. All of the hybrids had very significantly lower turf quality ratings under severe water stress. For example, 'Emerald' had a 5.8 rating under adequate water conditions and 4.2 under severe water stress.

Availability of Seeded Zoysia Cultivars

Seed production for many of the new zoysia cultivars is very limited. The J37, J36, and J14 cultivars were not

available in the U.S. as of late 1998. Development of new cultivars and availability of seed should increase rapidly in the next several years.

Summary of seeded zoysia cultivars

The new seeded zoysiagrass cultivars give promise that these species will soon have many improved seeded cultivars. The 1997 NTEP trials on several new zoysia cultivars show improvements in turf quality, establishment rate, color, performance under water stress, and turf appearance at low mowing heights. Some of the seeded cultivars have already surpassed the more established hybrids in several of these categories, giving definite hope for future success in the development of seeded zoysiagrass cultivars

Seed companies that provided materials for the 1997 zoysiagrass NTEP trials:

Zen 300, Zen 400, Zen 500	Fine Lawn Research Inc
J37, J36, J14	Jacklin Seed Company
Zenith	Zenith Patten Seed Co.
Others providing seed	Seed Research of Oregon Tomen Corp./Japan

How Low Can You Mow?

Thomas L. Watschke
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A traditional method of grouping turfgrass species has been according to their recommended height of cut. However, as new cultivars of almost every species enter the marketplace, it now has become virtually impossoble to make general recommendations concerning mowing height. Cultivars within species can now be seperated into groups with regard to mowing height, which was unheard of not too long ago.

Breeders have developed and released creeping bentgrasses specifically for their capacity to tolerate close mowing; Kentucky bluegrasses for their ability to persist under closely mowed golf-course-fairway conditions; and dwarf tall fescues tolerant of closer mowing than KY-31, the ancestor of contemporary cultivars. Cultivar development within other species has undergone similar change.

What does this mean to turfgrass managers as they make adjustments to their cultural programs? Do we really have the same need to manipulate cutting height in response to environment conditions as we did in the past? The answers to these questions may not be as simple as we would like. It is, therefore, important to review the classical responses that turfgrass plants have to height of cut.

Mowing Height Affects Turfgrass Health

Every turfgrass species (and often cultivars within species) has a range of cutting heights within which it remains most competitive. This competitiveness is due to the turfs ability to occupy available space, access water and nutrients, intercept light, resist disease and insects and maintain vigor. Lower heights of cut within the tolerance range minimize apical dominance, so the plant increases its basal-tillering rate. Increased basal tillering results in increased density, which improves the turfgrass plant's ability to occupy space.

However, with lowered height of cut, the amount of available leaf-blade surface for photosynthesis is less, and the root mass usually decreases. These negative responses can limit the plant's ability to tolerate mechanical and environmental stresses such as wear, heat and drought. Reduced root mass also limits the available pool of nutrients that the grass plant can exploit.

The reduction in photosynthetic area also creates problems for the plant with regard to carbohydrate metabolism. Because the available leaf area for photosyn-

thesis is lower, the plant must rely on stored food reserves for some of its regowth. As the plant depletes stored food reserves, growth, vigor and competitiveness decrease. Consequently, turf managers must increase maintenance intensity to provide an "assist" to the plant: more frequent irrigation, some foliar nutrition and more emphasis on disease management. When height of cut becomes so low that the maintenance intensity no longer can sustain the resulting aesthetic value and improved playability, the only wise course of action is to raise the height of cut.

Even a small increase in height of cut can provide significant benefits. Considering the total number of leaf blades in a given area, even a millimeter more of length for each blade can significantly increase total leaf area and the photosynthetic capacity of the sward. By increasing photosynthesis, the plant can produce more carbohydrates, allowing it to more effectively accommodate growth needs without utilizing stored food reserves. More leaf-blade tissue also results in denser shading of the soil, thus reducing heating of the root zone. Reduced soil heating reduces root sloughing as well as the severity of root diseases. Increasing the amount of leaf-blade tissue in the canopy also improves resistance to the mechanical stresses of mowing and traffic.

You'll often notice the first evidence of problems related to low mowing height on putting greens during the cleanup pass on the perimeter. This area of stressed, closely mowed turf has a much more difficult time maintaining high quality in contrast to the adjacent higher cut turf in the collar (which often consists of the same species or mix). I cannot think of a more "clear-cut" example of the benefits of a higher height of cut. Such an example can be useful to superintendents when they are asked to explain the benefits of a higher height of cut.

The New Generation of Turfgrasses

As I stated earlier, breeders have placed considerable emphasis on the development and release of new cultivars that tolerate a lower range of mowing heights. Turfgrass breeders have been able to accomplish these advances with a variety of methods. Skillful selection of plants that have evolved over decades of exposure to close mowing has resulted in varieties with enhanced close-mowing tolerance. These ecotypes tend to have:

- The capacity to maintain a deeper root system than less-adapted types
- The capacity to produce basal tillers at reduced heights, allowing for sustained competitiveness
- More horizontal leaf-blade growth (exceptions exist)
- Less leaf area removed during each mowing (due to horizontal leaf-blade habit), which lessens the usual negative impact on photosynthesis.

Additionally, new technology (the identification and manipulation of genes for close-mowing tolerance) has provided the genetic-engineering tool for the development of more turfgrasses that tolerate close mowing.

Because the range of recommended heights of cut also has an upper limit, it is important to understand that phenomenon as well. Generally, when you mow turf at a height taller than its recommended range, its overall density decreases. Apical dominance becomes more of a factor as the stimulus for basal tillering lessens. Without vigorous basal tillering, the turf becomes less competitive, weeds more easily encroach and chemical control may become necessary. Additionally, reduced density may compromise the playability of the turf to the extent that it is unacceptable. Therefore, advice touting the benefits of higher-cut turf only applies up to a point. Turf cut above its tolerance range also can result in puffiness, something you often see with creeping bentgrass or bermudagrass cut higher than 0.625 inch. This puffy condition creates mowing problems (increased scalping) and also reduces playability, particularly on golf-course fairways.

New cultivars have clouded the issue of mowing height in most species. However, I'm sure that as we move into the next century, research will allow us to better understand the cultural needs of this new group of turfgrasses. It would be useful for each cultivar to have its own ranking of mowing-height tolerances.

Perhaps the new cultivars can reduce the necessary maintenance intensity of those practices we traditionally think of as being critical. Currently, our knowledge base is limited with regard to the imposition of close mowing and the resulting morphological and physiological responses of the new generation of cultivars. Do they maintain their photosynthetic capacity? Do they continue to produce adequate basal tillers? Do they continue to produce adequate roots? Do they have good resistance to mechanical and environmental stresses? Do they tolerate disease and insect attacks well enough? The answers to these questions are slowly becoming known as a result of field evaluations at universities and in the private sector. For example, the National Turfgrass Evaluation Program (NTEP) continues to provide significant performance-evaluation data. However, we critically need more basic research to provide a better un-

derstanding of the responses these new cultivars have to cultural inputs and practices, including close mowing.

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Preliminary PGR Studies on Various Container-Grown Groundcovers

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Several studies have been conducted on the effects of growth regulators on ornamental plants, but little information is available on their use on landscape groundcovers. Synthetic growth regulators significantly reduced the growth of a number of woody landscape species in containers.

Flurprimidol decreased the growth of *Abelia grandiflora*, *Cotoneaster dammeri*, *Gardenia jasminoides*, *Nandina sp.*, *Ilex crenata* and *Photinia* x *fraseri*. Dikegulac reduced growth of *Abelia grandiflora*, *Cotoneaster dammeri* and *Euonymus kiautschovicus*. Spray and drench applications of Uniconazole suppressed growth of *Berberis thunbergia* 'Atropurpurea', *Lagerstroemia indica* 'Natchez', and a number of Rhododendrons. *Epipremnum aureum* was more marketable with uniconazole treatment. Paclobutrazol controlled the growth of *Codiaeum variegatum* 'Karen' and *Syngonium podophyllum* 'White Butterfly'. Paclobutrazol and Uniconazole have also reduced growth on a number of bedding plants such as *Begonia semperflorens*, *Catharanthus roseus*, *Impatiens sultani*, *Zinnia elegans*, *Salvia splendens*, *Petunia hybrida* and *Tagetes erecta*. Cimectacarb also caused growth suppression, but the effect was species dependent. On turfgrass, Cimectacarb eliminated the need for three mowings of tall fescue without effecting the quality of the turf.

We established two replicated studies to evaluate materials for degree and length of growth regulation, phytotoxicity, and to compare application methods of several growth regulators on containerized groundcovers commonly grown in Hawaii.

In the first study rooted cuttings of *Myoporum* spp. 'South Coast', *Myoporum* spp. 'Davis' and *Evolvulus glomeratus* (Blue Daze) were planted in one-quart pots with 2:2:1 peat : perlite : soil media amended with slow-release fertilizer. All plants were cut to 15 cm on October 29, and treated with growth regulators on November 18.

Flurprimidol 50W, Paclobutrazol SC, and Uniconazole 500 were applied as a drench with 20ml of water per pot at label recommendations (low) and three times label rates (high) of various growth regulators. Controls were not treated. Growth regulators were applied. Height was measured every two weeks for twelve weeks. Irrigation was applied daily through overhead sprinklers. Plants were fertilized periodically during the study.

In the second study, low and high rates of Cimectacarb, Dikegulac, Flurprimidol, Paclobutrazol, and Uniconazole, were applied as a spray or drench to two varieties of *Cuphea hyssopifolia* (one with red stems; one with green stems), *Evolvulus glomeratus*, *Liriope muscari* 'Variegata' *Wedelia trilobata*. Controls were not treated.

Results

In the first study, *Myoporum* species 'South Coast' showed no significant differences between treatments until eleven weeks after treatment. Only Flurprimidol at the high rate had any significant growth reduction. Paclobutrazol (high rate) and Flurprimidol (low rate) treatments also suppressed growth at eight weeks after treatment. No phytotoxicity was noted for any of the treatments.

Flurprimidol and Paclobutrazol showed some reduction in growth within three weeks after treatment. The low rate of Flurprimidol and the high rate of Paclobutrazol did not significantly reduce growth until eleven weeks after treatment. Neither Uniconazole treatment had any significant growth reduction.

The high rate of Paclobutrazol significantly reduced growth of *Evolvulus glomeratus* beginning two weeks

after treatment until the end of the study. Flurprimidol and low rates of Paclobutrazol significantly reduced growth starting eight weeks after treatment, although. Uniconazole treatments had no significant growth reduction.

Some necrosis of the leaf margins of *Evolvulus glomeratus* resulted from high rates of Flurprimidol and Paclobutrazol. Damage would not detract from plant quality.

In the second study, all treatments significantly reduced growth of the green stemmed *Cuphea hyssopifolia* throughout the study. Flurprimidol drench treatments had no growth for six weeks. Flurprimidol spray treatments caused some necrosis of the leaf margins. Damage was obvious within two weeks after treatment and lasted for two months. Paclobutrazol and Flurprimidol drenches resulted in unacceptable leaf drop and distortion, especially at high rates. Dikegulac treatments caused a noticeable increase in flowering of *Cuphea hyssopifolia*.

All treatments significantly controlled growth the red stemmed variety of *Cuphea hyssopifolia*. Dikegulac treatments slowed growth for the first twelve weeks after treatment. Low rates of uniconazole showed significant growth reduction beginning twelve weeks after treatment and lasted for two weeks. Drench treatments caused some greater growth reduction over spray treatments.

Flurprimidol and Paclobutrazol treatments resulted in leaf burn and drop and damage was greater at higher rates. The plants were not market acceptable. New leaf growth was small and distorted.

Differences Among Growth Regulator Treatments

Evolvulus glomeratus were significant throughout the study. Flurprimidol and Paclobutrazol drench treatments reduced growth beginning three weeks after treatment until the end of the study. All other treatments, with the exception of Paclobutrazol sprayed at low rates, showed significant growth reduction beginning seven weeks after treatment. Reduced growth by all Dikegulac treatments, and high spray treatments of Uniconazole lasted for five weeks. The other Uniconazole treatments lasted until the end of the study. Paclobutrazol at the low spray rates did not control growth until nine weeks after treatment and lasted for three weeks. Drench treatments had lower average growth than spray treatments, but the differences were not statistically insignificant.

High rates of Flurprimidol and Paclobutrazol applications, and low drench rates of Paclobutrazol caused foliage damage to *Evolvulus glomeratus*. Leaf burn and severe stunting showed within two weeks after treatment and lasted through the study. Uniconazole treatments caused some decrease in quality, but at levels that would be acceptable in the landscape.

Flurprimidol treatments caused the greatest reduction in growth for *Liriope muscari*, limiting plant height to 37% of the control by the end of the study. Phytotoxicity was caused by high rates of Paclobutrazol and Uniconazole. Chlorotic blades and distortion showed seven weeks after treatment .

All Cimectacarb, Flurprimidol, and Paclobutrazol treatments significantly controlled growth of *Wedelia trilobata* within three weeks after treatment and lasted until the end of the study. Dikegulac spray treatments controlled growth beginning three weeks after treatment and lasted for two weeks at the low rates and five weeks at the high rates. Uniconazole drenches at the high rate controlled growth after five weeks and lasted for three weeks.

At the end of the study, average height of *Wedelia trilobata* as a percent of control was 26% and 33% for Flurprimidol spray drench treatments at the high rates, 30% for Paclobutrazol drench at the low rate, and 35% for Cimectacarb at the high. There was no significant difference between spray and drench treatments although heights for drench treatments were generally less than those of the spray treatments.

Flurprimidol treatments at the high rate caused some phytotoxicity to *Wedelia trilobata* for the first four weeks of the study. Damage was at a level acceptable in the landscape and was grown out by six weeks after treatment. Paclobutrazol drench treatments showed severe leaf and stem tip burning and severe stunting throughout the study.

These preliminary studies showed that rates used in published studies, as well as label rates were a good starting point for further work. All rates exhibited some growth reduction on all species tested, although not always statistically significant. In the first study paclobutrazol and Flurprimidol reduced growth more than Uniconazole, indicating that rates needed to be higher for Uniconazole. Increased rates for paclobutrazol and Flurprimidol were also needed due to the long delays for growth reduction to occur, especially in the two *Myoporum* species. This study also showed that the effects of the growth regulators are species dependent for Paclobutrazol and Flurprimidol. *Evolvulus glomeratus* was more affected in terms of growth reduction phytotoxicity than the two *Myoporum* species. This may be due to it being less woody that the other two.

In the second study, Paclobutrazol and Flurprimidol had the greatest affect on growth reduction, although high rates caused phytotoxic damage to all species tested, some severely. Drench treatments generally caused more growth reduction than spray treatments.

This article is a portion of a Thesis submitted by Pam Paulsen in partial fulfillment for the degree of M.S. in Horticultural Science, Univ of Hawaii, 1999.

Additional work with growth regulators on ground covers will appear in later newsletters.

Noni Black Flag— A New Fungal Disease of Hawaiian Noni

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A new and relatively severe foliar blight disease of noni (*Morinda citrifolia L.)* was discovered on the Big Island of Hawaii in January,1999. The disease has been named "noni black flag" and is caused by a fungus, *Phytophthora botryosa*. This fungus has never been reported to occur on noni anywhere in the world, and has never been known to occur previously in the Hawaiian Islands.

Disease symptoms. The most striking symptoms of noni black flag include a wilting, collapse and blackening of all soft foliar tissue (leaves, petioles, stems) and a progressive soft, watery rot of fruit. For severely affected noni plants, virtually all of the seasonal, succulent growth may turn an inky black color. The blackened leaves tend to remain attached to the branches, but hang limply from the woody skeleton of the noni plant like so many "black flags." Leaves often have black veins prior to their collapse.

Disease development. Noni black flag often begins on developing flowers and fruit, although noni leaves are also susceptible to infection. The infection occurs through flowers and natural openings and wounds on noni fruit surfaces or leaves. The fruit rot often is first seen at the base of the noni fruit, close to where the fruit attaches to the stem. A watery soft rot of noni fruit develops soon after infection. This watery soft rot may expand to include the entire fruit before it can ripen. As the fungus grows from the fruit into the adjacent petiole, a typical black rot of the green tissue appears, which progresses to include all green (non-woody) petiole and stem tissue. Once inside the leaf petioles, *P. botryosa* rapidly infects the leaf veins, turning them and subsequently the entire leaf an inky black color. Dried, necrotic foliar tissue can later assume a parched, brown color as it dries out.

Several months after losing all existing green tissue, noni plants can recover by re-sprouting new growth from intact stems below the old blighted area. The new foliar growth is from unaffected woody stem tissue just below the withered, fleshy region of the stem destroyed by the blight. Apparently, the fungus is unable to penetrate and colonize woody stem tissues of the noni plant. However, the recovering growth may also become diseased as it emerges up through the old diseased black flags hanging around it. Apparently, the disease is not fatal to mature noni trees, but it is likely that young seedlings may be destroyed under the proper conditions.

Environmental conditions that favor infection of noni trees and subsequent disease development include rainy weather and high relative humidity. The disease is spread by winds and splashing rain.

The black flag pathogen, *Phytopthora botryosa* also causes leaf fall and pod rot of rubber trees in Asia. The pathogen was first observed and described from leaf petioles of the rubber tree in Malaysia and Thailand (a disease known as green pod decay). The fungus also causes pod rot of cocoa and was reported to infect taro in China.

The primary infective and dispersal stage of *P. botryosa* is the zoospore. Zoospores are small spores equipped with whip-like appendages that allow them to be self-propelled in water. When free water exists on a diseased plant surface (leaf or fruit), *P. botryosa* releases numerous zoospores that swim off to attach to a healthy section of leaf or fruit tissue to start a new infection. The fungus penetrates the host by forming germ tubes and hyphae from the zoospores. The hyphae reach deep into the plant tissues, destroying plant cells with enzymes and withdrawing their nutrients. Plant tissues are most easily invaded and colonized when weather conditions are wet and humid. Spores are produced on necrotic tissue when conditions permit (wet and humid). Spore production diminishes greatly during very hot, dry weather. The fungus may survive periods of dry weather by colonizing leaf litter or plant (fruit) debris, and as virtually dormant infections within noni stems that flare up into active infections when wet weather returns.

Disease distribution. Noni black flag apparently is limited to a small coastal area in the Puna District of the

Island of Hawaii. The disease was discovered adjacent to state highway 137 at a small noni farm near Opihikao and in the adjacent forest. The natural occurrence of the disease is limited primarily to humid, shaded, forested or sheltered areas along the highway and inland in the forests in that area.

Disease management. Currently, there are no fungicides approved for use on noni in Hawaii, so disease control is accomplished by the following cultural methods:

a) Sanitation. Incidence and severity of noni black flag may be minimized through sanitation. Diseased stems and branches should be pruned back, below the advance of the symptoms. The pruned material should be destroyed or discarded immediately, at a distance from all noni plants. Pruning shears should be dipped in disinfesting solution (e.g. 10% bleach or ethanol) between cuts.

b) Management of moisture and humidity levels. Promote good air circulation in the plant canopy to ensure rapid drying of leaves. This can be accomplished by selecting wider plant spacing or by pruning to open up the canopy. Control weeds to reduce relative humidity in the noni canopy and around noni plants. Ensuring adequate soil drainage will also reduce humidity levels.

c) Cropping systems. Avoid inter-cropping noni with other plants that are known to be susceptible to *P. botryosa* (i.e. taro, rubber, cocoa).

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New Legislation May Force Greater Use of IPM in Nursery Industry

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As the safety and efficacy of pesticides are called into question, the nursery industry has become interested in finding nontraditional approaches to controlling plant pests. There is a growing concern about the potential danger from exposure to pesticides, as well as a realization that some pest species have built up a resistance to certain pesticides. While some nursery professionals opt to exclusively use traditional pesticides, others are looking into integrated pest management (IPM) strategies. Soon, however, all nursery professionals may be practicing IPM because of the Food Quality Protection Act (FQPA), which was signed into law in 1996. As a result of this legislation, the FQPA is trying to reduce exposure to some of our most readily available and useful pesticides. Two classes of pesticides at the front of this effort are organophosphates, which include chlorpyrifos (Dursban) and malathion, and carbamates, such as carbaryl (Sevin). Both classes of pesticides are commonly used in the nursery industry.

Even though the FQPA focuses on pesticide residues on food, it also mandates the establishment of aggregate and cumulative risk assessments for pesticides that are used in the nursery industry. Aggregate risk assessments consider the risk from all routes of exposure for a single pesticide. Cumulative risk assessments consider the combined risk from all pesticides that have a common mechanism of toxicity. As a result of the increased regulations, pesticide users may want to investigate alternatives to traditional materials.

There are several IPM techniques used in the nursery industry, and the number of alternatives available allows nursery professionals an opportunity to find the method that works best for them. This article will focus on microbial insecticides, insecticidal soaps, horticultural spray oils, botanicals, and traps and attractants. Many insecticides in these classes generally have a short residual life, a relatively low acute toxicity to mammals and are readily biodegradable. However, toxicity, effectiveness, range of activity and persistence vary considerably among them. Properties of any potential pesticide should be carefully considered relative to their interaction with the pest to be controlled as well as nontarget organisms. Of course, label directions should be followed explicitly.

Before using any insecticide, it is important to identify the problem and consider other means of control. Sound plant health management and an integrated approach to pest management is highly advisable. Following appropriate cultural practices, planting adapted varieties and maintaining vigor through appropriate fertilization should minimize plant pests, but occasionally some additional help may be needed.

IPM Techniques: The Application of IPM Tools Can Improve the Effectiveness of Pest Management

Microbial insecticides are composed of microscopic living organisms, or the toxins produced by them. The advantages to using microbials include their specific toxicity and their compatibility with synthetic pesticides. Microbials also typically have no restricted entry or preharvest intervals and, in some cases, they may actually become established in the local environment. The disadvantages include a lack of control of other pests, and possible susceptibility to heat, desiccation and ultraviolet light degradation. Some microbials may be prohibited or restricted in Hawaii, or hard to get and expensive.

There are several microbial insecticides available from different sources. Viruses, which include the nuclear polyhedrosis viruses (NPV) and granulosis viruses, are developed and used by the US Forest Service as microbials. NPVs have been used against gypsy moth. Bacteria in the genus *Bacillus* can be used as microbials. The most common microbial in the genus is *B. thuringiensis* (Bt), which produces an endotoxin that kills certain insects by disrupting the gut wall, resulting in blood poisoning. *Bt* products are labeled for a variety of pests, including bagworms and tent caterpillars. They are generally effective against most caterpillar-type pests. Fungi, such as *Beauveria bassiana* and *Lagenidium giganreum*, typically kill insects by entering their bodies and producing toxins. Protozoans, such as *Nosema locustae*, often reduce the reproductive capabilities of their hosts, which include grasshoppers. Nematodes, such as *Steinernema carpocapsae* and *Heterorhabditis heliothidis*, are roundworms that penetrate insects' bodies and kill by infecting them with symbiotic bacteria. Nematode products are labeled for a variety of soil dwelling and boring pests. Finally, avermectins, including the toxins ivermectin and abamectin produced by *Streptomyres nvermitilis*, are toxic to a wide variety of insects and pathogenic nematodes.

Insecticidal soaps used in IPM programs are potassium salts of fatty acids. Certain types of fatty acids, such as oleic acid, have greater insecticidal activity than others. Therefore, the common insecticidal soaps now commercially available contain potassium oleate, the potassium salt of oleic acid, as the active ingredient.

Insecticidal soaps can be very helpful especially in home situations where repeat applications are possible, because soaps have almost no residual activity. Soaps are also useful in retail nurseries, because plants can be handled after treatment without worry. Soaps act by disrupting the insect cuticle or skin and interfering with basic metabolic processes resulting in death. Soaps are most effective against soft-bodied insects such as scales, aphids, whiteflies, mealybugs and leafhoppers, but are ineffective against large, thick-skinned insects. While soaps are very low in toxicity to mammals, including humans, they are potentially phytotoxic.

Because they are contact insecticides, the timing of applications is critical. Two applications of good coverage separated by seven to ten days are necessary to ensure all stages of an infesting population are controlled, particularly when managing whiteflies and mealybugs. Sprays should be applied to the leaf underside where insects are feeding.

Research has shown that liquid soaps are more effective than detergents. Some soaps are incompatible with hard water and the applied water will need conditioning to reduce buildup of insoluble salts in spray nozzles. Many commercial products contain the appropriate conditioning agents.

Horticultural spray oils, another tool used in IPM, have been used for many years and are quite effective against scales and certain fruit tree insects. These materials are distillations of petroleum, although cottonseed and other plant-derived oils are becoming more popular. Horticultural spray oil is effective against insects and mites because the low surface tension of oils allows them to flow into insects' breathing pores and cause suffocation, or causes cell membrane destruction of the pests that it contacts, as well as their eggs. Because of this mode of action, coverage is very important. Once dry, these materials have been shown to have little effect on beneficial insects. There are several advantages to oils, including their effectiveness against a variety of pests who have shown little or no resistance to them, are usually less harmful to beneficials, easy and safe to use, and inexpensive. Disadvantages include the potential for phytotoxicity and the need for direct contact with the pest.

When choosing a horticultural spray oil, nursery professionals should concentrate on the oil's viscosity, paraffinicity, unsulfonated-residue (UR) ratings and dis-

tillation range. Light- weight, paraffin-based oils with UR ratings of at least 92 percent and narrow distillation ranges are the best choice. Lighter, less viscous oils are composed of shorter-chain hydrocarbons and are less likely to injure plants.

Horticultural spray oils are used for pest control during plant dormancy as well as during the growing season, primarily due to the development of highly refined narrow-range oils and new application techniques. Most oils are combined with emulsifiers and other inert ingredients to enhance mixing with water. Adding an insecticide such as diazinon often increases effectiveness. Summer oils can be used for scale insects in Hawaii as both dormant and in-season sprays. Timing should coincide with crawler emergence for maximum effectiveness during the season.

Phytotoxicity has often been associated with the use of oils. However, with advanced refining technology, lighter oils with few impurities are available that minimize the potential damage. The potential for phytotoxicity is also influenced by temperature and plant water status. Therefore, oils should not be used when temperatures are over 85C, or under conditions of plant stress.

Botanical insecticides are an expanding class of chemicals derived from plant materials. They can include ground-up plant parts, flowers, leaves, stems and roots, that may be used directly or after some refinement of their extracts. Botanicals have a variety of modes of action ranging from nerve toxins to insect growth regulation. Some of the advantages to using botanicals are their relatively rapid degradation rate that leaves few residues, rapid action on the pest, generally low mammalian toxicity, selectivity against certain types of pests and low toxicity to plants. The rapid degradation rate of botanicals is also a disadvantage because it can result in poor long-term control. Other disadvantages include the high toxicity level of certain types, and high costs and reduced availability.

Common botanicals, in order of importance, include pyrethrum, rotenone, neem, nicotine sulfate, sabadilla, ryania and quassia. These materials have value for insect management, particularly when we are interested in alternatives with short residuals and low mammalian toxicity. By increasing our understanding of the chemical and insect we will be able to use these materials more effectively.

Pyrethrum is derived from *Chrysanthemum cinerariaefolium* (pyrethum daisy) and is a mixture of four closely related compounds, the pyrethrins. The flowers and extracts are imported from Africa and South America. **Pyrethrins** are noted for rapid knockdown of flying insects and for a broad range of activity. Pyrethrins biodegrade rapidly, especially in sunlight, and are low in toxicity to mammals. These compounds are sometimes mixed with other compounds to increase activity. Many synthetic pyrethrins, called **pyrethroids**, have been developed, including fluvalinate (trade name Mavrik). These synthetic compounds are based on the chemical structure and mode of action of the natural pyrethrins. Pyrethrin-containing products are labeled for aphids, Japanese beetle, and other plant bugs.

Pyrethroids are usually greater in toxicity and more persistent than the natural products. Pyrethroids have a broad range of activity, and their use, particularly in dry climates, may trigger spider mite flare-ups. These observed flare-ups have been attributed to significant reductions in mite predators and a change in the mite physiology.

Pyrethrins, with their shorter residual activity, are more selective than pyrethroids. Pyrethrins can be used on a broad range of insects, including whiteflies and caterpillars. However, against mites and some aphid species, pyrethrins are often ineffective. They are active as a contact insecticide, and applications should therefore be directed at the pest.

Other botanicals include **rotenone**, also known as derris, which is derived from the roots of *Lonchocarpus* (lancepod) species in South America and several other plants in the legume family. One of these plants is known as *cube* in South America and from this name we may read on a package, "contains rotenone and other cube resins."

Rotenone is a contact and stomach poison that inhibits the use of oxygen by body cells and tissues. It is a slow-acting material causing insects to stop feeding soon after contact or ingestion. When using rotenone, buffering may be necessary due to its inactivity in an alkaline solution. It is readily biodegradable in sunlight and air and does not leave toxic residues. It is low in toxicity to mammals but very toxic to fish. In fact, this material is used as a means of reclaiming lakes and streams for game fishing by removing unwanted species.

Applications of rotenone are useful against chewing insects, specifically for control of worm and thrips species. Sprays should be timed to act on small worms and multiple applications are often necessary for thrips control.

Neem derivatives have become readily available in the marketplace and sold under trade names including Neemazad, Neemix, and Margosan-O. Neem comes from the neem tree *(Azodirachta indica)* and is a mixture of triterpenoids, which act as insect growth regula-

tors and repellents. Neem is particularly effective against leafminers. It is low in toxicity to mammals and readily biodegraded. The active ingredient azadirachtin is structurally similar to ecdysone, an insect hormone, which inhibits development to the adult stage.

Work done in agricultural settings shows residual activity of approximately seven to ten days. Therefore, under high pest pressures, multiple applications are often necessary. It is important to note that neem is a slow-acting material. For example, when applications for control of leafminers and leaf-feeding worms are made as early as the pests emerge from their eggs, the full effect of these applications will not be observed until the pests try to transform into adults. Neem will reduce the build up of populations by preventing pests from completing development to the adult stage, but some initial damage to the insect population may also be observed.

Water extracts of tobacco leaves have been used to kill sucking insects on garden plants for hundreds of years. **Nicotine sulfate** has been available for about 80 years and has been sold under various trade names. It has some desirable properties but is highly toxic to mammals (category I) and not effective in cold weather. The California Certified Organic Farmers organization decided to exclude its use because of toxicity.

Sabadilla is an extract containing several alkaloids. It is derived from the seeds of a lily-like Caribbean plant (*Schoenocnulon officinale*) found in Venezuela. It acts as a stomach and contact poison with activity against caterpillars, leafhoppers, thrips and squash bugs. It has low toxicity to mammals, but is highly toxic to honeybees. Sabadilla has not been shown to be effective against aphids and mites.

Ryania *(Ryania speciosa)* is the name of a genus of tropical shrubs that contain an alkaloid effective as a contact and stomach poison against plant-feeding larvae. As a formulated product, ryania is low in toxicity to mammals. As a more concentrated material it is quite toxic, interfering with muscle contraction in a mode of action similar to that of strychnine. As stomach poisons, both sabadilla and ryania can be mixed with sugar or molasses to increase control. These additives act as bait to increase feeding of the insects. These materials are used for control of citrus thrips in commercial citrus groves.

Quassia is less common in the retail market. It is derived from water extracts of ground stemwood of West Indian quassia wood chips. It has slow activity against larvae as a stomach and contact insecticide and at one time was used in Europe to control aphids.

Other botanicals include **limonene** and **linalool**, which are crude citrus oils derived from orange and other citrus fruit peels; **Essential oils** such as **cedar, lavender, eucalyptus, pennyroyal** and **citronella** may also be considered insecticidal or repellent in nature.

Traps and attractants can be used as another tool for an IPM program because many insects use chemical and visual cues to locate food and mates. Traps are constructed of many types of materials, but most of them use an adhesive-coated surface or funnel-shaped entrance to capture target insects. They can be used to detect the presence of new or exotic pests, help estimate the density of a pest population, indicate the emergence and peaks in pest populations and possibly eradicate a pest population.

Nursery professionals can use chemical and color attractants to lure pests to the traps. An example of a chemical attractant used in IPM programs is pheromones, chemical substances produced by an animal that serve as a stimulus to other animals of the same species. The practical use of pheromones usually requires that specific active chemicals be isolated, identified and produced synthetically. For example, sex pheromones typically produced by females to attract males have been produced synthetically for many years and are often used in traps. Some examples of insects attracted by pheromone traps include the peach tree borer, lesser peach tree borer, dogwood borer, lilac/ash borer, Japanese beetle, gypsy moth, bagworm and European pine shoot moth.

A good example of a chemical feeding attractant is the sweet-smelling, food-type lure used in adult Japanese beetle traps. The active ingredients are eugenol and phenylethyl butyrate.

Other traps use color as an attractant. Most of these traps are bright-colored plastic sheets, coated on both sides with an adhesive to entangle insects. Certain types of insects are attracted to certain colors. Yellow sticky traps are effective in capturing pests such as aphids, fungus gnats, whiteflies, thrips, mushroom flies, leafhoppers and treehoppers. Blue sticky traps are effective in capturing Western flower thrips.

The application of one or more of these IPM tools can improve the effectiveness of managing pests and may reduce the use of broad-spectrum, more toxic compounds. Although these five methods could be the core of an IPM program, they do not represent a complete picture of all the available alternatives. Nursery professionals are encouraged to explore other techniques, such as biological controls, pest-resistant varieties and sani-

tation, in order to create an effective IPM program.

Sources:
An Intro to IPM Alternatives, Monte P. Johnson (entomology extension specialist, University of Kentucky, Lexington)
Soaps, Oils and Botanicals are a Natural Choice for IPM, John Karlok and James Brazzle (University of California Extension Service)

News You Can Use

In Technology
Ball Horticultural Co. has obtained exclusive rights to genetic transformation technology for most major floricultural species using the Biolistics gene gun delivery process. Ball has entered into agreements with The Scotts Co./Sanford Scientific Inc., giving its Ball Helix division freedom to use this technology on more than 130 genera of floriculture crops, including geraniums, impatiens, pansies and marigolds. Ball Helix is developing programs in genomics, molecular markers and unique tissue culture propagation. (630) 231-3600

Florigene, a flower biotechnology company in Victoria, Australia, introduced violet carnation Moonshadow last week. It's the first in a range of new flowers containing the company's patented blue gene taken from petunias. The company is looking at incorporating the gene into other crops, including roses, and plans to develop a range of colors form violet to blue. The first Moonshadow crop for U.S. sales was produced in Ecuador and scheduled for shipment this month. Florigene expects to market 500,000 flowers per month in the U.S. The company has also developed technology to extend vaselife of cut flowers, called EVA. Florigene@florigene.com.au

In Floriculture Production
If you're growing poinsettias, plant pathologist Gary Moorman at Penn State Univ. suggests starting to scout for powdery mildew in early to mid-Sept. If you wait, foliage and bracts could be permanently scarred since powdery mildew doesn't go away. Look at the top and bottom of the 4 most mature leaves on 1 out of every 30 plants. Remove infected leaves by cutting the petiole and gently placing them in a plastic bag, which should be closed immediately after inserting a leaf. After removing infected leaves, Moorman suggests spraying plants every 2 weeks with Strike at 4 oz./100gal. Don't add spreader stickers. Continue to scout and discard infected leaves. Source: S.E. Pa. Greenhouse Growers' News.

More on Y2K – the official color of the New millennium is expected to be cerulean blue, a shade of skyblue. Leatrice Eiseman, Exec. Dir. of the Pantone Color Institute, said gazing at a blue sky brings a sense of peace and tranquility to the human spirit. (So does looking at a garden full of blue flowers.) Products such as clothes and cars will be available in this color.

In the Floriculture Industry
The value of floriculture crops was up 1% in 1998, reaching $3.93 billion compared with $3.90 billion in '97. USDA released its "Floriculture Crops: 1998 Summary" this month, summarizing production and wholesale sales trends in the 36 states with the most production. Of the states surveyed, 21 showed increased value over the previous year. However, the 2 leading states – California and Florida – recorded decreases in '98. Michigan, Texas and Ohio rounded out the top 5 states.

A study released by the Univ. of Texas earlier this month indicates the Internet economy generated $301 billion in revenue and created 1.2 million jobs in 1998. In the past 4 years, growth on the Internet has averaged 174.5% a year.

1-800-FLOWERS.COM, an e-commerce and telephone provider of floral products and gifts, filed with the Securities and Exchange Commission for an initial public offering of up to $150 million of its class A common stock (proposed NASDAQ symbol: FLWS). The company also changed its name to 1-800 FLOWERS.COM.

A settlement agreement has been reached between organizations representing U.S. and Colombian cut flower

growers and importers to end antidumping duties imposed on imported carnations, mini-carnations, pompons and chrysanthemums. Under the terms of the agreement, Colombian growers would voluntarily contribute to a promotional fund an amount roughly equivalent to the duty amount.

Your company may qualify for federal income tax exemption by donating overstocked or slow-selling inventory. The nonprofit Nt'l. Assoc. for the Exchange of Industrial Resources offers a free publication that includes instructions on the donation process as well as a formula for calculating your company's potential tax savings.
http://www.misslink.net/naeir/naeir.htm

Workers in Alaska, California, Conneticut, Hawaii, Massachusetts, Oregon, Vermont, Washington, and the District of Columbia are paid an hourly minimum wage higher than the hourly national minimum wage ($5.15) enacted by Congress in 1996. Cities, including San Jose, Calif., and counties are also getting into the act, passing their worn livable wage laws for employees of city contractors. On Jan. 1, 11.4% of Oregon's hourly workers, about 107,000 people, received a 50-cent-an-hour pay raise, the 3rd of 3 annual increases approved by voters in 1996. One Fla. St. Univ. economics professor projects the Ore. Wage increases will result in a loss of 5,400 jobs in that state.

1 (888) USA-4Y2K is the toll-free number set up by the federal government to inform the public about Year 2000 problems. Supported by the FTC and Fed. Infor. Center of the General Services Administration, the line provides prerecorded messages on how the Year 2000 will impact personal computers, small business, telephones and other products and services.

About People

Kerry Herndon, president of Kerry's Bromeliad Nursery in Homestead, Fla., was named 1999 Floral Marketing Assoc. Floral Marketer of the Year, during the recent FloraWorld '99 in Atlanta. This was the 19th year that FMA presented the award, which recognizes an individual who has served the mass market floral industry with dedication and distinction.

Harry K. Tayama, professor emeritus in horticulture at Ohio State Univ. and past executive director of Ohio Florists' Association died of cancer on May 11. Beginning in 1977, Tayama led OSU and OFA to achieve recognition and prominence as international sources of floriculture information and education. He retired from OSU in 1992 and served as executive director of OFA for 17 years, retiring in 1994. Following his retirement, he became an international consultant speaking worldwide on all aspects of floriculture. Dr. Tayama spoke at several conferences and workshops in Hawaii in the early 1990s.

About Shows

Officials in Kunming, China, kicked off a 5-month $1.8 billion flower festival last month, in hopes of increasing flower sales. The 1999 International Horticultural Exposition in southwest Yunnan province is aimed at developing the country's upstart flower industry and increasing consumer demand. The expo, which runs through October, covers 600,000 sq yd and is expected to draw 11 million visitors, including 1 million from overseas. There are floral displays from 68 countries. More than 40% of China's flowers, worth $40 million annually, are produced in Kunming. Most are produced for domestic use.

The management boards of NTV Horti Fair, held in Amsterdam, and the Int'l. Flower Trade Show in Aalsmeer, Netherlands, are looking to combine the shows in 2000. These 2 events attracted more than 70,000 people last year. NTV '99, which focuses on all aspects of modern greenhouse and open-soil cultivation, is Nov. 2–5. The International Flower Trade Show runs Nov. 3–6. One of the new events at this year's NTV is the presentation of the Horti Fair Award, which will be given to the show exhibitor with the most innovative product on display. Fax 011 (31) 20-644-5059; http://www.rai.nl

About Legislation and Regulation

SAF submitted testimony in support of the Noxious Weed Coordination and Plant Protection Act (S. 910). The bill, introduced by Sen. Larry Craig, R-Idaho, would streamline and strengthen existing authorities of APHIS to better protect U.S. ag and the environment from foreign insects, diseases and noxious weeds. The act would also increase civil penalties for smuggling and other quarantine violations. SAF, ANLA and more than 25 trade associations and government agencies favor the legislation.

Legislators looking at increased sales of U.S. ag products are again introducing bills that would require mandatory labels indicating country of origin on those products. Co-sponsor Rep. Helen Chenoweth, (R-Idaho) said labeling would help protect American consumers from inferior foreign products. Another co-sponsor of the bill is Rep. Earl Pomerory,(D-N.D.) who said, "If it's good for T-shirts, it's good for T-bones."

A new group named Fresh Perspectives 2000 wants growers, distributors and retailers to certify cut flowers. This would increase the quality of fresh flowers and increase consumption, said chairman Terry Johnson, Pres. of Horticultural Marketing Resources. The voluntary certifications would be roughly based on SAF's Chain of Life standards, developed in 1978. Fresh cut flowers would be labeled with the dates they were cut and bouquets would have sell-by dates at retail locations. Supermarkets are already interested in certified flowers, Johnson said.

The U.S., Canada, Australia, Chile, Argentina and Uraguay last week blocked an environmental treaty on trade in genetically modified plants and animals. The European Union and 110 other countries agree to develop a Bio-safety Protocol, as a result of the 1992 U.N.-initiated Earth Summit in Brazil. The U.S. sought a narrowly focused treaty that protected the environment and didn't overly restrain international trade. Talks are scheduled to resume within 16 months.

USDA has proposed amending its cut flower regulations to require importers to pay for the cost of destroying flowers found to be infested with non-native pests if the flowers are not treated or re-exported. Currently, importers are required to pay all costs for treatment or for shipping the flowers outside of the United States, but not for destroying infested lots.

About Books

The 1999 membership directory of the Assoc. of Specialty Cut Flower Growers lists all members and provides a brief description of growers, buyers and suppliers. It contains a comprehensive index cross-reference of growers by fresh and dried crops, amounts bought and sold and market segment. It costs $20.
http://www.ascfg.bitshop.com.about.htm

Operators of horticulture businesses can learn how to create a work environment that motivates employees and is productive, profitable, safe and worker-friendly with the help of two publications from the Natural Resource, Agriculture and Engineering Service. The first publication is the proceedings of a recent conference titled *Workforce Management for Farms and Horticultural Businesses: Finding, Training and Keeping Good Employees.* The 140-page book contains 14 papers on various aspects of workforce management and costs $15 plus shipping. A companion workbook, *Workshop Handouts*, costs $12 plus shipping and includes self-assessments, checklists and guidelines on recruiting and hiring, communication styles, performance reviews leadership styles, and motivating employees.
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The revised edition of *American Standard for Nursery Stock* is now available through the American Nursery & Landscape Association (ANLA). Approved by the American National Standards Institute (ANSI), this book is widely recognized by the nursery industry as the primary reference for standardization of plant terminology. Published since 1949, as an approved national standard, this book is widely used by green industry professionals who need information on nomenclature and techniques for measuring plants, specifying and starting plant size, determining height and caliper, and determining root ball and container size specifications. The cost is $15 per copy for 1-5 copies, with graduated discounts for orders up to 80-plus copies. Shipping is $5.75 for a single copy with varying rates for multiple copies. To order you may FAX (202) 789-1893, call (202) 789-5980, or visit the web site at http://www.anla.org

C/T/A/H/R
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University of Hawaii at Manoa

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Thank you. We hope you've enjoyed this issue of *Landscape, Floriculture, and Ornamentals News.*

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