Managing The Cuttings' Environment

In the second article of a 2-part series on cuttings, researchers at North Carolina State, Clemson and Michigan State Universities provide insight on managing temperature and light and preventing diseases during propagation.

By Roland Leatherwood, Roberto Lopez and Amy Enfield

Large-scale cutting propagation. (Photos: Roland Leatherwood)

In the second article of our 2-part series, we are presenting research-based information from North Carolina State, Clemson and Michigan State Universities on how to properly manage two of the most critical components of the propagation environment: temperature and light. We will also discuss how to prevent pathogens and disease from devastating your cuttings during propagation.

Managing Temperature

Temperature has to be carefully balanced against cutting stress. Growers should maintain air temperatures high enough to encourage rooting but not so high that leaves become stressed. Bottom heat is very effective in hastening rooting, and systems employ either electrical heating cables or tempered water. Media is usually kept at 72-77° F while air temperature is maintained at 68-73° F. If bottom heat is not used, air temperature should be maintained between 77 and 80° F. Maintaining air temperatures lower than medium temperatures retards shoot growth while promoting root development.

Excessive heat can damage cuttings. Consequently, during the summer, it is usually a question of cooling the propagation area ➧

Points To Remember

- Prepare for the arrival of your cuttings by cleaning equipment and lining up resources.
- Check your cuttings on arrival, and remember it may not pay to stick damaged shipments.
- Store cuttings at 80- to 95-percent humidity at the lowest temperature possible for each species, and make sure they are not wet.
- Media should be well drained and never soggy. Incorporate slow-release fertilizer or use fertigation to boost root development as needed.
- Provide 100-percent humidity and adequate moisture to cuttings to counteract wilting and slow transpiration.
- Start with high mist frequency (such as six seconds of mist every six minutes) and gradually reduce both duration and frequency as cuttings develop callus and roots.
- Cuttings need gradually increasing light intensities to develop roots quickly. If the daily light integral is minimal, cuttings will stretch and rooting will be delayed.
- Watch for precocious flowering; control photoperiod where needed.
- Warmth is important and bottom heat, in particular, will encourage rapid root formation.
- Pathogen control requires frequent monitoring, record keeping, sanitation and rotation of fungicide types.
- The transition from propagation area to greenhouse should be gradual, but some water stress will encourage root development.

rather than heating. Both air and media temperatures should be monitored frequently; even in the summer, the media temperature can drop below set points from cold water and high rates of evaporation. Evaporative cooling using mist or fog is effective at lowering temperatures. Other cooling techniques limit the amount of sunlight entering the propagation space via shade cloths or hosing down the propagation space while running the exhaust fans. It is very important to remember that lowering your temperature set point in propagation will increase rooting time!

Managing Light

Photosynthesis, the process by which cuttings derive energy and food for rooting, is driven by light. Unrooted cuttings require indirect, diffused sunlight but never full sunlight. To initiate and develop roots, provide cuttings with sufficient light to support photosynthesis but not so much as to stress the cutting. Several methods are used to reduce the amount of light coming into the propagation space.

Shade cloth can be used to reduce light. It is available with high thread densities for light reduction or it can be used additively. Shade cloth is easily removed as needed and can be reused from year to year. Retractable shade curtains are an expensive option but provide excellent control of light entering the greenhouse. They can be opened on cloudy days and closed when it is sunny so consistent light intensities can be maintained. Depending on installation, retractable shade curtains also can save on heating costs and even be integrated into existing computer controls.

Whitewash can be used on the interior or exterior of greenhouses to reduce light intensities. It can be sprayed through a pressurized system, and a few workers can cover a large area in a short amount of time. Whitewash will gradually wear off with rain, hail or snow or it can be removed by hand, but once applied, it will persist for several months.

Rooted poinsettia plug that is ready for planting.

Gradually Increasing Light

Light is similar to moisture in that it should vary throughout root initiation and development process. However, unlike moisture, light is minimized initially and then gradually increased as the cuttings develop roots. The process for most crops is typically described in three stages for high light crops. (There are typically five stages in propagation from unrooted cuttings, including stage 0, before cutting harvest or delivery, and stage 1, cutting arrival or harvest and sticking. The other stages are as described here.)

Stage 2 is from stick to callus formation. Light intensity should be maintained at 500-1,000 foot-candles. In stage 3, after root initiation, usually 5-12 days after stick, light should be increased to 1,000-2,000 foot-candles. At stage 4, forming the plug stage or toning the cutting, 10-15 days after stick, cuttings require 2,500-4,000 foot-candles. Increasing light intensity gradually provides more light to the cuttings as they develop roots and are able to tolerate it. It is also a good method for hardening off cuttings. ➧

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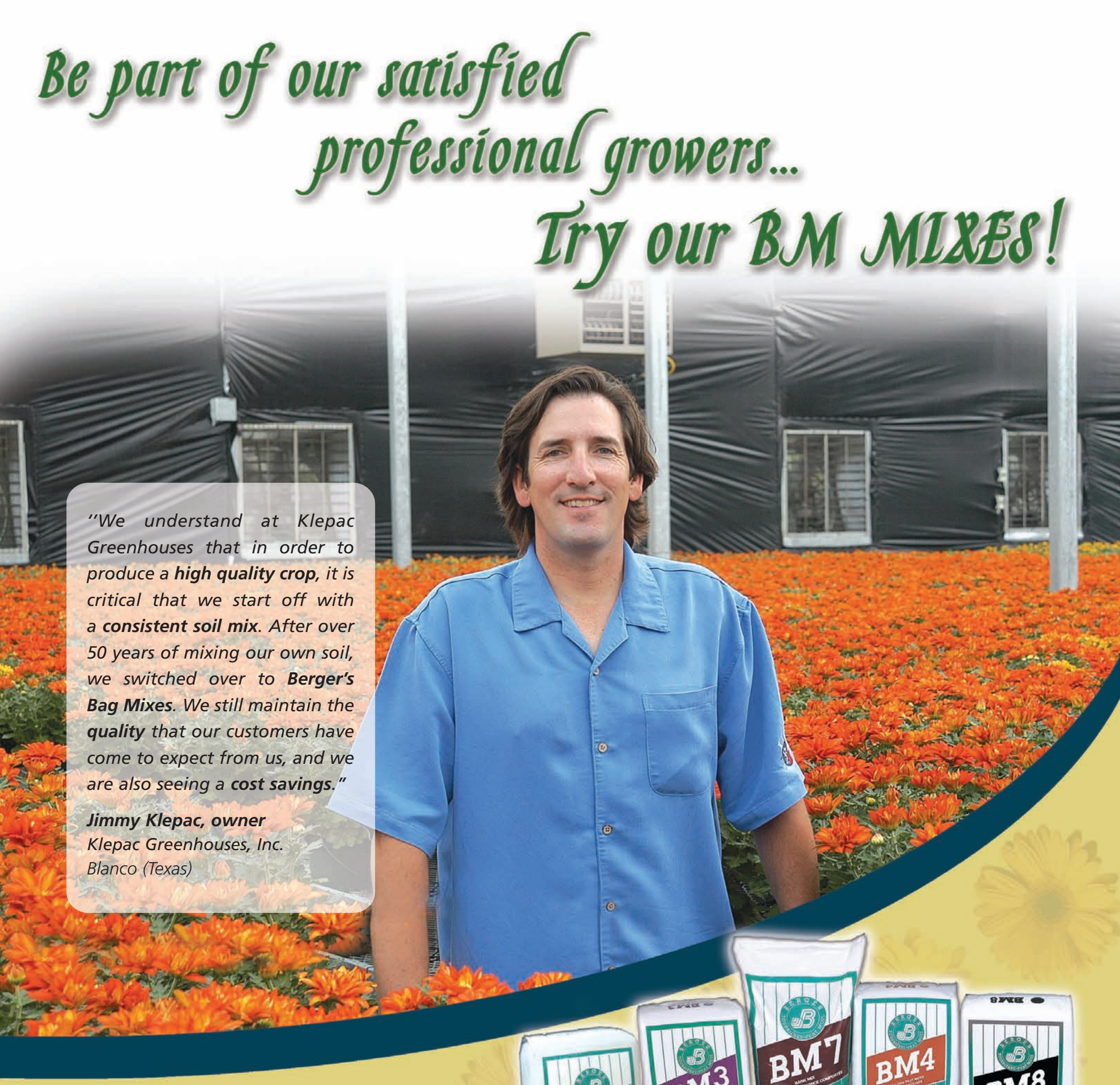

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These coleus cuttings are in propagation.

If cuttings are photoperiodic, day length during propagation must also be managed. Photoperiodic responses in plants require very low light intensities (roughly 10 footcandles) and can be provided easily and inexpensively using incandescent lights. The generally recommended photoperiod during propagation of unrooted cuttings is 12-13 hours. This photoperiod is not so short that it causes cuttings to become dormant. It is also sufficiently long so flowering in most short-day plants is not induced and not too long to initiate flowering long-day plants. Petunias, for example, will flower during propagation under long days, so the photoperiod should be reduced to assure accurate crop timing. There are exceptions, however. A few species, such as plectranthus (short-day plant), require a 16-hour photoperiod to prevent flowering of cuttings.

Both light intensity and duration are efficiently described by the daily light integral (DLI), which is defined as the amount of light per square meter per day ($mol \cdot m^{-2} \cdot d^{-1}$). During propagation, a DLI below or above an optimum range reduces or inhibits rooting. If the DLI is too low, the cuttings are unable to intercept enough light for adequate photosynthesis, thus delaying rooting. If the DLI is too high, transpiration rates are increased and drought stress can inhibit rooting. Researchers at Michigan State University have shown that higher DLI (≥ 3 $mol \cdot m^{-2} \cdot d^{-1}$) promotes more robust petunia and New Guinea impatiens cuttings with a greater root mass. Keep in mind that a particular DLI can be reached by increasing photoperiod or increasing light intensity.

Pathogens And Monitoring

Fungi and bacteria are plentiful in the greenhouse. Pythium, Penicillium, Rhizoctonia, Pestalotiopsis, Glomerella, Anthracnose and Botrytis are just a few organisms that cause havoc during propagation. Of these, Botrytis is usually the most common and destructive. Integrated pest management (IPM) has proven effective in dealing with these organisms. Preventive fungicide applications and regular rotation of chemicals can keep most diseases in check. Biocontrol agents such as the fungus *Gliocladium virens* are good preventative alternates to chemical control of *Rhizoctonia colani* and *Pythium ultimum*.

There are several other non-chemical disease control techniques. Frequent policing and removal of abscised or yellowing leaves, rouging of diseased or infested cuttings and stringent sanitation of propagation houses and work areas will go far in checking the outbreak of disease. It is also important to separate cuttings from different suppliers in case disease issues arise.

Mist and fog systems also play a role in preventing disease. The film of water on leaves can prevent fungal spores from colonizing plant tissues. However, water on foliage is typically necessary for Botrytis species to germinate and free water encourages bacterial spread, so clean cuttings, equipment and media are essential. Yet higher allowable irradiance under mist and fog permits cuttings to produce more energy for initiating roots and fighting off pathogens.

All of these techniques mentioned will help assure pathogen control and successful ➧

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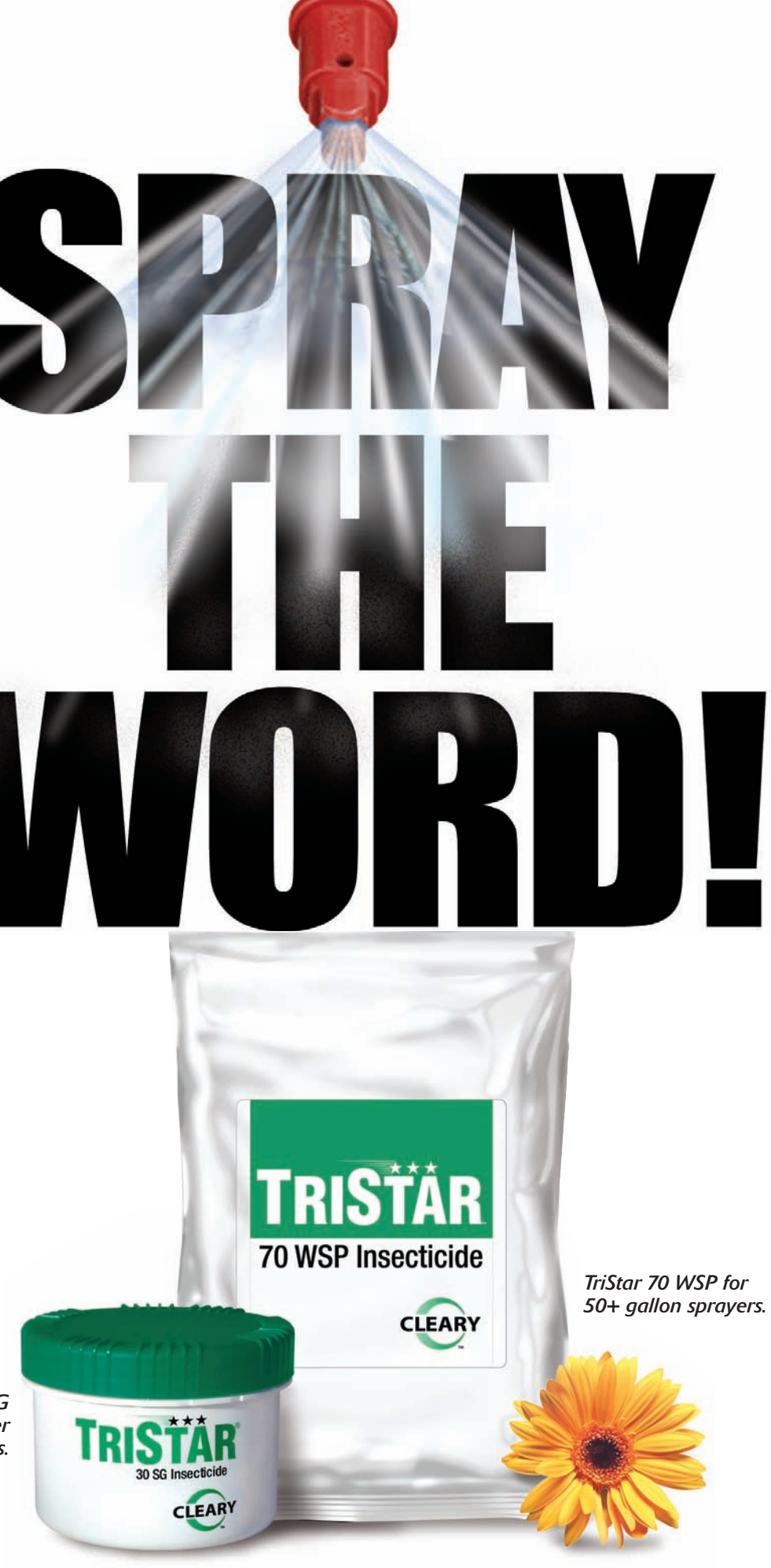

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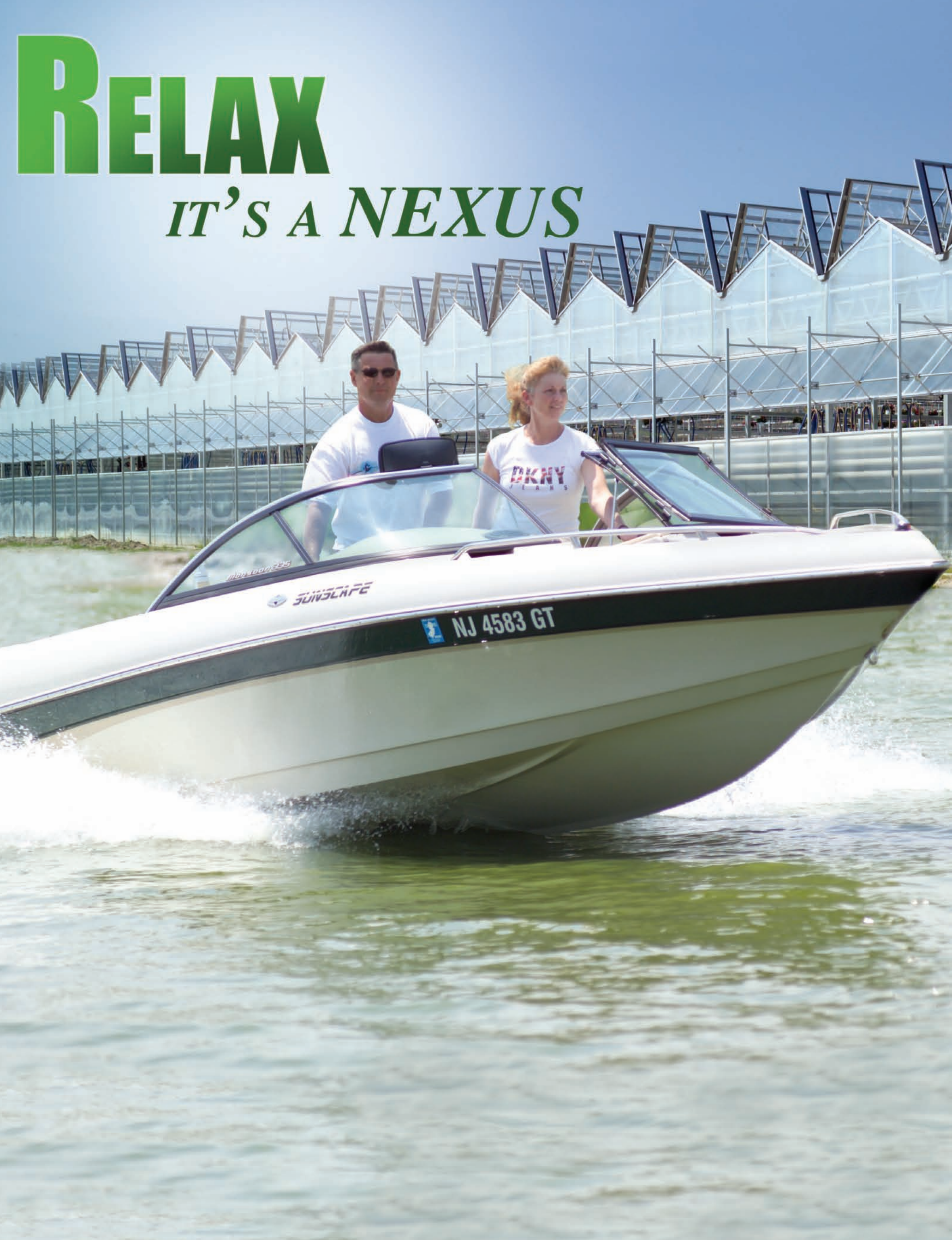

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rooting. But two other components are critical in the long term. The propagation environment is subject to broader environmental changes, and responding to these quickly requires regular and frequent monitoring. Also, early disease signs can be spotted and rapidly dealt with before they spread. Secondly, record keeping helps prevent repeating past problems and forms a valuable knowledge database for growers. Particularly when crops are unfamiliar or seasonal, knowledge from other seasons is a useful reminder in guiding current efforts and producing a more successful crop.

After Rooting

Hardening off, or toning, is the process where newly rooted cuttings are acclimated from the soft environment of the propagation area to the harsher greenhouse environment. Managing this transition in a timely and correct fashion will assure prior hard work is not lost. In order to prevent excessive stretching and etiolation, cuttings should be removed from the propagation area as soon as they are rooted. The time to rooting can vary from one to several weeks, so regular monitoring is important.

A sudden change from the propagation environment to the greenhouse should be avoided in favor of a gradual transition. The new plants should be "babied" along. If light intensities have been gradually increased and moisture amounts gradually decreased during propagation, cuttings will already be partially hardened-off prior to leaving propagation. Remember, a little stress actually encourages root development, so slight wilting is fine. If cuttings have been rooted in a fairly dark environment, be cautious about leaf scald when light intensities increase. A gradual transition to full sun will take a few days. GPN

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