weed seeds as well as protecting crops from insects. The easy tricks to using remay are as follows:

- Learn to apply the correct amount of water. I would suggest putting enough water to completely wet the Remay, but not so much that the water puddles on the top or that it creates droplets that hang below the cloth.
- Learn the correct interval. The correct interval can be determined by allowing the cloth to almost completely dry out (some varieties may allow for more drying). The cloth will slightly change color when it is completely dry. However, I would suggest that you use your sense of touch rather than your eyes to monitor the moisture level.

Computers are not a luxury. Usually when it is time to think about a computer system, it has become a necessity. Many things may need to be considered when choosing a computer system. Dynamics of a greenhouse can be very complex and the needs of your crop should be met with a system that works for the grower, the propagation environment, and the crops that are being grown.

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Using Compost Successfully in Propagation Systems©

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INTRODUCTION

Composting vegetative and animal waste has been part of intentional human activity for centuries. With the increasing urbanization of the world's population and the concentration of waste products, compost products have become increasingly available. Compost use in horticulture falls primarily into three areas. The first is amending field soils to improve organic matter and nutrient retention. The second use is as a partial replacement for bark fines or peat in containerized production. Finally, compost may be included in a container or greenhouse media for disease control.

CHARACTERISTICS OF COMPOST

Compost for propagation systems should be evaluated for maturity, salts, pH, particle size, and nutrient levels. Compost maturity may be measured by microbial respiration, carbon-to-nitrogen ratio, a seedling germination test, or the ratio of available nitrate to ammonium. Not all of these parameters are accepted as being useful in predicting compost maturity. For a propagation compost, low ammonium is a critical factor so a lab analysis or a Solvita ammonium test should be required. A Solvita test available from Woods End Laboratory measures CO_2 respiration and ammonium and may be provided by your composter. A highly stable compost will show a result of 7 or 8 on the colorimetric scale.

Electrical conductivity ranges widely in compost depending on the initial feedstocks. Electrical conductivity readings may range from 0.5 $dS \cdot m^{-1}$ to 12 $dS \cdot m^{-1}$ or

greater. Since the EC is a measurement of soluble salts in the compost, it is also helpful to look at the individual levels of the salts, if a lab report is available. High levels of sodium will be extremely detrimental to developing roots while potassium may not be as problematic.

The pH of compost is usually neutral to alkaline. In the limited studies (Cheuk et al., 2003; Chong, 2000; Smith, 2002) conducted on compost amended propagation mixes, the pH was not a limiting factor. Generally, compost is included with more acidic components such as bark or peat and the final pH of the blend falls within a slightly acid (6.0) to neutral (7.0) range.

Particle size of compost depends on the final screening of the product at the operator's site. A finely textured compost may adversely impact air porosity in the rooting medium so a particle size analysis is helpful. In our experience, the percentage of fines passing the 100 mesh screen should be no greater than 15% to minimize the possibility of reduced air porosity.

VARIATION BETWEEN COMPOST TYPES

Essentially, any organic waste product can be composted. In the horticulture industry, there are several composts that have been used across the country.

Fish waste composted with sawdust or bark has been an acceptable compost in our greenhouse evaluations. The pH falls within the range 6.0 to 6.5 and soluble salts have been below 1.60 $dS \cdot m^{-1}$.

Spent mushroom substrate is often very high in soluble salts and pH which limits its use to containerized media. Leaching and follow-up testing is important in using this product.

Vermicompost has strong absorbability of nutrients with readily available forms of nutrients such as nitrates, exchangeable phosphorus and soluble potassium, calcium, and magnesium. The chemical and physical parameters will depend on the initial feedstocks.

Manure is usually composted with sawdust or other wood products, rice hulls, or straw. Manure composts are readily available especially in rural areas. When properly composted and tested, they can be a desirable product. Evaluate for pH and soluble salts as well as ammonium and boron levels.

Biosolids or composted sewage sludge is available in some parts of the country. The pH range can be broad on this product based on the additives used at the wastewater treatment plant.

Food waste, pre- or post-consumer, is becoming more available as municipalities and large facilities seek to divert organic waste from the landfill. Food-waste composts in a relatively short time and is consistent in pH and soluble salts if the feedstock stream stays consistent.

Yard debris composts are the most prevalent composts in the market. The variability of the feedstocks depends on the season and is the chief drawback to increased horticultural use. However, yard debris compost can be low in soluble salts and neutral in pH making it suitable for use in propagation systems, if properly matured.

BENEFITS OF COMPOST

So why would anyone go to all the trouble to use compost in a propagation system? Enhanced nutrient retention and recycling back to plants is a key reason. The slow-release nature of compost provides the developing roots with a steady supply of

macronutrients. Likewise, the continuous supply of trace elements is vital to young plants. Research by Atiyeh et al. (2000) showed enhanced germination of marigold and vegetable seeds when planted in a peat/perlite or coir/perlite mix containing 10% or 20% vermicompost. When the seedlings also received fertilization, the dry matter increased beyond the seedlings grown in a commercial potting medium.

However, most growers are interested in the disease suppressiveness of compost due to the increased microbial populations. The natural microbiological balance in composts helps prevent disease outbreaks in propagation primarily through competition and predation. Work conducted in British Columbia by Cheuk et al. (2003) on tomato plugs showed a 55% reduction in *Fusarium* when the plugs were topdressed with compost produced from plant waste and sawdust.

MATCHING COMPOST TYPE TO CROP NEEDS

Dr. Calvin Chong, a well-known researcher in compost science, presented his findings on compost use in propagation systems to this group in 2000. Dr. Chong examined rooting of evergreen and deciduous cuttings in compost amended media and found the best rooting occurred in media containing 45% to 75% municipal solid waste compost. Certain plants were adversely affected by increasing levels of soluble salts in his study while others were tolerant of higher salt levels. He further examined rooting in compost amended media that had been leached prior to sticking of the cuttings and reported that compost often enhanced rooting.

Athens Wholesale Nursery in Athens, Georgia, is a grower of woody ornamentals including azaleas, rhododendrons, abelia, barberry, crepe myrtles, junipers, and holly. Joe Napoli, the owner, decided to try a potting medium containing biosolids compost in Fall 2000 for his 1-gal and larger containers. He was extremely pleased with the results on all of his crops, including the acid-loving plants and decided to use the same mix for propagation in Spring 2002. Joe has just completed his second year of using the biosolids mix for propagation and reports that even azaleas are rooting better in the compost mix. The majority of his crop is rooted in 40-cell packs or 4-inch liners. This year, however, he experimented with direct stick of cotoneaster cuttings into 1-gal containers and had 100% take. Additionally, he had no losses from diseases although it was the wettest spring he has ever experienced. Joe feels that the steady release of nutrients from the compost feeds the developing roots, allowing them to establish faster and the microbial population in the compost acts to prevent diseases from establishing.

TROUBLESHOOTING

Immature composts are physically unstable. They will continue to decompose and increase in bulk density. In addition, the decomposing microorganisms may produce fatty acids which can be phytotoxic. Microbes can out-compete plants for available nitrogen during the rapid phase of composting. If you note nitrogen deficiency symptoms in your crop, this is the most likely cause. Biological activity will decline as the material ages, so conversely, you will receive less benefit from the microbial flora and fauna as the compost ages.

High salts and/or pH are the next most common problem in using composts successfully. Having a lab test for the delivered compost is ideal but if that is not available, check the EC of the compost and also of your finished blend. Depending on your end use, keep the final EC within the range of 0.2 to 0.6 $dS \cdot m^{-1}$. The final pH

should be below 7.0 and preferably in the range of 6.0 to 6.5. Excess salts may be leached from the compost/medium blend by successive irrigations in shallow flats or plug trays.

CONCLUSION

In order to use compost successfully in your propagation system, you will need to take several steps. First, review the available composts in your area and ask for laboratory results from the producers. Check for excessive salt levels or high pH. Examine the levels of major and minor nutrients to see if any are excessively high. Review the maturity index provided by your composter. Start by incorporating compost at a low rate of 10% to 30% and test the pH and electrical conductivity. Use a control medium so you can assess the performance against a standard containing no compost. Check root development periodically and document the performance of the crops. When you are pleased with your success, expand it to other crops and share your results with your compost producer so they can continue to provide you with the exact product you need.

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