Series content is coordinated by Dr. Lloyd Nackley, associate professor of nursery production and greenhouse management at Oregon State University in Corvallis, Oregon.

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What's in the pot?

Comparison of plant growth in side-by-side pots using stratified and traditional homogeneous substrates. While homogenous substrates on the left produced slightly larger plants, the stratified mix showed superior root development in the lower half of the pot, along with enhanced water retention at the same growth stage. PHOTO COURTESY OREGON STATE UNIVERSITY

Exploring stratified substrates and soil hydraulics in agricultural science

BY LLOYD NACKLEY AND JEB FIELDS

TRADITIONALLY, THE NURSERY FIELD has focused on creating homogeneous potting mixes that maintain structure while offering suitable hydraulic properties.

Classic blends are often comprised of bark, coir, peat, perlite, vermiculite, and pumice. However, a recent shift in focus has led scientists to explore how layering media can simulate natural soil hydraulics — an approach known as stratified substrates.

Stratified substrates involve arranging potting media of varying textures in layers within a single container. This structured layering entails placing coarser-textured substrates at the bottom and finer-textured ones on top, mimicking natural soil layers.

This allows growers to "defy gravity," so to speak, by keeping moisture uniform throughout the container as opposed to wetter on the bottom and drier on the top. Maintaining balanced air and water proportions throughout the container, this technique aims to influence water movement, nutrient distribution, and hydraulic behavior within the confines of a container.

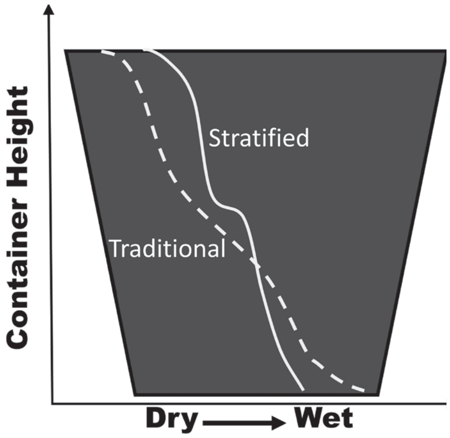
By borrowing from the stratification seen in the ground, stratified substrates strive to optimize resource efficiency, plant growth, and root development in controlled settings like potted plants. Some may draw parallels between stratified substrates and the practice of placing rocks or gravel at the bottom of larger plant pots.

While both concepts involve layering materials, there are distinctions.

The practice of adding gravel or rocks to enhance drainage in larger pots shares a kinship with stratified substrates. However, it doesn't replicate the comprehensive layering dynamics seen in stratified substrates. Both adding gravel to the bottom and stratifying substrates reduce the overall height of the substrate within the container, which, in turn, increases the proportion of water that is held within that substrate.

With gravel at the bottom, there is

Close-up of a pot filled with stratified substrates. The top half contains a blend of fine substrate with CRF, while the bottom half features a layered coarser mix, showcasing the stratified structure. PHOTO COURTESY OREGON STATE UNIVERSITY



Graphical representation illustrating the moisture profile difference between stratified and traditional homogeneous substrates. Traditional mixes exhibit a proportional relationship between container height and substrate moisture, while the stratified mix displays two distinct profiles: consistently dry at the top and uniformly moist in the bottom half. COURTESY OF OREGON STATE UNIVERSITY

such a large difference in particle size (bark to gravel) that water transfer is greatly reduced, and thus you create a "perched water table" which results in more water holding overall.

In stratified systems, there is less difference in particle size between the layers, resulting in a "transient water table." The difference is subtle, but a perched water table is constant and prevents the water from spreading throughout the container, while a transient water table is temporary and only exists while the container is being irrigated, thus allowing water to distribute throughout the container.

Dr. Jeb Fields at Louisiana State University has been at the forefront of investigating stratified substrates in containerized plant growth. His research delves into how layering different potting media textures can enhance water retention, nutrient availability, and overall plant performance.

The studies highlight promising outcomes, such as heightened root productivity, improved growth, and enhanced quality under stratified conditions compared to conventional substrates. This technique holds potential for bolstering sustainable crop cultivation within controlled environments.

In the past couple of years, Fields has released a series of articles that showed that stratifying pine bark can serve as a substitute for peat-based media in floriculture and bark-based woody plant production. Through layering premium floriculture media over cost-effective » pine bark within containers, they reduced reliance on peat. In their study focused on *Petunia* hybrid 'Supertunia Honey', the stratified substrates yielded crops of comparable size and quality, along with enhanced root productivity. Their work also showed superior performance of bark:coir querried Lloyd substrates in a stratified setup, even when subjected to reduced irrigation when producing *Loropetalum chinense* 'Ruby' liners. Positive microbial communities in stratified systems further aided in mitigating water stress.

He has observed improved drought resistance in stratified-grown crops, likely a result of increased water access due to more balanced water to air conditions. Furthermore, Red Drift® rose plants grown in stratified substrates exhibited equal or superior crop growth despite receiving 20% less controlled-release fertilizer. This suggests potential for reducing fertilizer and irrigation rates while upholding crop quality, offering a sustainable avenue for containerized crops.

Beyond the resource efficiency that is presented by substrate stratification, the Fields lab has also shown improved root productivity for crops grown in stratified substrates. Fields' current Ph.D. student, Kristopher Criscione, who has been working with Fields for nearly four years on substrate stratification, has focused his research on the root system.

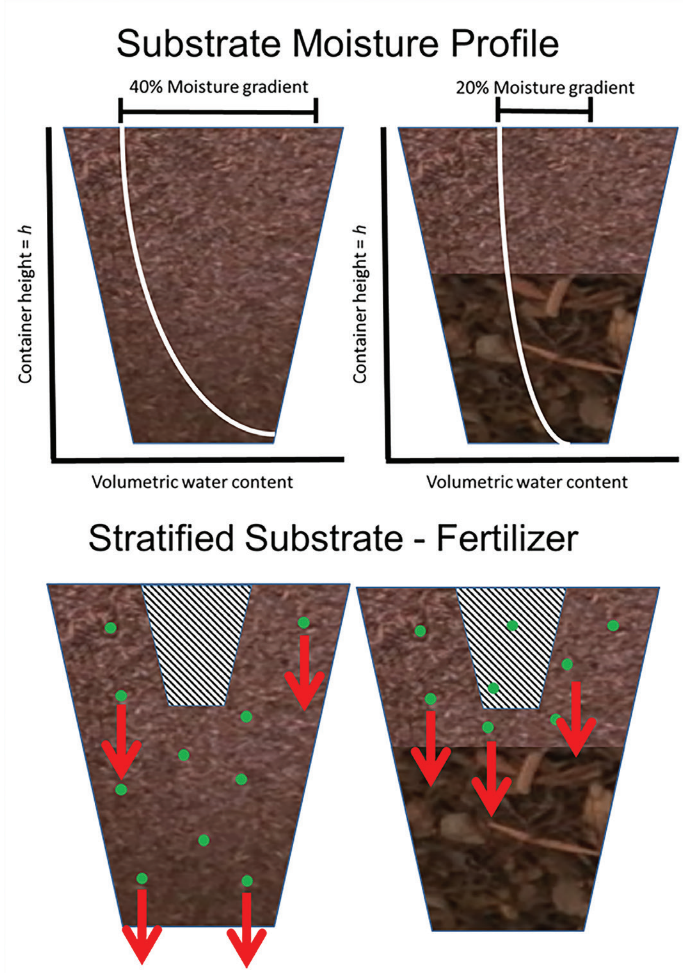
In many instances, they have found that stratification can lead to 400% more root mass. The balance of air and water throughout the profile allows for healthier and more rapid root growth. This improved rooting also changes how roots grow, a topic that Criscione and Fields are currently pursuing.

Instead of rooting to the bottom of the container and filling in, plants in stratified systems tend to fill the volume of the container as they move down, somewhat like a piston moving down the profile of the container. This results in more root mass upon crop completion. With a faster finishing root mass, growers could adjust parameters to finish crops quicker. Aside from improving the health of the crop, this improved rooting can support more successful transplanting, something that customers greatly appreciate.

Nevertheless, it's crucial to acknowledge that findings from studies conducted in one geographic region — such as the Southeast — may not seamlessly extrapolate to other areas with distinct climates and environmental conditions, like the Pacific Northwest. Climate, temperature, humidity, and other factors can significantly influence plant growth and water dynamics. Given this variation, research in regions like the Pacific Northwest, such as Oregon, is crucial.

The unique environmental factors here, including cooler temperatures and higher rainfall, can affect water movement, nutrient availability, and plant response to stratified substrates. Bark-based substrates, common in some areas, may behave differently in terms of water retention and drainage in regions with distinct soil compositions.

To address this, the Nackley lab initiated a collaboration with Dr. Fields and others in 2022, planning to explore the impacts and benefits of stratifying substrates in nursery production. The first stratified substrate experiment was launched in 2023 at Oregon State University North Willamette Research and Extension Center (NWREC), aiming to reduce resource demand and provide insights into the effectiveness of stratified substrates in that context, contributing to more informed decision-making for nursery production and horticulture practices in the region.



Four-square graphical representation highlighting moisture gradients in traditional (top left) and stratified (top right) containers. The bottom figures depict CRF placement with green circles, demonstrating how CRF in a fully blended mix leaches more quickly from the bottom. In the stratified mix, where CRF is only blended in the finer upper half, it has the potential for slower leaching and greater nutrient absorption in the coarser blend. COURTESY OF OREGON STATE UNIVERSITY

Dr. Lloyd Nackley is a plant physiological ecologist at the Oregon State University North Willamette Research and Extension Center (NWREC) in Aurora, Oregon. He can be reached at **Lloyd.Nackley@OregonState.edu**. *Dr. Jeb Fields is Assistant Professor of and Extension Specialist at the Hammond Research Station, at Louisiana State University in Hammond, Louisiana. He can be reached at* **JFields@AgCenter.LSU.edu**.