GROWING KNOWLEDGE

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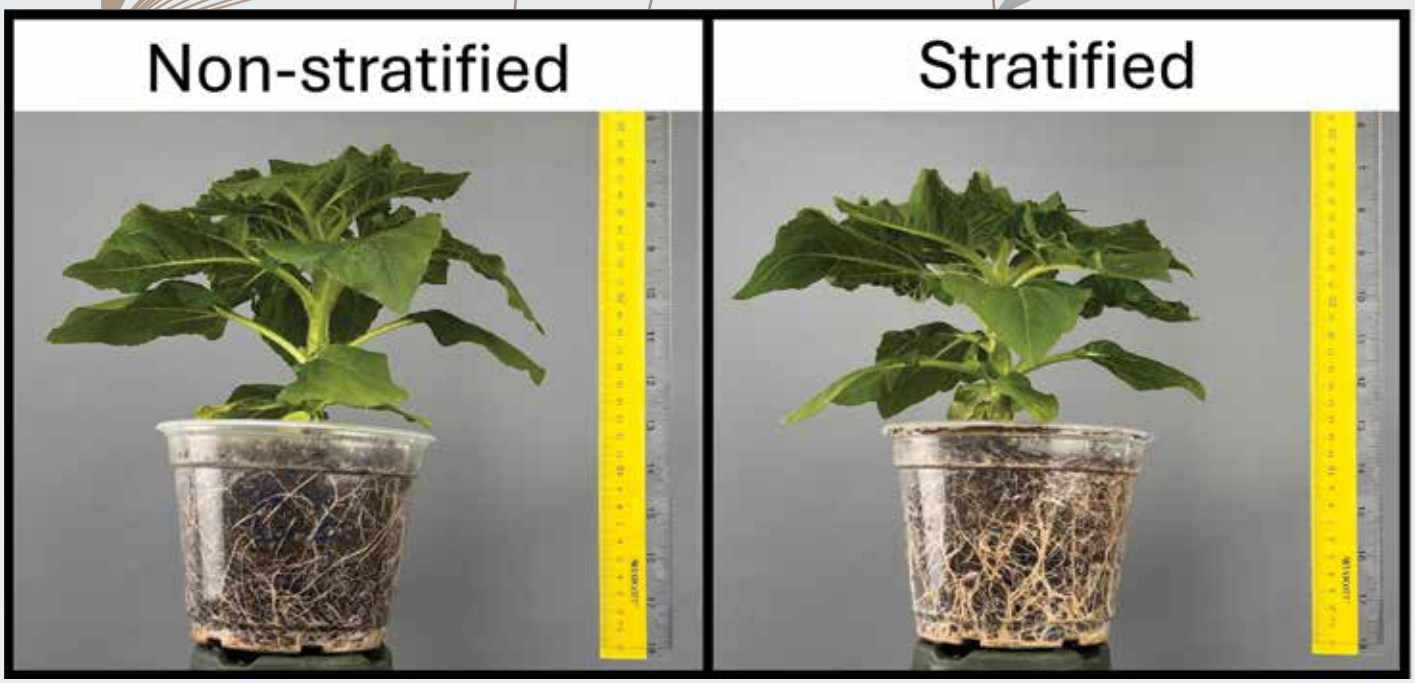


Traditionally and stratified-grown plants in clear pots. Stratified-grown root systems are more prolific and fill the pot more efficiently. PHOTO BY KRIS CRISCIONE

Rethinking substrates for modern growing

How layering mixes, wood fiber, and filling practices can cut peat use without cutting crop quality

BY LLOYD NACKLEY

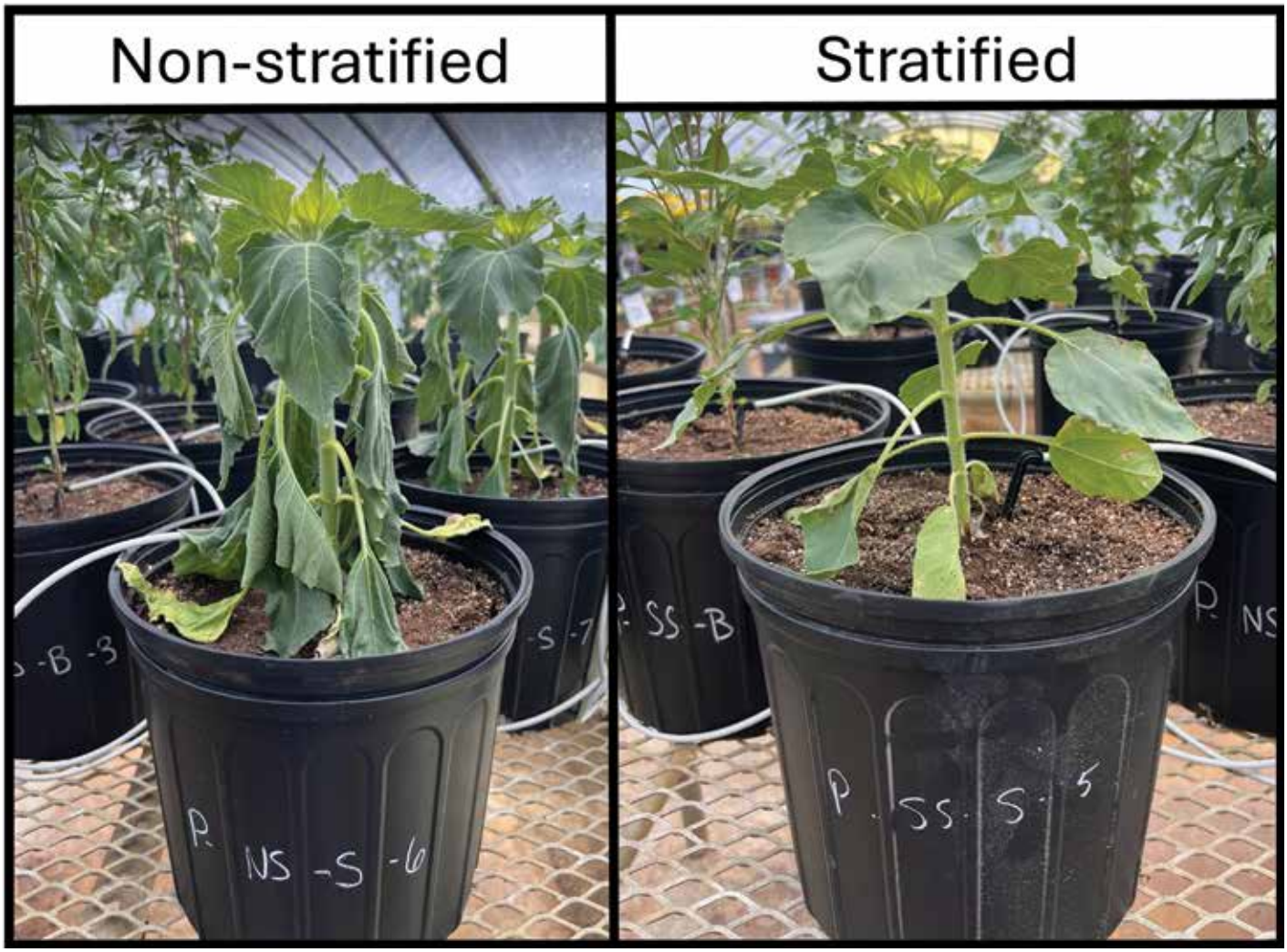
This September, I had the opportunity to travel halfway around the world to Freising, Germany, to present at Growing Media 2025, the International Symposium on Growing Media, Compost Utilization and Substrate Analysis for Soilless Cultivation. At this global gathering of scientists, substrate producers, and greenhouse innovators, we were all wrestling with the same question: *What will we grow in when peat becomes harder to rely on?*

The symposium, organized by the International Society for Horticultural Science and the International Peatland Society, brought together experts to talk about everything from novel raw materials and composting to biochar, sustainability, and future directions for soilless cultivation. Walking through the sessions and getting to spend time with colleagues, I was struck by how much of this work connects directly to the day-to-day challenges we discuss with growers in Oregon.

It reminded me that on our Nackley Lab Nursery News blog, we've been highlighting several of these advances in separate stories by Dr. Jeb Fields and Dr. Kris Criscione. Here, I want to pull those threads together and show how recent research is pointing growers toward practical, peat-saving strategies — ones that could help your bottom line while preparing for the future of greenhouse production.

Rethinking the foundation of greenhouse production

Substrates may not grab headlines like new varieties or pest alerts, but every grower knows they are the foundation of successful greenhouse and nursery production. The growing medium dictates how roots develop, how much water and fertilizer a crop needs, and ultimately »



A non-stratified plant hastily wilting while a stratified plant remains fully turgid under hot and humid conditions. This can be attributed to greater fibrous feeder roots accessing more water in stratified systems. PHOTO BY KRIS CRISCIONE

whether plants leave the greenhouse looking strong and market-ready.

For decades, peat moss has been the go-to base for greenhouse substrates. Peat has a reliable texture, excellent water-holding capacity, and proven performance across a wide range of crops.

But it also comes with challenges. Peat is costly to extract and transport, its supply chain can be unpredictable, and there are mounting environmental pressures to reduce its use. For many growers, the question is no longer *if* peat reduction will be necessary, but *how* to do it without compromising crop quality.

Fields and others have been exploring that "how." Their group has published a series of studies that tackle substrates from three angles: first, reducing peat by layering or "stratifying" mixes; second, identifying promising peat alternatives such as wood fiber, bark, coir, and perlite; and third, looking at how growers handle substrates during potting — specifically, how tightly or loosely they are packed.

Together, these studies point to practical, flexible strategies that can help growers reduce peat use, improve rooting, and maintain salable crops.

Stretching peat by layering mixes

One of the most promising approaches is substrate stratification. The concept is straightforward: instead of filling a pot or plug cell with one uniform mix, different substrates are layered within the same container. A finer, high-performance mix can be placed on top where young roots establish, while a coarser, lower-cost material sits below to provide structure and reduce peat use.

In a 2025 study, Fields and colleague Kris Criscione tested stratification with greenhouse petunias (Fields & Criscione, 2025a). They compared traditional peat-based mixes ("peatlite"), coir-based mixes ("coirlite"), and stratified systems where either pine bark or engineered wood fiber formed the bottom half of the pot, with peatlite or coirlite layered above.

The results were encouraging. Petunias grown with a 50% peat reduction using either pine bark or wood fiber as the substrata performed just as well as those in full peat mixes. Plants were similar in size, flower number, and overall marketability. Even peat-free systems, where coir replaced peat entirely, produced marketable crops, though they showed slightly smaller shoots and fewer flowers.

The takeaway is clear: growers can slash peat use in half without losing crop quality. And with coir-based mixes, peat can be eliminated altogether if some reduction in size and flower count is acceptable for certain crops or markets.

Extending substrate stratification to plug production

Another study, led by graduate researcher Maureen Thiessen with Fields, looked at stratification in much smaller containers: young plant plugs (Thiessen & Fields, 2025).

Plug production has unique chal-

lenges. The shallow trays hold very little substrate, so the lower portion of each cell often stays saturated. That reduces oxygen for roots and raises the risk of disease. Since plugs are the foundation of later production, weak rooting at this stage can ripple throughout the crop cycle.

Thiessen and Fields tested layering bark- or peat-based mixes over either wood fiber or perlite in 37 cm^3 plug cells. The goal was to see if stratification could both reduce peat and improve rooting in this tight, high-stakes environment.

The results again highlighted the importance of material choice. Perlite layers increased air space in the trays, which might sound like a good thing, but they also reduced plug integrity the plugs tended to crumble or fall apart during transplanting. Perlite treatments also produced less root biomass overall.

By contrast, wood fiber layers »

Representative photo of how stratified-grown roots begin to explore the container. Stratified-grown roots grew throughout the container more uniformly, ultimately producing stronger and larger root systems. PHOTO BY KRIS CRISCIONE

increased container capacity and often produced root systems with equal or greater total root length and surface area compared to standard mixes. Importantly, plugs from wood fiber treatments held together well for transplanting.

The implication for growers is that wood fiber stands out as a promising peat alternative not just in finished crops, but also in plug production. Stratification with wood fiber can maintain plug quality while reducing reliance on peat, an important finding as propagation operations look to cut costs and improve sustainability.

Beyond ingredients: why packing density matters

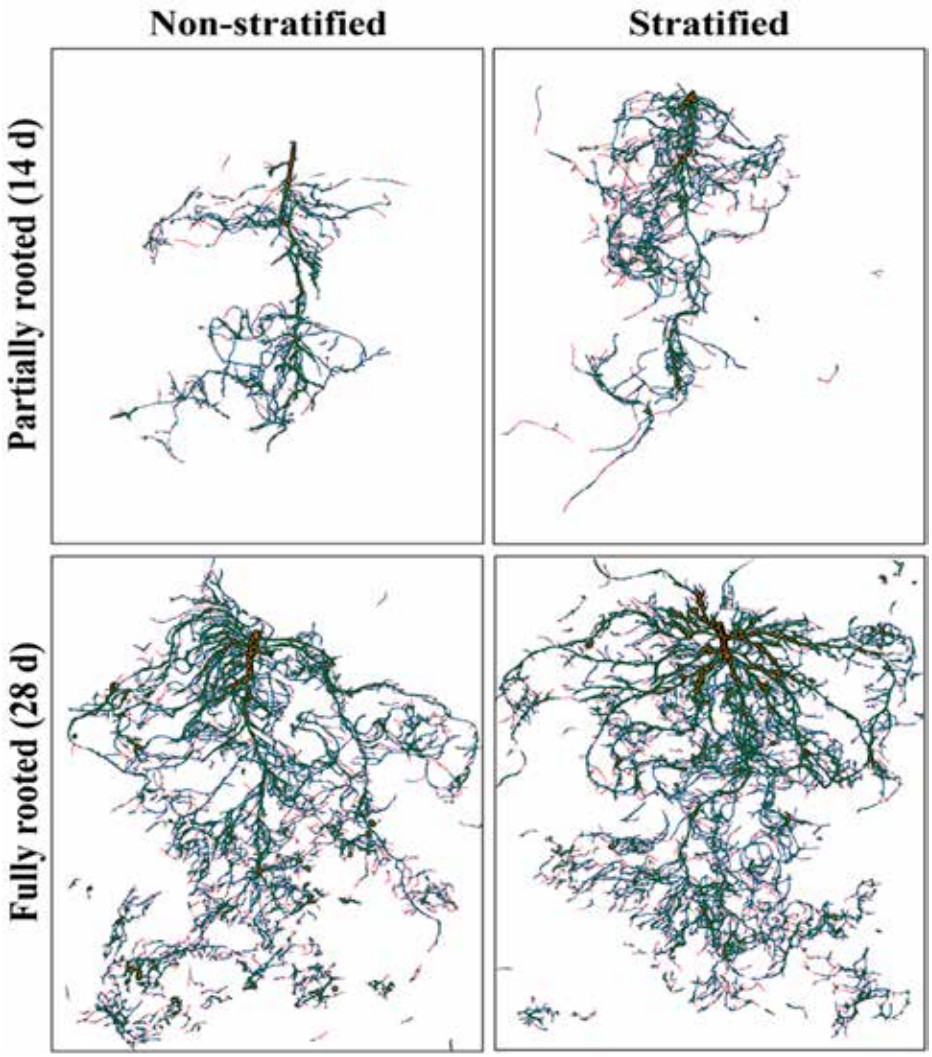
While ingredient choice and layering strategies get much of the spotlight, Fields and Criscione (2025b) also asked a simpler but often-overlooked question: how does the way substrates are *handled* during potting affect plant growth?

Anyone who has run a transplanting crew knows that pot filling is not perfectly uniform. Workers may press the plugs in firmly, lightly, or somewhere in between. Even automated filling lines can vary in how much compaction they create. That variability raises a practical question: does packing density matter for crop performance?

To find out, the researchers grew petunias in peat-based mixes packed at four densities, ranging from loose (0.08 g/cm^3) to relatively firm (0.14 g/cm^3). Shoots, flowers, and overall salability were unaffected by density. Every plant looked good on the bench. But root systems told a different story.

Root length, surface area, and biomass all peaked at moderate densities. Looser substrates provided less contact between roots and media, limiting water and nutrient uptake. Extremely tight packing, while not tested beyond the moderate range, could theoretically restrict pore space. But within the range of normal greenhouse practice, the data suggest that a firmer hand actually benefits root development.

This finding is a reminder that soilless substrates behave differently than field soils. In mineral soils, high bulk densities usually spell trouble because compaction reduces pore space. In greenhouse substrates, however, moderate compaction increases root–substrate contact and can stimulate more branching and lateral root growth.



Example of a non-stratified and stratified root system that was processed in a root imaging software. We can measure important root characteristics that are responsible for taking up water and mineral nutrients (fibrous feeder roots; blue and red roots), or the roots that deliver water and nutrients to the shoot (coarse roots; yellow). PHOTO BY KRIS CRISCIONE

For growers, the lesson is practical: paying attention to pot filling can pay off. Training crews or fine-tuning machine settings for consistent, moderate packing could improve rooting across batches at no added cost.

Flexibility in substrate management

Taken together, these studies highlight a common theme: growers have more flexibility with substrates than many assume. Peat doesn't have to be the immovable foundation of every mix. By thinking creatively about layering, alternative materials, and even packing density, growers can meet production goals while reducing reliance on peat.

Some clear trends emerge:

Wood fiber is a reliable performer. Whether layered beneath peat in finished crops or beneath plugs in propagation trays, wood fiber consistently supported strong rooting and crop quality.

Peat reduction is possible without sacrificing marketability. Half of the peat can be cut out of mixes with no noticeable difference in petunias. Even full peat replacement with coir can work if growers accept slightly smaller plants.

Handling matters as much as ingredients. The way a pot is filled can change root architecture just as much as what's in the mix. Moderate packing densities improve root development without hurting shoots or flowers.

For growers under pressure to reduce inputs, these insights are good news. Incremental changes — like layering a

coarser substrata, choosing wood fiber over peat for part of the mix, or adjusting how pots are filled — can yield measurable gains. Importantly, none of these strategies require an overhaul of existing systems. They can be phased in gradually and tested crop by crop.

Looking ahead

Peat isn't going away overnight, but the trend is unmistakable. Pressure is only growing from costs, supply chains, and environmental regulation to reduce its use. What Fields' lab is showing is that growers don't have to wait for the "perfect" peat alternative to appear. Solutions are already available, and they're flexible enough to adapt to different crops, markets, and production systems.

Wood fiber, coir, bark, and even perlite each have roles to play, but the key is smart management. Whether it's stratifying layers in a pot, tweaking how plugs are propagated, or training crews on consistent packing, growers can act now to future-proof their operations.

For an industry where margins are tight and consistency is everything, that flexibility matters. Research from the Jeb Fields Laboratory shows that the future of substrates may not hinge on a single replacement for peat, but rather on a toolbox of strategies that make the most of every cubic inch of media.

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