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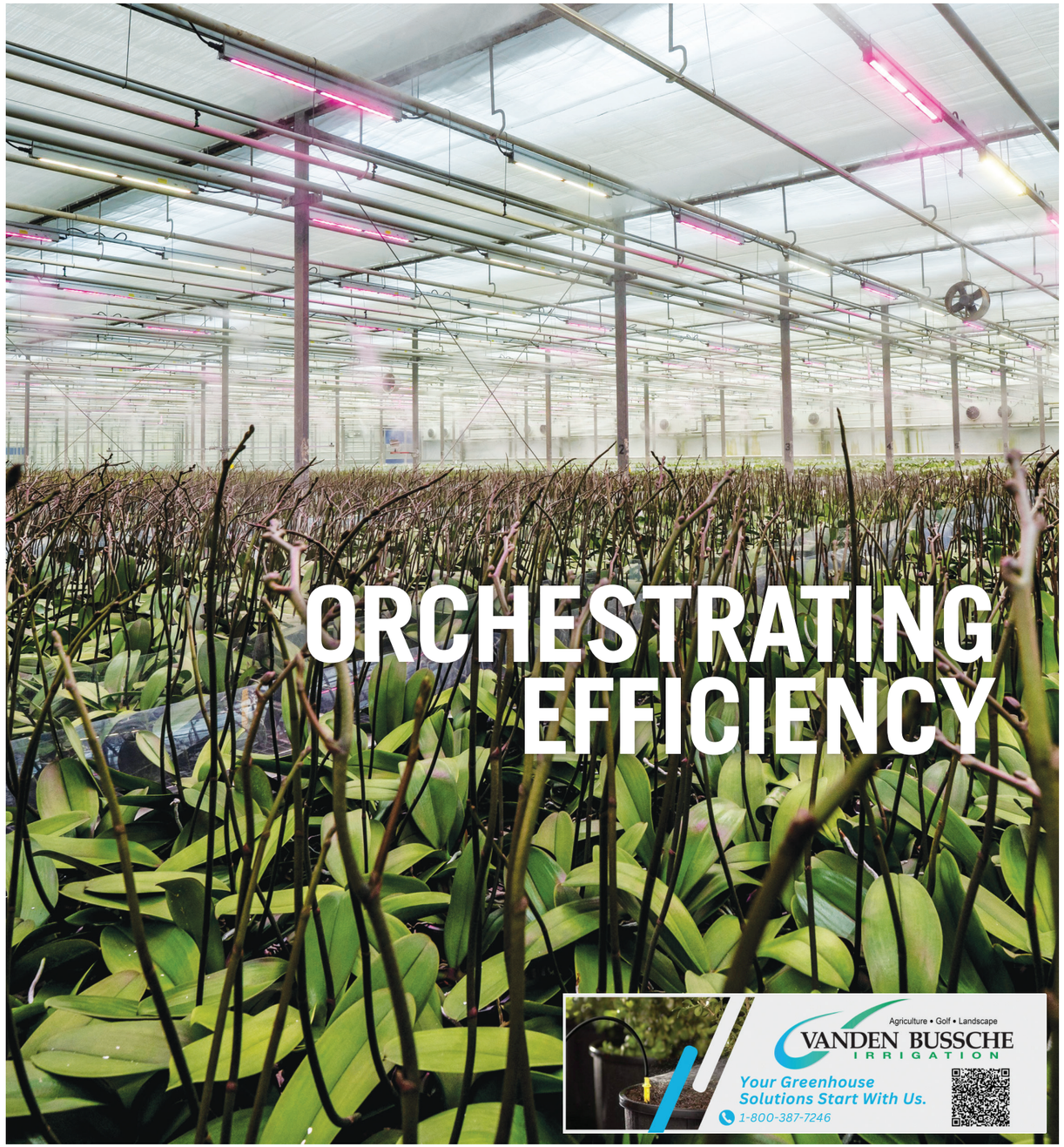

PHOTO: MOHYUDDIN MIRZA

ROOT ZONE RUNDOWN

Optimizing the unseen driver of greenhouse success

BY VIKRANT DHAWAN AND MOHYUDDIN MIRZA

Root zone health is a very complex area for study and management. In early 1980 the vegetables were grown in "virgin" prairie soil in Alberta and many other parts of Canada. Early history of root zone improvements and engineering is very impressive in Canada. Some may recall, in soil in the early 1980s, where the root zone was just top four- to six-inches of soil amended with some peat moss or manure. The root knot nematode and many fungal diseases, like pythium, forced researchers and growers to experiment with growing media like peat moss, saw dust and some other soilless growing media.

Back then, many saw a switch to strawbale culture, but there too, the nematodes found a way to get to the roots. So back to the drawing board to find a better growing medium. Eventually, different products were developed like rockwool, coir came to Alberta in late 1990s and Nutrient Film Techniques (NFT) were studied.

RETHINKING THE ROOT ZONE

The move to soilless cultivation redefined root zone health; placing greater emphasis on air porosity, water- and air-holding capacity, and cation exchange capacity. This also paved the way for the development and promotion of improved growing media.

In commercial cultivation, the root zone is the unseen driver of plant performance. While lighting, genetics, and canopy management often dominate attention, the roots dictate nutrient uptake efficiency, stress tolerance, disease susceptibility, and the quality of final product.

Problems in the root zone rarely appear suddenly, unless there is no water; they develop gradually through oxygen limitation, improper irrigation, salinity buildup, pH drift, temperature imbalance, or suboptimal media structure. By the time above-ground symptoms such as leaf

ABOVE

Roots of a cucumber plant grown in sand in a hot climate and high sodium water. All the top leaves were yellow and senescing and the fruit was malformed and colourless.

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ABOVE
Roots from a cucumber crop grown in coir with good quality water. Plants were about 14 weeks old whenthis picture was taken.

yellowing or reduced vigour become visible, yield and quality losses are already locked in.

THE CRITICAL ROLE OF OXYGEN AND WATER IN ROOT PERFORMANCE

Oxygen is vital for energy production, nutrient transport, and root growth. It reaches roots through dissolved oxygen in irrigation water and air-filled porosity in the growth medium. Research and field data from Canadian greenhouses demonstrate critical performance thresholds for dissolved oxygen in the root zone:

- Optimal: 7–9 mg/L
- Functional but reduced efficiency: 4–6 mg/L
- Disease-prone conditions: <4 mg/L
- Near anaerobic stress: 1–2 mg/L

Even when irrigation water enters the system with sufficient oxygen, dissolved oxygen levels often decline before reaching the roots due to elevated water temperature, high electrical conductivity (EC), long distribution lines, or overly frequent irrigation. Low-oxygen environments favour pathogens such as *Pythium*, *Fusarium*, and *Phytophthora*. Maintaining oxygen availability is therefore both a growth and disease-management strategy.

Irrigation water temperature plays a central role: oxygen solubility decreases as water temperature rises. Maintaining water between 18–20°C reduces hypoxic stress.

Drainage design also affects oxygen retention. Containers or slabs that allow standing water at the base reduce effective root volume, creating chronic low-oxygen zones.

Roots that escape containers or cluster along edges often

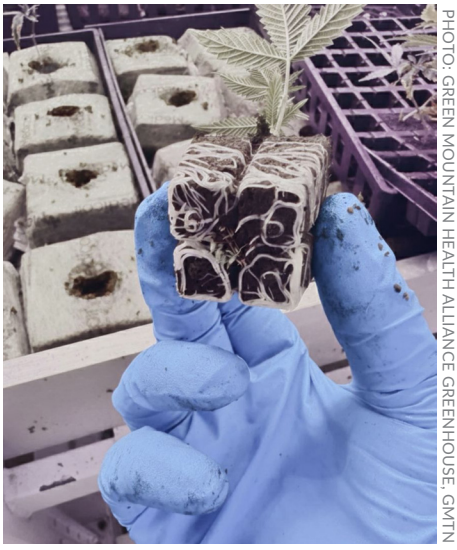

PHOTO: GREEN MOUNTAIN HEALTH ALLIANCE GREENHOUSE, GMTN

ABOVE

Young cannabis plugs, well rooted in 4 weeks. Good white, water and nutrient absorbing roots.

indicate insufficient aeration in the main root mass.

Irrigation timing is more influential than total volume. Aligning irrigation with plant transpiration and vapour pressure deficit, rather than rigid schedules, restores oxygen to the root zone and promotes uniform root distribution.

Partial dry back between irrigations enhances root zone health and thus root proliferation.

PHOTO: GMTN

LEFT

Roots from a mature cannabis plant. Very good root development and showing good integrity reflective of light triggered irrigation, proper balanced nutrients and good climate management.

ELECTRICAL CONDUCTIVITY, SALINITY, AND OSMOTIC STRESS

Electrical Conductivity in the root zone governs water movement into the plant. Under high-light greenhouse conditions, elevated EC reduces water uptake even when moisture is abundant, slowing leaf expansion and increasing stress. Conversely, excessively low EC weakens root structure and reduces tolerance to environmental fluctuations. The goal is stable EC aligned with transpiration demand.

Sodium accumulation is a slow but significant risk. Sodium competes with calcium and potassium, damages root membranes, and degrades media structure by reducing drainage. Sodium-induced stress develops gradually and is often misdiagnosed. Routine leachate monitoring allows early detection of EC drift and sodium buildup. Corrective flushing, adjusted for crop stage, prevents irreversible root damage. In coco media, controlled "starving"—allowing the medium to approach a lower EC threshold before feeding — promotes maximum nutrient absorption efficiency and encourages roots to explore the entire pot volume.

ROOT-ZONE PH AND MICRONUTRIENT AVAILABILITY

Root zone pH directly controls micronutrient solubility. Plants themselves change the root zone environment by influencing pH in the growing medium. For example, during rapid vegetative growth the roots secrete more hydroxyl (OH-) ions which pulls the pH towards alkaline side and if not monitored and corrected iron and manganese deficiency can occur. On the other hand, during generative growth when flowers and fruit are set, the pH can move into the acidic side which results in toxicity of microelements. This also happens when fruit load is high in crops like cucumbers and tomatoes, when the flow of nutrients to the roots slows down. Growers should be aware of strategies to manage these

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LEFT
Lettuce in a floating hydroponics system with proper and balanced nutrients and dissolved oxygen at 8 to 9 ppm.

aspects, but a best course of action would be to regularly monitor pH and adjust early rather than later.

TEMPERATURE, MEDIA SELECTION, AND ROOT GROWTH

Root zone temperature regulates enzymatic activity, nutrient transport, and disease susceptibility. Temperatures below 18°C slow metabolism and increase vulnerability to pathogens, while 18–22°C supports consistent uptake through vegetative and flowering stages.

Media selection must balance air-filled porosity with water-holding capacity. Coir remains a widely used medium but varies in quality. Washed, buffered coir with known EC and sodium levels ensures predictable performance.

COMMON ROOT DISEASES

Root health is strongly linked to pathogen pressure. Key diseases include:

- **Pythium spp.** – causes root rot under low-oxygen conditions.
- **Fusarium spp.** – chronic vascular wilt and stunted growth.
- **Phytophthora spp.** – aggressive root and stem decay in overly wet media.
- **Rhizoctonia spp.** – root tip necrosis and brown lesions.

Preventive strategies include maintaining oxygenation, appropriate irrigation, humidity level, pH and EC control,

RIGHT

Cucumber crop showing four irrigation drippers showing that proper watering and nutrition is essential for a good root zone environment.

and media hygiene. Many biologicals are available and used by growers to manage these root diseases.

Tips for success:

- Monitor dissolved oxygen in irrigation water daily; keep water below 20°C.
- Use partial dry back in potted coco pots to encourage maximum root spread.
- Regularly flush media to prevent sodium and EC buildup, particularly in long-cycle flowering.
- Track pH trends rather than reacting to spikes; maintain 5.8–6.2 in coco.
- Develop the practice of checking the root health. When tops of plants show any problem, then check the roots first.

Root health is not invisible; it is often overlooked. Treating it as a measurable, manageable system transforms it into one of the most powerful drivers of long-term production success and profitability. By investing in root-zone health, growers are investing directly in the quality, consistency, and wealth generated by their crops.

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