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Mist Chamber Technologies in Fruit Crop

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Mist chamber technology represents a significant advancement in the field of horticulture, offering a controlled environment that ensures high success rates for rooting and acclimatization. Mist chamber technology is a vital tool in modern horticulture, particularly for the propagation and growth of fruit crops. The article mainly highlights the role of automated control systems, different types of misting nozzles, and the use of shading to optimize the environment. By maintaining a high relative humidity and a controlled microclimate, mist chambers create an ideal environment for rooting cuttings, minimizing water loss from leaves, and enhancing the success rate of vegetative propagation. This technology is crucial for the multiplication of fruit varieties that are difficult to propagate through conventional methods.

Introduction

A mist chamber is essentially a structure equipped with a misting system that generates fine water droplets to maintain high humidity and create a microclimate suitable for plant growth. The misting system is coupled with temperature and humidity controls, ensuring optimal conditions for various agricultural and research purposes (**Ravanshree M *et.al.*, 2024**). Enclosed structure in which artificially mist is generated for the propagation of Plants or seedlings. In Mist Chamber, Relative humidity is maintained at high level (95 %) with the help of mister's, which spray water under high pressure. Size of mist partials lies between 50 to 100 µm. High relative humidity facilitate better root initiation and cooling effect prevents the cutting from drying out (**Agrimania, 2018**).

Principles of Mist Chamber

The core principle of a mist chamber is to artificially create and maintain a microclimate with near-saturated humidity (typically over 95%) and a cool temperature. This is achieved by automizing water into fine droplets (50-100 µm in size) and periodically spraying them over the plant cuttings. The high humidity minimizes the transpiration rate, preventing dehydration of the cuttings before roots can form. Simultaneously, the evaporative cooling effect of the mist helps to lower the ambient temperature, further reducing plant stress. This controlled environment not only facilitates root initiation but also provides a conducive atmosphere for the overall growth of the cutting. The misting is often intermittent, controlled by a timer or other sensors to prevent waterlogging and oxygen deficiency in the rooting medium, which can be detrimental to root development **(Malathi *et al.*, 2024).**

Components of mist chamber:

A standard mist chamber consists of several key components working in synergy to maintain the optimal microclimate.

- **Structure:** The main framework is typically made of galvanized iron or a similar sturdy material, enclosed with UV-stabilized polyethylene film or polycarbonate sheets to retain heat and humidity.

- **Misting System:** This is the heart of the chamber. It includes high-pressure pumps and fine atomizing nozzles that spray water in the form of a fine mist. The nozzles are strategically placed to ensure uniform coverage.
- **Control System:** This system regulates the misting cycle. It can be a simple timer-based system or a more advanced setup with sensors.
- **Timers:** These controls the on/off cycles of the misting system (e.g., misting for a few seconds every minute) to prevent over-saturation.
- **Photoelectric cell or "Electronic Leaf":** This advanced sensor-based system works by detecting the drying of a simulated leaf surface. When the surface dries, it triggers the misting system, ensuring mist is applied only when needed, which is more efficient and prevents nutrient leaching from the leaves **(Haider Saveer, 2018).**
- **Rooting Medium:** The cuttings are planted in a sterile, well-aerated medium like cocopeat, vermiculite, perlite, or a combination of these. The medium must be able to hold moisture while allowing for adequate drainage and aeration to prevent root rot.
- **Shade Netting:** A shade net is often used over the polyfilm to reduce light intensity and prevent excessive temperature buildup, especially during peak summer months.

Control mechanism of a mist chamber

In general, the mist has 5 control mechanisms. Timer, electronic leaf, thermostat and timer, screen balance and photoelectric cell.

1. **Timer:** The two types of timers are used in a mist unit, one turn on in the morning and off at night and the second operate during day hours to produce an intermittent mist, usually 6 seconds “on” and 90 seconds “off”.
2. **Electronic leaf:** In electronic leaf, a plastic with two terminals is placed under the mist along with cuttings, the alternate drying and wetting of the terminal breaks of the current, which in turn control the solenoid valve.
3. **Thermostat:** A thermostat controls the temperature of the mist.
4. **Screen balance:** In screen balance control mechanisms, stainless steel screen in attached to a lever with mercury switch. When mist is on, water is collected on the screen and when weight of water is more, it trips the mercury switch.
5. **Photoelectric controls:** The photoelectric controls are based on the relationship between light intensity and transpiration rate.

Application of Mist Chamber in Fruit Crops

Vegetative Propagation: They are widely used for rooting cuttings of various plants, including ornamental species, fruit trees (e.g., pomegranate, grapes, fig etc), and medicinal plants (e.g., bamboo) **(Singh *et.al.*, 2018)**. The high-humidity environment provides a conducive microclimate for the formation of adventitious roots, even in hard-to-root species

Hardening of Tissue-Cultured Plantlets: After plants are grown in vitro (in test tubes), they are extremely sensitive to environmental stress. Mist chambers serve as an ideal environment for acclimatization or "hardening," gradually preparing the plantlets for ex vitro conditions by increasing their tolerance to lower humidity **(Abdel-Raheem *et al.*, 2023)**.

Seed Germination: While not their primary use, mist chambers can also be used for germinating seeds that require a consistently moist environment **(Singh *et.al.*, 2020).**

Advantages

- Mist chambers facilitate a faster growth of cuttings and the rooting process
- They help in creating an optimum and appropriate micro environment for the root initiation and development process
- Ensures that the plants are not subject to a pest infestations, pathogens and insect attacks
- They have proven to have higher success rates in the propagation of hard wood cuttings
- Automation and external control of temperature and humidity ensure that the relative humidity can be maintained easily and remotely
- The mist chambers have a long life if installed and maintained properly and can be an extremely successful investment that gives returns quickly **(Greenly irrigation systems, 2022).**

Limitations

While mist chambers offer numerous benefits, they require proper maintenance and management to function effectively. Common challenges include:

- Clogging of Nozzles: Fine nozzles can get clogged by impurities in the water. Regular cleaning and filtration are necessary.
- Power Dependency: Mist chambers rely on electricity for pumps and control systems, making them vulnerable to power outages.
- Initial Investment: The setup cost for a mist chamber can be high, especially for largescale operations (**Ravanshree M *et.al.*, 2024**).

Future Trends

The future of mist chamber technology is leaning toward greater efficiency, automation, and integration with modern horticultural practices. Key trends include:

- **Smart Automation:** The integration of IoT (Internet of Things) devices, sensors, and microcontrollers (like Arduino) will enable precise, real-time control of misting based on temperature, humidity, and light intensity, optimizing resource use and plant health **(MDPI, 2023).**
- **Nanotechnology:** The use of nanotechnology in nozzles to create even finer mists will lead to more efficient cooling and humidification with less water usage **(True MIST, 2023)**.
- **Integration with Soilless Culture:** Mist chambers are a natural fit for aeroponics, where plant roots are suspended in the air and misted with a nutrient-rich solution. This method is being explored for high-density fruit crop production, especially for soft fruits like strawberries **(Christie and Nichols, 2003).**
- **Renewable Energy Sources:** The use of solar panels to power misting systems will make the technology more sustainable and accessible in remote areas.

Conclusion

Mist chamber technology has been a game-changer for the vegetative propagation of difficult-to-root fruit crops. By providing a finely controlled microclimate, it has significantly improved rooting success rates, accelerated growth, and enabled year-round production. While initial costs and the need for careful management are present limitations, the ongoing advancements in automation and sensor technology promise to make these systems more efficient and accessible. As we move towards precision horticulture, mist chambers, especially when integrated with smart systems and soilless culture, will continue to play a pivotal role in meeting the growing global demand for fruit crops.