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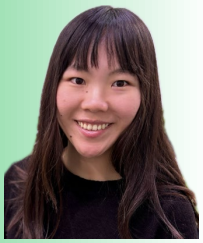
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Some Considerations in Pursuing Indoor Vertical Farm Strawberry Production

From sourcing clean planting materials to pest and disease management, from cultivar selection to crop management, this article discusses the specific requirements and unique challenges in strawberry indoor vertical farming.

Locally produced strawberries are popular among consumers, as the closely located production sites can reduce shipping distance, allowing the strawberries to be harvested closer to maturity.

Figure 1. Strawberry plants grown in an indoor vertical farm system (photo by Yiyun Lin)

However, producing local strawberries with consistent quality can be challenging due to environmental variations. Indoor vertical farming, a controlled environment agriculture system, is commonly recognized for local food production and can support the year-round production of local strawberries. Theoretically, indoor vertical farms can maximize yield and enhance fruit quality by optimizing growing conditions and providing a low-pest environment during cultivation, although they typically require high capital and operational expenses. While leafy greens are the most commonly selected crops in vertical farms, interest in cultivating indoor strawberries is increasing due to their high value, popularity, and relatively compact plant size. Nevertheless, achieving a consistently high productivity of strawberries in indoor vertical farms is not an easy task.

Obtaining clean plant materials

Accessing clean planting materials is a primary challenge for strawberry growers. Many strawberry diseases, such as Anthracnose crown rot and Angular leaf spot, may not show any symptoms until they encounter certain environmental conditions or until the plants start fruiting, causing severe crop loss. The best solution is to eliminate the chances of carrying diseases by using clean planting materials. However, most widely available strawberry planting materials in North America, such as bare roots and plug plants, are propagated in soil-based propagation beds in open-field nurseries. Using sterile soilless substrates under controlled environments can effectively reduce soil-borne pathogens. For this reason, indoor vertical strawberry farms often propagate their own materials in-house, with appropriate license, to eliminate the chance of introducing diseases into the production systems.

Alternative solutions include using disease-resistant cultivars, clean tissue culture plants, or seed-propagated strawberries as planting materials. The use of disease-resistant cultivars can be limited because the resistance to different diseases may be variable, and new diseases or pathogen strains continue to emerge, such as the recent Neopestalotiopsis outbreak. Tissue culture can effectively produce disease-free plants, but it is much more costly and often not considered as an ideal starting material due to its overly vegetative growth characteristics. Additional infrastructure to operate tissue culture is also an issue for many farms. Seed-propagated strawberries could be alternatives that offer clean planting materials. However, commercially available seed-propagated cultivars with desirable traits are still limited.

Limited tactics for disease and pest management

Although indoor vertical farms are relatively enclosed areas and typically present low pest pressure, pests and diseases can still occur due to foot traffic and air exchange. Currently, only a limited number of pesticides are applicable for controlling pests and diseases in strawberry indoor vertical farming, while most of them are biological or botanical. Some examples include biofungicides (e.g. potassium bicarbonate, *Bacillus* spp.) for disease management and bioinsecticides/ biomiticide (e.g. potassium fatty acids, pyrethrins, horticulture oils) for pest management. If disease and/or pest pressure continue to escalate during production, management can be problematic. It is critical for government agencies to update current pesticide labels for indoor vertical farm food crop production.

Cultivar selection

Another challenge indoor growers may encounter is cultivar selection. Growers often select cultivars based on harvest time, yield, disease resistance, shelf life, and/or specific fruit quality such as unique color or outstanding flavor. Nevertheless, it is important to select cultivars that are suitable for indoor growing environments with artificial lighting. Strawberry plants of the same cultivar grown in indoor vertical farms may display different growing habits, yield, and/or quality than growing with sunlight. Therefore, evaluating the characteristics of strawberry cultivars under indoor vertical farm environments is critical for cultivar selection.

Semi-dormancy under short-day conditions

Strawberry cultivars can generally be divided into two types, June-bearing and everbearing strawberries, based on their flowering responses. June-bearers are obligate short-day (SD) cultivars that produce flowers when plants are exposed to a photoperiod shorter than the critical photoperiod (13-14h). In open fields, they typically induce floral buds in the fall and produce harvestable fruit early summer (hence the name June-bearer). Ever-bearers are facultative long-day (LD) cultivars that produce more flowers when plants are exposed to longer photoperiods, and they can produce fruit from early summer to fall in open fields. Some cultivars (e.g., 'Portola' as reported by Garcia and Kubota (2016)) are a true 'day-neutral' type, meaning they are insensitive to photoperiod.

In indoor vertical farms, the production timing is easier to manage with June-bearers by adjusting the photoperiod, and many June-bearers produce high-quality fruit with unique flavors. However, a challenge of growing June-bearing strawberries under prolonged exposure to SD photoperiod is the induction of semi-dormancy. Plants under semi-dormancy can be identified by their unique morphological changes, including shortened leaf petioles, smaller leaf size, and shortened flower and fruit trusses, reducing overall growth and productivity (Figure 2A).

Semi-dormancy is induced when plants are exposed to SD photoperiod for 4-6 weeks, and it can be managed using multiple methods. After flower induction under SD photoperiod, growers can extend the photoperiod to reverse the semi-dormancy symptoms, promoting plant growth and fruit production.

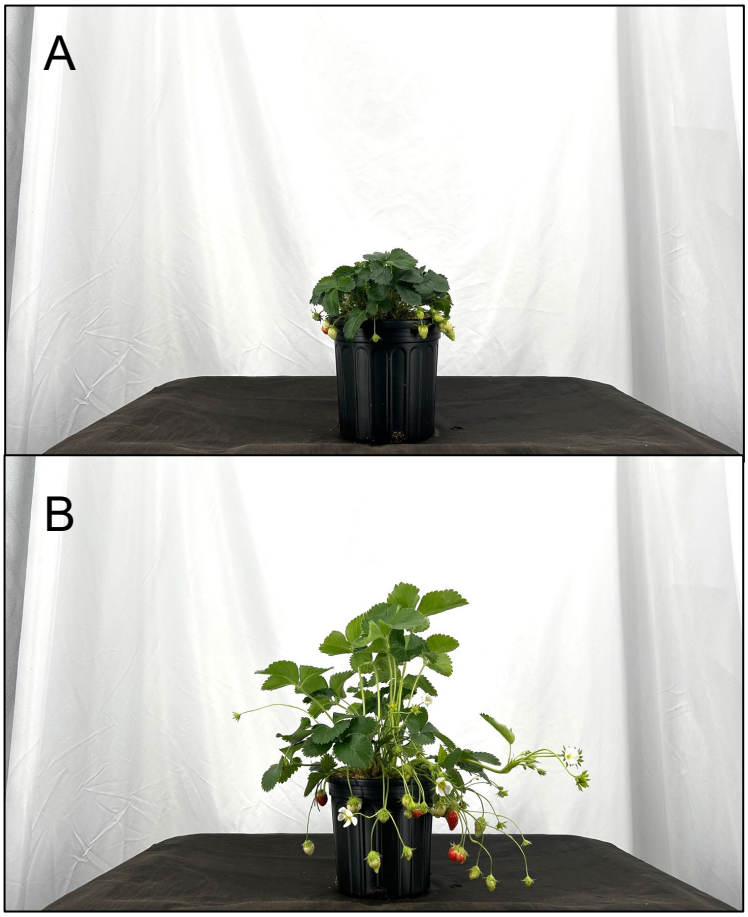

Figure 2. Representative photos of Strawberry 'Earliglow' plants (A) showing semi-dormancy symptoms after being grown under short-day photoperiod for 22 weeks and (B) grown with supplemental far-red light under short-day photoperiod for 22 weeks (Lin et al., 2025).

However, it is unclear how long specific SD cultivars can continuously flower under LD. As the number of flowers gradually decreases after harvest, the photoperiod can be altered back to SD for another round of flower induction. Recent preliminary research at the Ohio State University indicates that changing indoor light quality by adding a large far-red photon flux (700-750 nm) can also prevent semi-dormancy while increasing yield and fruit quality in strawberries under continuous SD (Figure 2B) (Lin et al., 2025). Selecting cultivars with lower sensitivity to semi-dormancy-inducing SD photoperiod is another solution. Ever-bearers do not require SD, and therefore they are more suitable in indoor vertical farms.

Production system design

Compared to leafy greens and herbs, strawberries require more crop management, and therefore, being able to access the crops in the facilities is important. Tasks such as leaf pruning, runner pruning, and supporting fruit trusses need to be conducted on a weekly basis to prevent disease and enhance production. More importantly, access to plants is also necessary for fruit harvesting, which may occur every 1-2 days.

Pollination

Pollination is critical for the production of high-quality strawberries, as uneven pollination results in misshapen fruits. Open-field and greenhouse strawberries are pollinated mainly through wind or insect pollinators, such as bumblebees and honeybees. However, in indoor vertical farms, bees seem to show reduced foraging activities, making pollination difficult. More research is needed to improve the environment to allow insect pollination. Currently, alternative solutions include manual pollination and mechanical pollination. Strawberries can be pollinated by flicking the flowers with fingers or using an electric vibrating pollinator to help distribute the pollen onto the stigmas. A less labor-intensive method is to create air movement that is strong enough (for example, with a leaf blower) to vibrate the flowers.

Despite the many challenges in producing strawberries in indoor vertical farms, strawberry remains a strong candidate for local production using indoor vertical farming approaches, because it is one of the most high-value and popular fresh fruits in the United States.

Further research and development in lighting requirements, pest and disease management, and pollination strategy can shed light on the advancement of strawberry indoor farming.

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