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GREENHOUSE STRAWBERRY CULTIVATION TECHNOLOGY

Mamasidiqova Nafisaxon Khamidullo qizi
Student of Andijan Institute of Agriculture and Agrotechnologies Tel: +998979738185 Email: mamasidiqovanafisaxon1826@gmail.com

Abstract: *This article analyzes modern agrotechnologies for growing strawberry (Fragaria × ananassa Duch.) in protected cultivation systems – greenhouses, plastic tunnels, and vertical systems. Hydroponic methods, substrate types (perlite, peat), mulching materials (black polyethylene), nutrient regimes (NO_3/NH_4 ratio, MasterBlend formula), temperature and light management, as well as integrated pest management (IPM) strategies are discussed in detail. Research indicates that the highest yield is achieved in vertical systems using a perlite-peat mixture combined with black polyethylene mulch. Key challenges include pH stabilization in hydroponic solutions and the seasonal decline of biological control agents during cold periods.*

Keywords: *strawberry, greenhouse, hydroponics, mulching, IPM, substrate, pH control, vertical farming.*

INTRODUCTION

Strawberry (Fragaria × ananassa Duch.) is one of the most important berry crops worldwide. Traditional open-field cultivation is limited by seasonality, weather risks, and high disease pressure. Greenhouse technologies enable higher productivity, improved fruit quality, and year-round production. Based on recent scientific literature, this article presents optimal agrotechnical practices for strawberry cultivation in greenhouses.

Hydroponics and Substrate (Soilless Cultivation). Soilless systems are widely adopted in greenhouse strawberry production because they enhance control over root-zone conditions and reduce soil-borne diseases. Vertical systems (columns or polyethylene pipes) maximize space use. Research has shown that a substrate mixture of 80% perlite + 20% peat yields the highest productivity (up to 250 g per plant). Deep Water Culture (DWC) is another effective hydroponic method. However, a major challenge in DWC is the rapid drop in solution pH. Using MES buffer is an effective solution, whereas potassium bicarbonate ($KHCO_3$) has proven less effective. Therefore, special attention must be paid to the nitrate-to-ammonium ratio to maintain pH stability.

Importance of Mulching. Mulching plays a critical role in conserving soil moisture and regulating temperature in greenhouses. Black polyethylene mulch (treatment T3) increased soil temperature (20.75°C) and moisture (29.08%), producing up to 45 marketable fruits per plant. Organic mulch (straw-like grasses) improved fruit protein and carbohydrate content but resulted in lower overall yield compared to synthetic mulches. In conclusion, black polyethylene mulch provides the highest yield under protected cultivation.

Nutrient Management (Fertigation). Strawberry is highly sensitive to the form of nitrogen supplied (NO_3 vs. NH_4) and to pH fluctuations. The standard recipe for hydroponics – the MasterBlend 9-12-34 formula – is widely used (e.g., 8.5 g MasterBlend + 8.5 g calcium nitrate + 5.6 g magnesium sulfate per 5 gallons of water). To maintain stable solution pH, an 80% nitrate (NO_3) to 20% ammonium (NH_4) ratio is recommended. If ammonium exceeds 20%, pH drops sharply, inhibiting nutrient uptake. As a result, plant growth slows, leaves turn yellow, and yield decreases.

Temperature and Light Regime. Strawberry growth and flowering are highly temperature-dependent. In protected cultivation (especially plastic tunnels), the day-night temperature difference affects both plant development and pest dynamics. Heat stress severely reduces fruit quality. Therefore, greenhouses must be equipped with ventilation systems or shading nets. During winter months, the use of supplemental artificial lighting (grow lights) significantly increases yield and fruit sugar content.

Integrated Pest Management (IPM). Closed environments require a combination of chemical and biological control methods. Recent research emphasizes the importance of IPM in greenhouse strawberry.Major pests: Two-spotted spider mite (Tetranychus urticae) and cotton aphid (Aphis gossypii).Biological control agents:Phytoseiulus persimilis – for spider mites;Aphidius colemani – for aphids.

Temperature and Light Regime.Growth stage Day temperature (°C) Night temperature (°C) Critical limit.Flowering and pollination 18–22 10–12 ‹8°C or ›28°C.Fruit development 15–18 8–10 30°C (quality decreases).Winter supplemental lighting (grow lights) 12–16 hours/day – 100–150 μmol/m²/s PAR.Fruit firmness reduction due to heat stress: Up to 35%.Yield reduction with 30% shading: ~20%.

Integrated Pest Management (IPM).Pest Biological agent Effective temperature range Efficacy.Tetranychus urticae (spider mite) Phytoseiulus persimilis 15–30°C 85–95%.Aphis gossypii (cotton aphid) Aphidius colemani 18–28°C 75–90%.Chemical control (selective use during cold seasons):Abamectin (0.5 L/ha) – for mites.Pymetrozine (0.4 kg/ha) – for aphids.Important: After chemical treatment, allow 7–14 days before reintroducing biological agents.

Leaf and Runner Removal Schedule.Operation Frequency Number removed per session.Old leaf removal Every 2–3 weeks 2–3 leaves per plant.Runner removal Every 1–2 weeks All runners (if not needed for propagation).Nutrient solution concentration during fruit ripening Reduced by 50–60% Compared to standard regime.

Overall Performance Indicators.System type Yield (kg/m²/year) Fruit quality (avg. weight, g) Efficiency.Vertical + perlite/peat + black mulch 14–18 25–30 High.Conventional (horizontal, soil) 6–9 18–22 Medium.Deep Water Culture (DWC) 10–13 22–27 Medium–High (pH management critical).

Key challenge. During cold winter months, the activity of these natural enemies declines significantly. In such periods, selective insecticides and acaricides should be used, followed by reintroduction of biological agents when temperatures rise.

Physical methods. Silver-reflective mulch films repel aphid vectors.Additionally, regular removal of old leaves and runners reduces plant density, improves air circulation, and minimizes disease risk. During fruit ripening, reducing fertilizer concentration (e.g., to prevent misshapen berries) is very important.

Conclusion. For greenhouse strawberry production, it is recommended to use soilless systems (hydroponics), maintain stable pH with an 80:20 NO_3/NH_4 ratio, apply black polyethylene mulch, and combine selective chemical pesticides in cold seasons with biological control agents (Phytoseiulus persimilis, Aphidius colemani) in warm periods. The best results are achieved in vertical growing systems. These technologies not only increase strawberry yield and quality but also help reduce negative environmental impact.

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