Recent advances in the cultivation of CEA tomatoes: evidence from 2015–2025

Hydroponic tomato yields are already high, yet many operations still leak performance through nutrient scheduling, canopy design, and stress control. Below is a blunt, data-driven synthesis for controlled environments based on recent scientific studies. The pattern is consistent: stabilize nutrition and irrigation first, then layer biostimulants or hormones only where trials show a payoff.

A soilless cherry tomato crop

Mineral nutrition and solution management

A 2024 greenhouse study across six cultivars found that a constant nutrient concentration program matched yield and improved size distribution compared with stage-based ramps when EC was well controlled (1). A 2023 review distills

current best practice for recirculating systems, stressing stage-appropriate EC, ion ratios that avoid antagonisms, and disciplined monitoring in closed loops (2).

Closed systems are viable when sanitation and monitoring are tight. A greenhouse comparison showed closed hydroponics achieving similar yields with better water and fertilizer use efficiency than open run-to-waste setups (3). Calcium balance still matters. Whole-plant experiments showed that simply pushing calcium does not prevent blossom-end rot and that imbalances can backfire, so keep Ca adequate and balanced rather than excessive (4).

Irrigation and pruning practices that scale

Partial root-zone drying and moderate deficit irrigation remain the most defensible water-saving tactics in greenhouses. Grafted tomatoes under PRD or deficit regimes saved 30 to 40 percent water with only minor yield penalties and sometimes higher fruit mineral concentrations (5).

On canopy design, a low-truss high-density approach can raise kilograms per square meter. In a hydroponic sub-irrigated trial with the indeterminate hybrid Rebeca, the top treatment was two trusses per plant at 11.1 plants per square meter, reaching 22.61 kg per square meter in 134 days without harming fruit quality (6).

Biostimulants with signal, not hype

Seaweed extracts and chitosan have the most consistent tomato evidence in soilless systems.

A greenhouse study in inert substrates showed that foliar seaweed extract at 100 000 to 200 000 ppm improved chlorophyll, gas exchange, and fruit quality indices. Silicon

at 75 ppm (as sodium silicate) increased firmness and yield per plant in a palm-peat mix. Effects were substrate and dose dependent, so you must calibrate to your product and spray volume per area (7). A 2022 review synthesizes similar benefits for seaweed extracts under salinity stress, with gains tied to photosynthesis and ion homeostasis rather than magic bullets (8).

For chitosan, a 2025 greenhouse study on Floradade and Candela F1 tested 500, 1000, and 2000 ppm foliar programs. Higher rates improved growth and physiology, with cultivar-specific responses. Product specs like degree of deacetylation and molar mass were not reported, so do not assume equivalence across suppliers (9).

Exogenous hormones: targeted, not blanket

If fruit set is the bottleneck during heat or low pollen viability, exogenous hormones can help. In protected cultivation of cv. Srijana, a conservative foliar program of GA3 at 50 ppm with NAA at 25 ppm increased fruit set and total yield. The response surface penalized higher rates, reminding you that timing and dose are critical (10). For mechanism and limits, a 2022 review explains how auxin and gibberellin signaling induce parthenocarpy in tomato and why misuse leads to malformed fruit (11).

Summary tables

Table 1. Mineral nutrition and system practices with yield impact in CEA tomatoes

Factor	Cultivar or type	Dose or setting (ppm)	Observed effect	Source
Constant vs stage-based nutrient supply	Six cultivars, greenhouse	Program choice rather than dose	Constant feed matched yield and improved size distribution	(1)
Nutrient solution management review	General CEA	Program design	Best practice for EC, ion ratios, and closed-loop monitoring	(2)
Closed vs open hydroponics	Determinate tomato, greenhouse	System choice	Closed loop improved water and fertilizer efficiency with comparable yield	(3)
Calcium balance	Modern genotypes	Balanced Ca supply	Lower BER risk depends on overall ion balance, not brute Ca	(4)
Partial root-zone drying and deficit irrigation	Grafted tomato, greenhouse	Irrigation scheduling	30 to 40 percent water savings with minor yield penalties	(5)

Table 2. Biostimulants in soilless tomatoes

Biostimulant	Cultivar or type	Application	Dose (ppm)	Observed effect	Source
Seaweed extract	Cherry tomato, greenhouse substrates	Foliar	100 000 to 200 000	Improved physiology and fruit quality indices under stress	(7)
Silicon as sodium silicate	Cherry tomato, greenhouse substrates	Foliar	75	Increased firmness and yield per plant in palm-peat mix	(7)
Chitosan (medium MW, commercial)	Floradade and Candela F1	Foliar, multiple sprays	500, 1000, 2000	Improved growth and physiological performance, cultivar dependent	(9)
Seaweed extract review	Multiple tomato types	Seed or foliar in soilless culture	Various	Stress tolerance and modest yield gains under salinity	(8)

Table 3. Exogenous hormone programs with documented yield or set effects

PGR	Cultivar or type	Application	Dose (ppm)	Observed effect	Source
GA3 + NAA	Srijana, protected cultivation	Foliar during flowering	GA3 50, NAA 25	Increased fruit set and total yield; higher rates underperformed	(10)

PGR	Cultivar or type	Application	Dose (ppm)	Observed effect	Source
Auxin and GA context	Tomato, general	Mechanistic review	N/A	Explains parthenocarpy induction and risks of misuse	(11)

Practical takeaways

Do not chase clever ramps before you can hold EC steady. A constant, well-tuned feed can match yield and improve size distribution when the rest of the system is under control (1), (2). Closed loops pay only if you earn them with monitoring and sanitation (3). Low-truss high-density recipes push kg per square meter, provided irrigation and nutrition meet the faster sink demand (6). Seaweed extracts and silicon can help under stress, but responses are product and substrate specific. Chitosan works, yet cultivar and formulation matter, so trial first (7), (8), (9). Hormones are scalpels for set problems, not a replacement for climate and pollination management (10), (11).