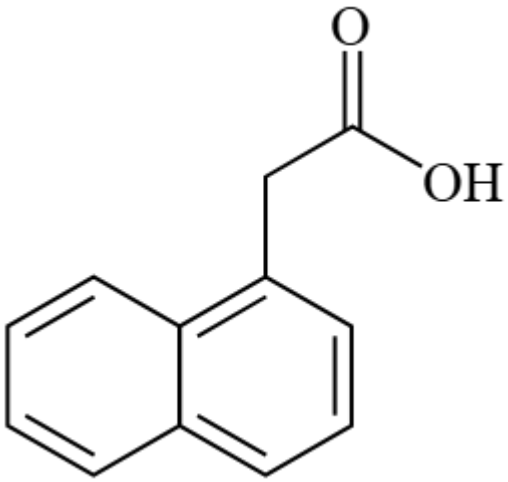
Root-applied auxins in hydroponics: where they help, where they don’t

Introduction

Auxins can modulate root architecture, fruiting and stress responses. In hydroponic and substrate soilless systems, exogenous **root-zone** applications at very low ppm sometimes boost yield or quality. Push the dose and you flip the response. Below I review peer-reviewed work on widely grown crops, focusing on species, timing, exact dosages converted to ppm, and toxic thresholds. Where possible I prioritize reviews to frame context, but yield data come from primary trials.



Model representation of the NAA molecule, a very commonly used auxin in plant culture.

Evidence & discussion

Sweet pepper. Two lines of evidence exist. First, fertigation with a commercial IBA product at **0.4 percent** active (4000 ppm in the stock) applied **weekly from early fruit development** at **0.5 L ha^{-1}** outperformed **1.0 L ha^{-1}**, increasing marketable

yield while improving root mass and water and nutrient uptake in perlite culture (1). Second, a separate trial compared **root fertigation vs foliar** using a formulation containing **6.75 g L^{-1} NAA** and **18 g L^{-1} NAA-amide**. The fertigation rate was **0.6 mL L^{-1}** of product in the solution, equal to **~4 ppm NAA** plus **~10.8 ppm NAA-amide** per application; foliar used **0.4 mL L^{-1}** or **~2.7 ppm NAA** plus **~7.2 ppm NAA-amide**. Early and total yield were higher with fertigation, while foliar favored some quality traits like firmness and soluble solids (5). Practical read: peppers respond to root-zone auxin in the **single-digit ppm** range, but more is not better.

Melon. The same IBA approach that helped pepper flopped in melon. In perlite greenhouse culture, **0.4 percent IBA** applied **weekly** at **0.5 or 1.0 L ha^{-1}** did **not** improve yield or water or nutrient relations. Authors concluded it is not an effective tool for commercial melon in soilless culture (2). Species matter.

Strawberry. In long recirculating systems, autotoxic phenolics depress growth and fruiting. A **one-time root or crown dip** in NAA **before transplant** at **5.4 µM** NAA, which is **~1 ppm**, mitigated autotoxicity and restored flower and fruit numbers compared with untreated plants. A higher **54 µM** dose, about **10 ppm**, was less effective (3). Timing was everything.

Toxic thresholds from hydroponic seedlings. While not a yield trial, maize in nutrient solution shows the margins. IBA at **10^{-11} M** is **~0.000002 ppm** and stimulated root growth, but **10^{-7} M** is **~0.02 ppm** and significantly stunted primary root elongation and biomass. The same hormone switches from helpful to harmful across four orders of magnitude (4). That narrow window explains why melon trials can miss and pepper trials can hit. For broader context on root-zone biostimulation via fertigation programs, see this review (6).

Tables

Table 1. Positive responses to exogenous auxin at the root zone in soilless crops

Crop & system	Auxin and delivery	Dose in root zone (ppm)	Timing	Outcome
Sweet pepper, perlite	IBA 0.4 percent product via fertigation	Stock is **4000**; applied **0.5 L ha^{-1} weekly**	From early fruit development	Higher marketable yield at 0.5 vs 1.0 L ha^{-1}; improved root mass and water and nutrient uptake (1)
Sweet pepper, soilless	NAA + NAA-amide via fertigation	**~4** NAA + **~10.8** NAA-amide per application	Weekly during production	Higher early and total yield vs foliar; foliar favored firmness and °Brix (5)

Crop & system	Auxin and delivery	Dose in root zone (ppm)	Timing	Outcome
Strawberry, recirculating hydroponics	NAA root or crown dip	**~1** optimal; **~10** less effective	One time at transplant	Mitigated autotoxic yield loss; restored flower and fruit counts under closed reuse (3)

Table 2. Null results and toxic thresholds

Crop or context	Auxin & delivery	Threshold or tested dose (ppm)	Timing	Result
Melon, perlite greenhouse	IBA 0.4 percent via fertigation	Stock **4000**; **0.5 or 1.0 L ha^{-1} weekly**	Season-long	No improvement in yield or water or nutrient relations (2)
Maize seedlings, hydroponic assay	IBA in solution	**0.000002** stimulatory vs **0.02** inhibitory	Continuous exposure	Root growth stimulation at ultra-low ppm but marked stunting by **0.02 ppm** (4)

Conclusion

Root-applied auxins are not a silver bullet. They can raise yield or preserve quality, but only when dose and timing line up with the crop’s physiology. Peppers respond to **single-digit ppm** root fertigation with higher early and total yields, while melons do not. Strawberries benefit from a **~1 ppm** pre-plant dip that preempts autotoxicity, whereas **~10 ppm** underperforms. Hydroponic seedling work reinforces the risk: **~0.02 ppm** IBA already suppresses maize roots. The safe play is to trial low, crop-specific ppm near published values, apply at the stage that matters, and stop if marketable yield does not move. If you treat auxins like a nutrient and “turn them up,” they will punish you. If you treat them as a precise signal, they can pay off.