From Seed to Sprout
Nursery Management Guide

Plant nurseries refers to specialized facilities dedicated to nurturing plants at an early developmental stage i.e., seed germination and seedlings. Unlike other production systems optimized for biomass increase at a later developmental stage, plant nurseries provide different conditions in light intensity, temperature, humidity, and nutrient level, promoting seedling root development and growth. Growing strong robust seedlings through proper nursery management is important for subsequent development and growth of plants, contributing significantly to reliable and resilient plant production.

Terminologies

Seedlings: Plants that just emerged from seeds and in their earliest stage of growth. Characteristics include a small and delicate structure, minimal development of leaves and roots, with remnants of the seed coat possibly attached.

Photosynthetic Photon Flux Density (PPFD): Expressed in µmol/m²·s, measures how many Photosynthetic Active Radiation (PAR) Spectrum (400-700nm) photons are landing per unit area. Values can differ depending on distance from the light source.

Daily Light Integral (DLI): Expressed in mol/d·m², measures the total amount of light in the PAR Spectrum that is delivered to a plant daily for photosynthesis.

Young Plant: Plants that have progressed beyond that of seedlings but have yet to be fully mature. Characteristics of young plants includes the emergence of “true leaves”, which are leaves that appear after the cotyledons, with the same shape as the adult foliage as well as more developed and well-established roots.

Light-sensitive Germination: Refers to the process in which specific light conditions are required for seed germination. While most seeds do not require light for germination, some species such as *Lactuca sativa* (lettuce) do.

Electrical Conductance (EC): Expressed in dS/m, Measures the electrical conductivity of a solution within a unit distance and represents the content of soluble salt ions i.e., nutrients, in a solution. The optimal EC for plant growth can vary between plant varieties and growth stages.

Environmental conditions for plant nurseries differ from production systems[1-3]

Figure 1: Nurseries in greenhouse (left), indoor controlled environment agriculture (CEA) with full spectrum light (middle), and indoor CEA with red/blue light (right). Images created using Canva.

Light: Seedlings generally require ***less intense light*** compared to young plants as they are more sensitive and can easily become stressed or burnt.

Temperature: Seedlings generally require slightly ***higher temperatures*** compared to young plants to activate enzymes responsible for breaking down stored nutrients and promote root development.

Humidity: Seedlings require ***higher humidity*** levels compared to young plants to reduce water loss from the leaves as their delicate and developing roots are not efficient in absorbing water.

Density: Seedlings can be grown in ***higher densities*** compared to young plants as they have yet to develop extensive root systems, allowing maximization of growing spaces.

Nutrients: Seedlings require ***less nutrients*** compared to young plants as they are still in the early stages of growth, and their roots are not well developed.

Growth Media: Growth media for seedlings should have ***finer texture,*** allowing easy penetration by the delicate developing roots and increasing root contact with the substrate.

Choosing the right environmental conditions

General timeline from seed to harvest (Asian leafy vegetables):

Seed
Sown in nursery

Seedlings
Grown in nursery
(4 - 18 days)

Young plant
Transplant to production system
(14 - 25 days)

Mature plant
Grown in production system
(25 days - day of harvest)

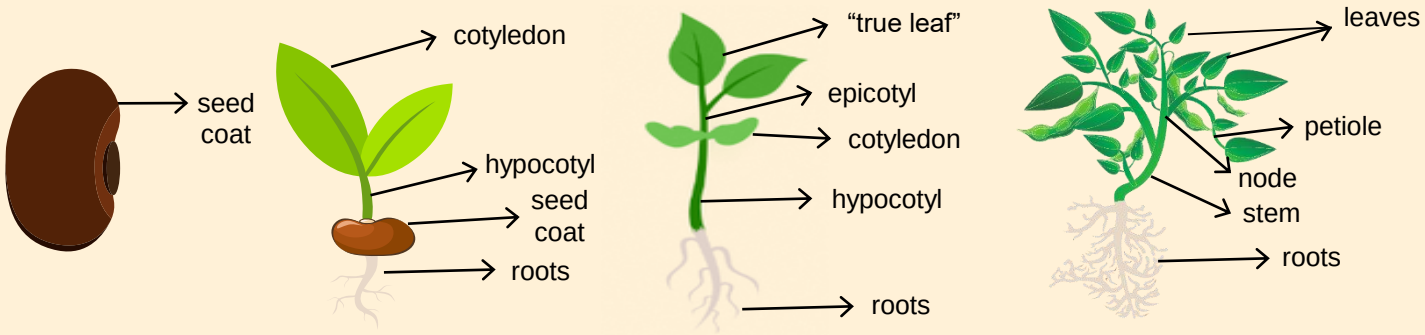

Figure 2: Plant development stages and growing timeline for Asian leafy vegetables. Images created using Canva.

Recommended conditions from seeds to mature plants in indoor production systems[1-5]

Factors			During seed germination	Seedlings in the nursery	Young Plants	Mature Plants
Light	PPFD (µmol/m²·s)	Seeds not requiring light	0	150 - 200	200 - 350	350 - 450
		Seeds requiring light	50 - 100			
	DLI (mol/d·m²)	Seeds not requiring light	0	7 - 10	12 - 15	15+
		Seeds requiring light	3 - 6			
	Quality		Full spectrum	Full spectrum	Combination of red/blue/green or full spectrum	Combination of red/blue/green or full spectrum
Temperature (◦C)			20 - 30	18 - 28	16 - 25	16 - 25
Humidity (%)			80 - 90	60 - 70	50 - 70	50 - 70
Plant Spacing (cm x cm)			2 x 2	2 x 2	10 x 10	10 x 10
Nutrients (dS/m)			0 - 0.5	0.5 - 1.5	1.5 - 2.5	2.5 - 3.5
Growth Media*			Fine with high water holding capacity	Fine with high water holding capacity	Coarse with relatively good drainage	Coarse with relatively good drainage

Note: Values may vary between species and cultivar.
*For substrate culture. For nutrient flow technique or deep-water culture (hydroponics), typically polyurethane sponges are used for all growth stages.

Tips and Case Study

Tips for germination and seedling growth[3,6]

- **Keep relative humidity high during germination:** Germination begins with the absorption of water. Consider having a dedicated germination room with a misting/fogging system to keep the relative humidity high.
- **Minimize seedling elongation:** Insufficient light intensity can result in weak and elongated seedlings. Therefore, do consider reducing the distance between light source and seedlings or install supplementary lights. A minimum PPFD of 150 µmol/m²·s is recommended.
- **Minimize environmental stress and transplanting shock:** EC should not be increased by more than 0.5 dS/mm each time. Similarly, light intensity should be increased gradually, thus allowing the plants to acclimatize to their external environment.

Effects of varying light intensities on seedlings[7]

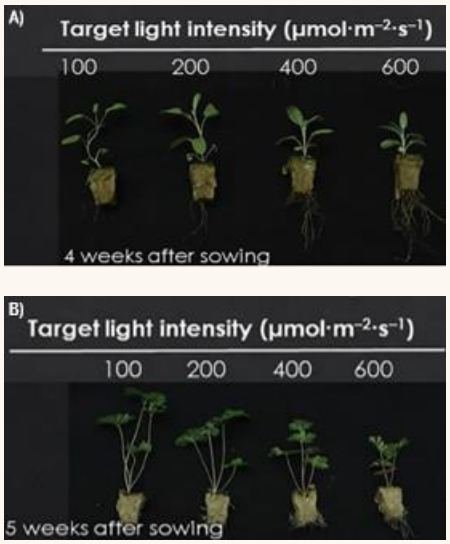

Figure 3: Effect of light intensity on (A) sage and (B) parsley seedings (Adapted from "Indoor production of herb seedlings: light intensity & carbon dioxide" by KJ Walters, Produce Grower. Retrieved July 2024)[7]

Treatment	1	2	3	4
PPFD (µmol/m²·s) (16h photoperiod)	100	200	400	600
DLI (mol/d·m²)	6	12	24	35

Takeaways:

- Seedlings grown under higher light intensities (200, 400 and 600 µmol/m²·s) had less elongation and better root growth compared to seedlings grown under 100 µmol/m²·s.
- Compact and sturdy seedlings could potentially require less labour or make automation of transplanting easier as it would be less delicate than that of elongated seedlings.
- After transplanting and grown in a greenhouse (temperature: 22.7◦C, DLI: 14 mol/d·m²), seedlings grown under higher light intensities resulted in higher yields at harvest compared to those grown under 100 µmol/m²·s.

Find out more!

Local farms can tap on the Agri-Cluster Transformation (ACT) Fund with the enhanced Energy Efficiency Programme (EEP) to build capabilities and capacities that drive higher productivity in a sustainable and resource-efficient manner. Farms can tap on co-funding under the EEP to undergo an energy efficiency audit which would establish their baseline energy consumption and identify potential areas for improvements. Farms can also leverage the enhanced Capability Upgrading component to adopt resource and energy-efficient equipment and technologies from SFA's prequalified list. All licensed farms can apply for co-funding under the EEP.

Let us know your thoughts

About the Author

Caleb Beh is from the Agri-Technology and Food Innovation Department of the Urban Food Solutions Division, with a background in Biological Sciences and Sustainable Agricultural Technologies. His current research includes indoor agriculture production systems and plant nursery management.

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