Paradigms & Gold Standards

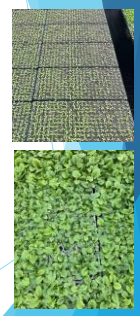
Underdeveloped Roots	Canopy too Large/Leggy	Rootbound	Gold Standard
Damage during transplant, or unable to transplant	Overshading of plugs, temperature, poor quality in production	Delays production time after transplant	Good shoot/root ratio, neither overgrown

compact habit, thick stem diameter, reduced leaf area, and high root and shoot biomass

1

Paradigms & Gold Standards

- Successful plug production should consider the following from sowing to growing:
  - **Uniformity**
    - A crop across a given space should receive as much uniformity as possible from the grower and environment
  - **Avoiding extremes**
    - i.e. moisture, temperature, light, pH, EC, etc.
  - **Plugs pass it on**
    - Any issues in quality or uniformity in the plug will carry on to the next production stage



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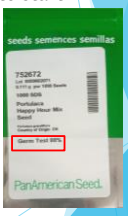
Starting with Quality Seed

The best place to start a good seedling is to start from a good seed

- Buy from a reputable supplier
- Understand germination standards provided
  - Min vs. test %
- Know what seed form you are purchasing



AMP - Amplified Seed
COT - Coated seed
DRL - Drilled seed
MPL - Multi-seed pellet
PEL - Pelleted seed
PNPL - Precision™ Multi-Pellet
PRM - Primed seed
RAW - Raw seed
TRT - Treated seed

3

Starting with Quality Seed

Proper storage

- Smaller increments helpful
- Ideal: ~40˚F, 30-50% RH
- Two rules to keep in mind:
  - Harrington's rule
    - 50% decline in shelf-life for every 1% increase in seed moisture, or 10˚F increase in temperature
  - James' rule of 100
    - Combined value in storage of RH (%) and temperature (˚F) should not exceed 100

4

Starting with Quality Seed

Seed Storage Infrastructure

	GOOD	+/→	BETTER	+/→	BEST
Temp. Control Capability	Below 55°F/13°C *(i.e., flower cooler)*	→	Below 45°F/7°C; avoid freezing *(i.e.,conventional refrigerator)*	→	Precise control at 41°F/5°C *(i.e., industrial cooler)*
%RH Control Capability	Gasketed tubs for seed packages	+	With a commercial desiccant inside, OR	→	Integrated relative humidity control
Cooler Location	In a temperature-controlled environment	+	With humidity control	+	Separated from other areas by air-conditioned hallway/room

Always ensure packets remain open for up to 24 hours inside storage area before sealing, to ensure RH equilibrates

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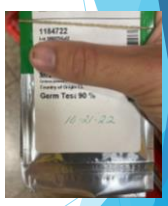
Starting with Quality Seed

Tracking tips to save time and improve success down the road:

- Dating seed packets upon arrival
- Keeping track of batch numbers when sowing in case issues arise

Crop	Variety	Sow Date	Batch #
Petunia	Easy Wave Pink	12/1/2023	324576891
Petunia	Easy Wave Denim	12/7/2023	324574832
Petunia	EZ Rider Blue	12/1/2023	324576531
Vinca	Titan White	1/7/2024	876432111
Vinca	Titan Red	1/7/2024	876432442
Pansy	Matrix Yellow Blotch	11/19/2023	465212345
Pansy	Matrix Morpho	11/19/2023	465214933



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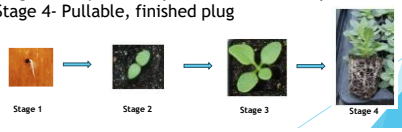
Production
Stages of Germination

- Plug production assorted into stages for cultural purposes
  - Stage 0- Sowing operations
  - Stage 1- Germination, ends at radicle emergence
  - Stage 2- Root emergence to cotyledon expansion
  - Stage 3- Cotyledon expansion to true leaf pair
  - Stage 4- Pullable, finished plug



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Production
Stage 0: Sowing

Plug Tray Selection

- Size
  - Choose the right size for the crop and finish size
- Depth
  - Deeper cells drain better, but take longer to root in
- Shape
  - Better root production in square or hexagonal cells than round

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Production
Stage 0: Sowing

When Reusing:

- Ensure no mechanical damage
- Do not reuse trays with paclobutrazol
- Wash and soak in disinfectant (i.e. quaternary ammonium) for at least 30 minutes

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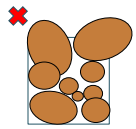
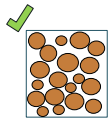
Production
Stage 0: Sowing

Media Selection

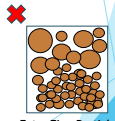
- Crop dependent
  - More moisture retentive mix (peat/vermiculite) for quick crops to act as a moisture/nutrient buffer
  - Better draining mix with perlite for certain drier species or longer crops (i.e. begonia)



Large Particles
promote bridging and nonuniformity across plugs



Mix of Fine Particles
Even fill across plug tray and blend of water-holding & drainage



Extra Fine Particles
"Dusty" particles clog pore spaces and settle to bottom

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Production
Stage 0: Sowing

Flat filling

- Pre-Moisten Media
  - Even plug fill
  - Ensures no settling of fine particles
  - Improves ability to water in plugs
- **Add ~100% moisture by weight to mix**
  - Media should hold its shape when squeezed, but break upon pressing

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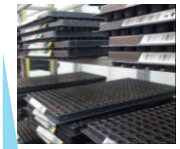
Production
Stage 0: Sowing

Avoid compaction

- Reduced drainage and porosity (more water, less oxygen)
- Careful stacking trays



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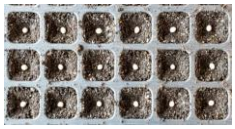
Production
Stage 0: Sowing

Flat filling continued
- Brush off excess media from top of tray to avoid bridging/moisture issues
- Dibbling
  - Allows seed to fall in center of plug and leaves room for cover
  - Depth of dibble depends on crop/seed size



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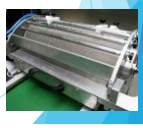
Production
Stage 0: Sowing

- Seeders
  - Proper maintenance goes a long way
  - Make sure calibrated to right plug tray
  - If using a vacuum-based seeder, run a test batch



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Production
Stage 0: Sowing

Covering

- Requirements depend on crop (no cover, light cover, heavy cover)
- Purpose is to retain moisture and help lock in seed, so apply evenly!
- Provides darkness for some seeds

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Production
Stage 0: Sowing

Covering

Light to Germinate	Dark to Germinate
Begonia	Viola
Petunia	Vinca
Gerbera	Zinnia
Impatiens	Marigold
Celosia	Dianthus
Coleus	Pansy
Alyssum	Verbena

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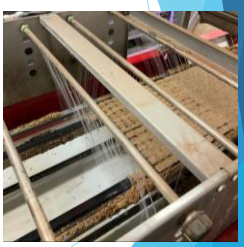
Production
Stage 0: Sowing

Water Tunnel

- Purpose- to help lock in seed
- Even, gentle application of water is critical, so:
  - Keep irrigation system clear of debris
  - Watch pressure coming out of nozzles



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Production
Stage 1: Germination

- Location: Germ Chamber
- Pros:
  - Easier to maintain environmental conditions
  - Frees up greenhouse space
- Cons:
  - Requires dedicated space/infrastructure
  - Requires close monitoring for germ

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Production
Stage 1: Germination

- Location: Greenhouse
- Pros:
  - Doesn't require additional infrastructure
  - Does not require additional handling
- Cons:
  - More difficult to maintain environmental stability
  - Utilizes potential finish-growing space
  - Options:
    - Booms or remay fabric

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Production
Stage 1: Germination

- Location: Greenhouse (floor)
  - Better space efficiency
  - More subject to temperature changes
  - Must keep trays raised to avoid moisture/pathogen issues

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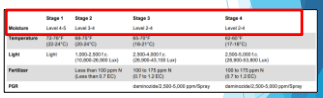
Production
Moisture

- Arguably the most important variable in plug production, and the easiest to manipulate!
  - Germination
  - Rooting quality
  - Uniformity of plugs
  - Height control
  - Pest/disease pressure



	Stage 1	Stage 2	Stage 3	Stage 4
Moisture	Level 4-5	Level 3-4	Level 2-4	Level 2-4
Temperature	72-75 °F (22-24 °C)	69-72 °F (20-22 °C)	65-72 °F (18-21 °C)	62-65 °F (17-18 °C)
Light	Light	1,000-2,500 f.c. (10,800-26,900 Lux)	2,500-4,000 f.c. (26,900-43,100 Lux)	2,500-6,000 f.c. (26,900-63,800 Lux)
Fertilizer		Less than 100 ppm N (Less than 0.7 EC)	100 to 175 ppm N (0.7 to 1.2 EC)	100 to 175 ppm N (0.7 to 1.2 EC)
PGR			daminozide(2,500-5,000 ppm/Spray	daminozide(2,500-5,000 ppm/Spray

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Production
Temperature

- Critical for development
  - Germination
  - Grow time
  - Toning/Finish Quality
- Know what you're monitoring
  - Air vs. substrate (top vs. bottom growth)
  - Substrate temperature affected by water, air, media, bottom heating

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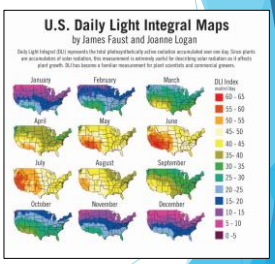
Production
Lighting

- Affects:
  - Finish time
  - Quality
- Target ≥10 mol.m2.day
  - Sufficient root mass and plant height

Grand Rapids Winter DLI	
Monthly Average	**DLI (mol.m2.day)**
Dec	5-10
Jan	5-15
Feb	15-20
Mar	25-30

Less with clouds and greenhouse glazing!
As little as 1-2 mol.m2.day in Dec/Jan



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Production
Fertility

- Before anything, check water quality!
  - Issues arise fast in the small volume of a plug
- Know your crop's preferred pH range
- Constant feed programs easiest to manage
- Avoid excessive N and P

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