PROPAGATION OF CUTTINGS

Clonal propagation is, at present, an integral part of the cannabis growing process. Propagating uniform, healthy, and vigorous cuttings lays the foundation for consistent and quality harvests. Growers can ensure the production of quality propagules year-round by measuring and adjusting environmental parameters and root zone conditions.

Mother Care

The quality, strength, and establishment time of new cuttings are highly dependent upon the health of the source plant material. The cultivation of hardy, active, and vigorous mother plants plays an integral role in the successful establishment of clones. Proper plant nutrition, ideal climate, and a tailored irrigation strategy, are among the most important components of developing strong mother plants. The nutrient solution applied to mother plants should be maintained at a minimum of 1.5 mS/cm or higher (highly dependent on light intensity) and applied in frequent daily irrigations that achieve drainage fractions of 15% -25%, depending on the age and size of the mother plant.

Mother plants should be pruned and topped early and often to generate large quantities of upright and uniform cuttings. Mother plant canopies should be trained in a balanced manner to maintain an open canopy structure that will produce healthy new shoots without over-stressing the plant. Mother plants should be culled and re-started from fresh cuttings every 3-4 months to avoid proliferation of latent viroids. Retaining individual mother plants for extended periods of time will typically lead to a gradual decrease in cutting quality, vigor, and rooting time.

PROPAGATION OF CUTTINGS

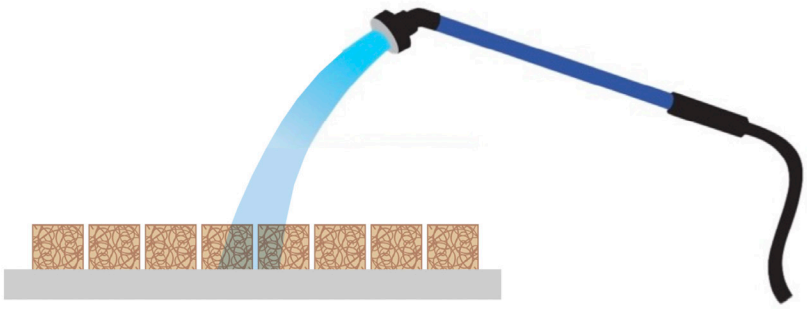
Saturating the Starter Plugs

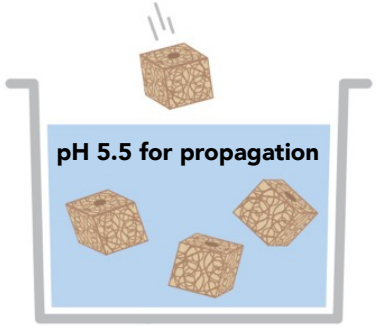
Correct saturation of the growing media sets the stage for proper root development. Because stone wool is an inert and clean substrate, lacking essential nutrients, growers must provide complete and balanced fertilizer to sustain the cuttings as their roots develop. Cuttings will need a near-immediate source of nutrients to maintain existing tissue and growing, so it is imperative that cultivators saturate the plugs with fertilizer initially. A steady nutrient supply becomes especially important once rooting has been initiated. Starter plugs and cubes should be saturated in a nutrient solution of 1.5 mS/cm or higher and 5.5 pH.

The saturation process can performed by soaking plugs and cubes in the solution for several minutes or via overhead saturation through a watering wand fitted with a coarse spray head. If saturating via a watering wand, it is important to apply the solution multiple times to ensure full saturation. Cubes and plugs may not reach full saturation if only one pass is made overhead.

Facilities with wettings lines or irrigation booms can automate the overhead saturation process, but must allow the substrate to pass under the nutrient solution multiple times to ensure full absorption.

After initial saturation, allow excess nutrient solution to drain away. Measure the weight of a few starter plugs or trays to ensure that they are uniform and fully saturated. Now you are ready to take cuttings.

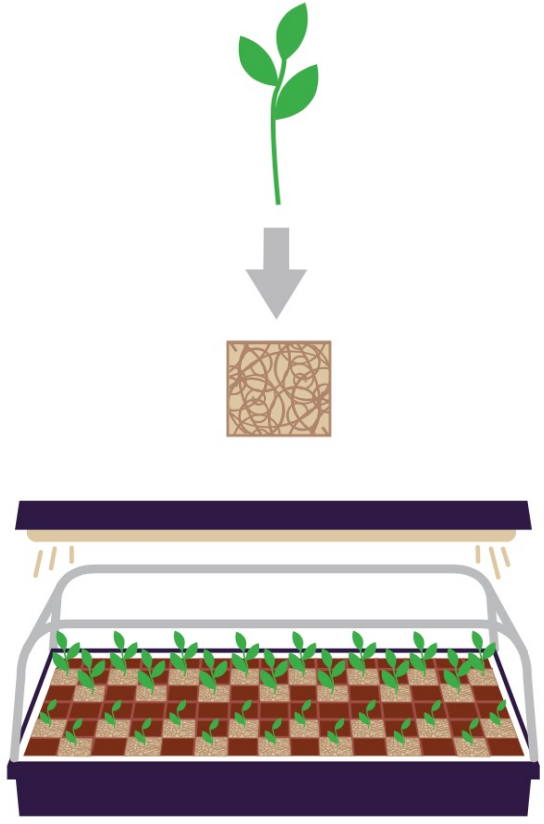




PROPAGATION OF CUTTINGS

Tips for Taking Cuttings

- Select sturdy, straight, and upright shoots, preferably from the top of the plant.
- Select shoots equal in length and diameter to ensure a uniform canopy.
- When applying a rooting solution, avoid excess powder or gel on the stem, as this can potentially cause disease and/or slow down root development.
- Stems should be placed around 1/2in (1cm) into the starter plug. This allows for root initiation in the plug from the top.
- Measure and note the starting weights of completed clone trays to help determine when to apply irrigation.
- Target a humid environment once clones are cut to prevent water loss to the environment through the leaves and maintain turgor in plant cells.
- Moisture loss can be controlled via a humidity dome, or by maintaining a consistent high relative humidity and low vapor pressure deficit throughout the propagation chamber.
- Humidity domes can be gradually vented and eventually removed once root-colonization is underway. This process of hardening off must be monitored closely and performed gradually.
- If maintaining cuttings in a propagation chamber, the relative humidity should be gradually reduced until it matches the relative humidity of the environment that plants will be transferred to in the vegetative stage.
- Acclimating plants to slightly lower humidities as they approach transplant will ensure a seamless transition from the clone stage to the vegetative phase.

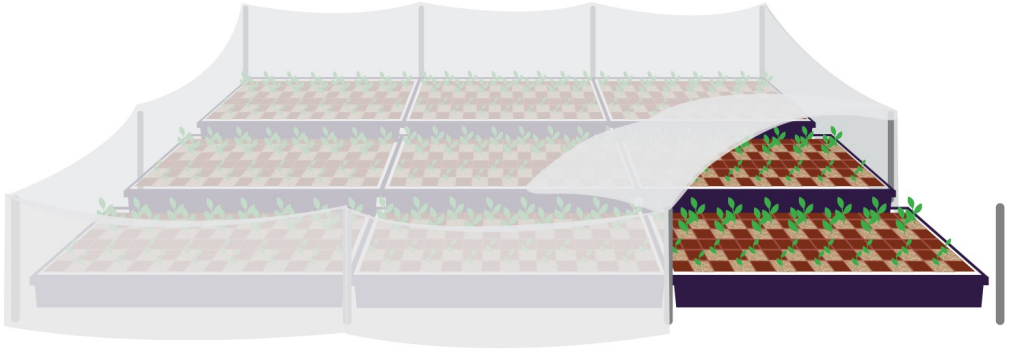


PROPAGATION OF CUTTINGS

Cutting Care

Once cuttings have been placed in starter cubes or plugs, they need to enter an environment that encourages root development. Humidity, temperature, light intensity, and air movement will affect how the cuttings develop, so monitoring and adjusting the climate daily is important. While small propagation domes are a popular choice, they can create a challenging environment for growing quality cuttings on a large scale. High humidity (90%+) and overly wet conditions in the canopy slow root initiation and increase disease, pest, and pathogen pressure.

If using humidity domes, it can be helpful to fill trays at 50% capacity to improve air flow and avoid fungi and bacteria development. For large-scale cutting production, an alternative is to use controlled-environment propagation chambers or large humidity tents to cover batches of cuttings. Chambers and humidity tents allow for better air movement, and the larger air volume creates a more stable climate.



PROPAGATION OF CUTTINGS

Cutting Care

In addition to environmental conditions, irrigation plays a significant role in root development. Overly wet conditions in the root zone can slow root initiation and facilitate the establishment of pathogens. The best way to determine when to irrigate is to:

1. Measure the weight of a tray of dry plugs filled at your desired density. This could be 50 plugs per tray, 39 per tray, 25 per tray etc. This depends on your style of tray and your number of cutting per tray. You will be taking the cumulative weight of the tray, the insert (if using), the dry plugs, but no dome. Notate this weight.

2. Next, fill a tray with your choice of fully saturated blocks or plugs at the same planting density/quantity per tray. Notate the total weight of the system with the plugs at full saturation.

3. Take the second weight (fully saturated plugs + tray + insert) and subtract from it the first weight (dry plugs + tray + insert). This number is your total water weight in the plugs per tray. Post this number in the propagation room.

4. Next prepare and place your cuttings

5. After you have filled the plugs with cuttings, take the final weight of the tray (tray, insert, saturated plugs, and clones) and notate it on the front of tray.

6. Weigh trays daily without their domes and apply irrigations to the cuttings once the total tray weight notated on the front in step 5 has decreased by 40-50% of the water weight calculated in step #3. This formula = (weight from step 5) - (40-50% of water weight from step 3).

7. By following these steps you can target an specific decrease in water content in the root zone and apply irrigation accordingly, no matter how many cuttings you choose to fill each tray with. This is especially important when growing multiple varieties, as they will consume water at different rates.

It is imperative that you do not weigh your trays with standing water in the base. This will skew the weight measurements and lead to incorrect irrigation.

Apply irrigations using a water wand, ebb/flow system, or by manually dipping the trays in a nutrient solution of 1.5 mS/cm or higher, 5.5pH about 1⁄2 to 3⁄4 inch (1 to 2cm) up the side of the starter plugs or cubes. If dipping whole trays into nutrient solution, dispose of the solutions between each tray to avoid cross-contamination. It is important to drain away excess solution because overly wet conditions at this stage will slow growth and increase the likelihood of disease, mold, algae, and pests.

PROPAGATION OF CUTTINGS

In conclusion, applying precision growing techniques can maximize propagule development speed and improve a cutting's final quality. Healthy mother plants that receive proper nutrition, and daily irrigations are the key to healthy cuttings Monitoring and adjusting climate conditions will improve root initiation and prevent the development of plant diseases.

Using a balanced fertilizer solution from the very beginning will ensure the cuttings have the optimal nutrition to develop without deficiencies. Measuring the weight of the starter cubes or plugs throughout the cutting stage will help determine the ideal moment to irrigate.

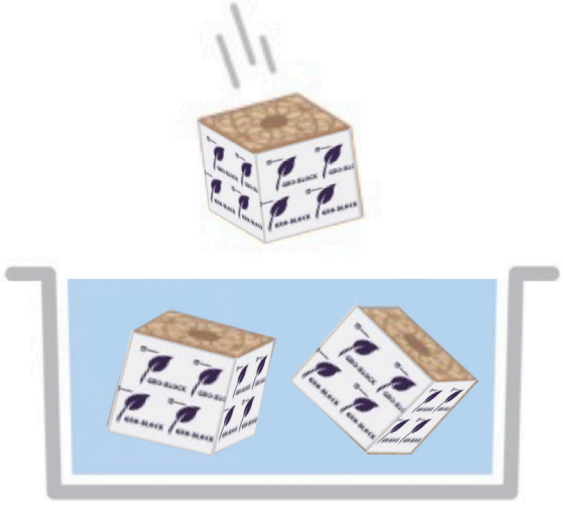
Propagation Table for Indoors: 18-22 hrs light per day

Days	1 - 4	4 - 7	7 - 10	10 - 14
Humidity (%)	80 - 90	75+	70+	70+
Temperature (°F)	75 - 80	75 - 80	75 - 80	75 - 80
Fertilizer (EC)	1.5-2.5 mS/cm	1.5-2.5 mS/cm	1.5-2.5 mS/cm	1.5 -2.5 mS/cm or more

Transplanting

Transplanting from a small block to a large block or slab is an important step in plant development, allowing for further root development and greater plant stability for large fruiting and flowering crops.

Extra care must be taken throughout this process to prevent plant shock, delayed growth, and poor root development. Transplanting from a smaller volume of growing media into a larger one provides better irrigation control and allows the plant to develop the root system required to support maximum flower and fruit development.



Preparation

The initial conditioning of blocks and slabs sets the stage for proper rooting-in. First, the EC of the conditioning nutrient solution should be close to what the plant has already been receiving. Using a similar EC will make it easier for the roots to grow into the new substrate. Ideally, the plant should already be irrigated with a nutrient solution of 1.5-3.0 mS/cm and a pH of 5.5-6.0 before transplanting.

Slabs can be conditioned using a drip irrigation system by filling the bags with the proper nutrient solution until they are full, ballooning, and taught at the seams. Once slabs are fully saturated, drainage slits should be cut at the lowest point of the slab, beneath the seam, closest to the drain. Placement of drain slits is important as it allows for optimal WC and EC management throughout the remainder of the crop cycle.

Large blocks may be conditioned using a watering wand, automated wetting line, or boom system by making several low-speed passes over the top of the blocks with a course spray until full saturation is achieved. Block weights and water contents must be checked to to ensure that full saturation has been consistency achieved.

Blocks can also be conditioned by fully immersing them in a reservoir containing the proper nutrient solution until they sink.

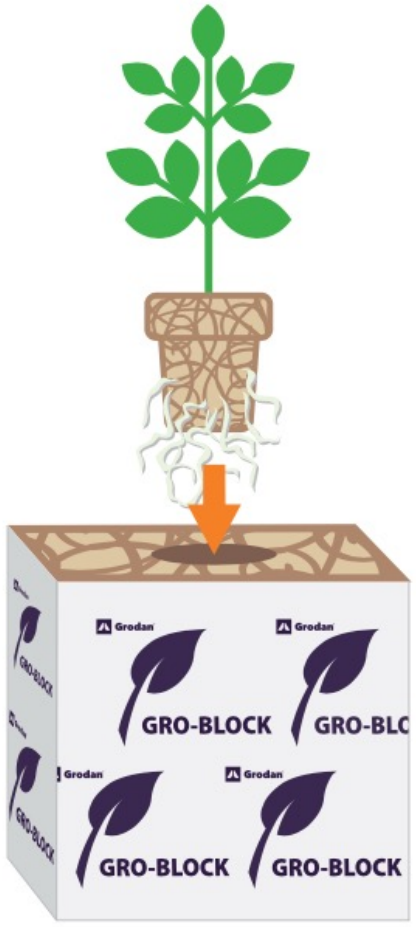
Blocks may also be conditioned using a flood table, as long as the solution can reach the top of the block and be held for a few minutes at that height.

PROPAGATION OF CUTTINGS

Transitioning to Transplant

Plants must be carefully transitioned to new environments to avoid transplant shock that will delay growth, reduce final product yield, and negatively impact quality. Environmental conditions such as temperature, humidity, CO2, light intensity should be maintained as close as possible to what the plant has already been acclimated to for the first 48-96 hours after transplant. After this acclimation period climate and lighting conditions can be intensified and manipulated as needed to target maximum growth and photosynthesis.

When transplanting, the water content (WC) of the transplanted block should around be 70% to 80% at field capacity. Once the transplant is placed on the slab or larger block, a single irrigation event equal to 3% of the total substrate volume should be delivered to even out the WC and EC at the point of interface and encourage water holding in the upper block. Irrigation events should be delivered via pressure-compensating drip stakes with a maximum flow rate of 0.3-0.5 gph.



VWC = ~ 70 - 80%

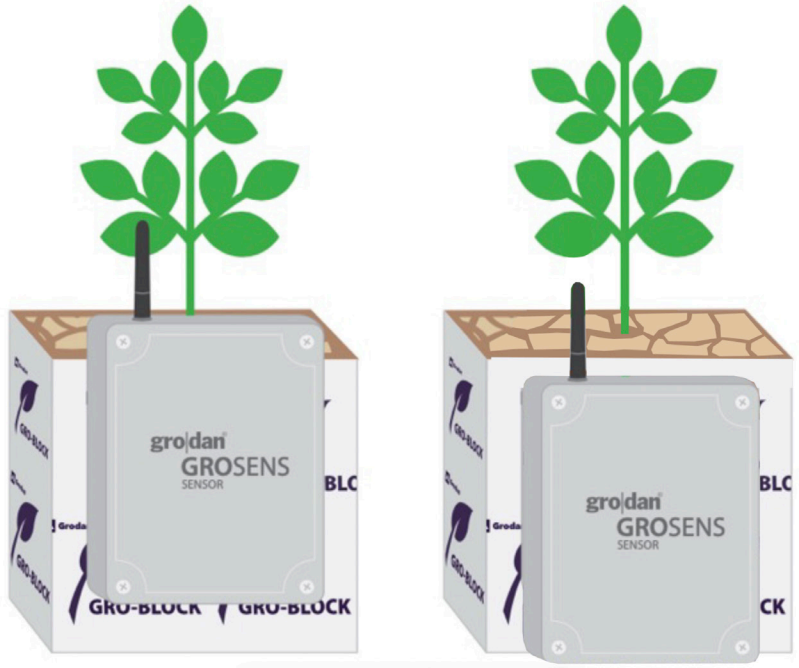
TRANSPLANTING TO BLOCKS

Irrigation Strategy

Irrigation strategy plays an important role in how a plant develops during the transplant phase. By utilizing the Grodan root-zone sensors to accurately measure substrate WC, EC, and temperature, you can determine the optimal irrigation strategy for your crop.

After the initial transplant, the Grodan root-zone sensors should be placed in the top block for the first 24-72 hours. Irrigation volumes of 1-3% should be applied approximately every 1 to 4 hours for the first 24-72 hours hours after transplant to maintain a WC between 60-70% in the top block. With small shots and a rest time between irrigation events, growers can maintain upper block water contents high enough to sustain existing roots until they transition to the lower block or slab, while simultaneously preventing the top block from becoming over-saturated.

24-72 hours after the initial transplant, any night-time irrigations should be eliminated, and the Grodan root-zone sensor should be moved to the bottom slab or block. Day-time water content should be monitored and maintained at 50-75%. Roughly 5-7 days after the initial transplant, the plant should be well rooted into the new substrate, and the desired crop steering irrigation strategy can be implemented for vegetative or generative growth.



Rooting-In Position **Steering Position**