

Seedlings production

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What problem is being solved?

In order to obtain a product of high quality, with plants of uniform appearance, the cultivation needs to follow some basic rules. The seedling production protocol is meant for “low-tech” operation.

Procedure

1. From Seed to Seedling

Substrate selection

The substrate for seedling production can be organic, inorganic, or synthetic (Figure 1). For example, rockwool is a widely used inorganic substrate and very suitable for seedling production, as it has a high-water storage capacity and no added nutrients. Please, make sure that you are using rock wool that is suitable for seedling production and not meant for insulation. On the other note, seeds can be seeded into soil, coco fiber substrates or any other organic substrate, and then lightly covered with vermiculite. This approach is preferred if no micronutrients will be provided to the plants later in the system.

The substrates can be pre-soaked and disinfected with 3% hydrogen peroxide (H_2O_2) solution for 15 min. This is especially important if you suspect that the seeds might have fungal infection (seeds such as coriander can be problematic) or the substrate is not clean. After the disinfection, the substrate should get washed with clean water again, especially if you work with seeds that germinate fast.



Figure 1. A selection of possible substrates for seeding. From left to right: foam plug (example: Growfoam® with 2.5 cm/1 inch diameter), rockwool (2.5 cm/1 inch edge length, example: Grodan), peat plugs.

Preparation

We recommend seeding 1/3 more seedlings than needed in the system adjusting for the germination rate. See our Practice Abstract on “**Germination Test**”.

The rockwool cubes or any other substrate should be placed in waterproof, low-rimmed boxes, and fresh (tap) water should be added until the cubes no longer absorb water (**Figure 2**). There should always be 1.5 cm / 0.6 inch of fresh (tap) water in the box. However, not more as otherwise the seeds will not germinate. The capillary forces of substrate supply the seeds, and later the seedlings, with sufficient water.

Seeding

Depending on the plant variety and seed size, one seed (e.g., lettuce, cabbage) or a few seeds (e.g., basil, parsley, mint) are placed on the substrate. Make sure you use a suitable cube size for the crop you want to produce. For example, tomato seedlings should require a bigger cube, or you must transplant them in between.

Seeds (if possibly pelleted) should be placed in the small hole just below the surface of each substrate. If the seeds are not pelleted, take care to place them with the visible seed scar facing downwards. The seed scar, also called the hilum, marks where the seed was once attached to the mother plant. In a seed with a pointed tip, there is often a little nub at the point of the tip.

Check whether the sown plant species is a light or dark germinator and place the seedling production boxes in the appropriate conditions. Ensure that the plant species-specific germination temperature is maintained.

If multiple seeds sprout, the sprouted seedlings should be reduced to 1-3 healthy seedlings per cube, depending on the plant species, before the transplantation to the hydroponic or aquaponic system by weeding out the weakest-looking plants. If growing herbs such as basil, also more seeds can be left.

The seedling boxes should be placed at table height in the greenhouse, with sufficient light, no draught, and a warm, steady temperature. Do not put them on the ground to avoid excessive temperature changes.

You need to know the germination conditions of the seeds. Lettuce needs light to germinate, while spinach needs dark. Therefore dark-germinating seeds need to be covered with something lightproof until they have germinated, but make sure that fresh air can still circulate.



Figure 2. Watering rockwool cubes with fresh water



Figure 3. Seed 6 spinach seeds per rockwool cube (and reduce to three plants per cube before transplanting)



Figure 4. The plants in the picture are at the two-cotyledon stage. Now fertilization can start. For this purpose, a commercial fertilizer or aquaponic system water can be used. It is important to start with one-third of the final nutrient solution concentration and slowly increase it to the final concentration over time. The nutrient solution should be changed about 2-3 times per week to provide sufficient nutrients for the plants and to reduce algae growth.

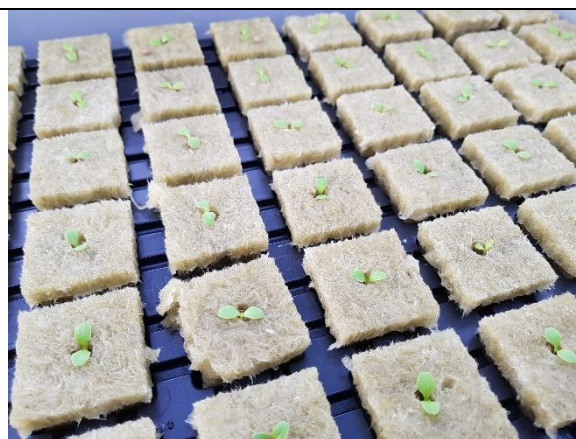


Figure 5. It is advisable to plant the seeds of dark germinators a little deeper into the cube so that the plants grow strongly and have an optimal hold in the rockwool.



Figure 6: Seedlings in containers with nutrient solution



Figure 7: Lettuce seedlings after approx. 4 weeks.

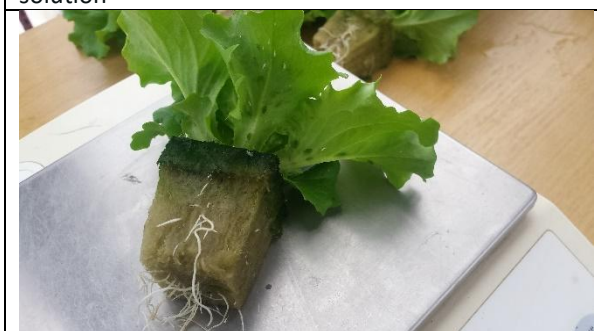


Figure 8: Seedlings before transplant into the system.

Integrated pest management should be integrated into the seedling production. It is advisable to use **sticky traps** already during seedling production to monitor the presence of insects. Depending on the environmental conditions, the **use of beneficial insects** is also recommended. Ensure good ventilation to reduce the risk of pests and diseases.

As the plants grow, it is important to give them a little more space from time to time to develop well. However, please note that some plants, such as arugula, dislike transplants. Thus, moving them is not beneficial. With the transplant, the roots can get damaged, slowing the growth or even causing plants to die.

2. From seedling to adult plants

As soon as both cotyledons of the seedlings have completely opened, fertilization can be started. You can also start the fertilization from the seed, however, this can result in higher fertilizer costs. For this, a conventional nutrient solution such as Wuxal® Profi fertilizer from Maag, Dielsdorf, CH with an electrical conductivity (EC) slowly increasing from 800 up to 1'600 $\mu\text{S cm}^{-1}$ should be used. Make sure that in the first two weeks, you do not exceed more than 1000 $\mu\text{S cm}^{-1}$. Fertilizers, such as Wuxal®, must be used in combination with tap water as they do not supply Ca or Mg to the plants.

● **Important:** Only 1.5 cm / 0.6 inch of nutrient solution is needed in the box, and care must be taken to ensure that no nutrient solution touches the plants. There is a risk of burns in combination with sunshine. The nutrient solution should be changed twice a week.

As soon as the roots of the seedlings are long enough i.e. 5 cm / 2 inch (**Figure 8**), normally after 3-5 weeks for lettuce (depending on the season), and 2 weeks for spinach, the seedlings can be transplanted to the aquaponic or hydroponic unit (**Figure 10**). Make sure that the roots have sufficient contact with the system water. It is recommended to do this in the evening so that the plants can slowly get used to the new conditions (without too much sunshine).

● **Important:** When the seedlings are transplanted into the system, ensure each rockwool cube contains the same number of plants if you plan the experiments. For the industrial production, this is not required.

The plants should grow for 4-6 weeks (depending on climate and weather conditions) until they have reached the marketable head size of around 200-250 g / 7-9 ounce (**Figure 14**) if you are growing lettuce.

● **Attention:** If your cultivation data are used for scientific experiments and you remove any biomass (old or diseased leaves, for example) from the plants during the entire cultivation period, please record the weight of the removed biomass because we want to record the entire growth.



Figure 9: Lettuces in the hydroponic unit when 5-week-old seedlings were transplanted into the aquaponic system.



Figure 10: Week 1 in the aquaponic system



Figure 11: Beginning of week 4 in the aquaponic system. When the roots grew longer, plants were transplanted into holding cups for better support.



Figure 12: Lettuce roots in the aquaponic system at the beginning of week 4.



Figure 13: Lettuce with roots in 7th week of growth in the aquaponic system.



Figure 14: Marked lettuce intended for detailed analyses as part of the final sampling in the 8th week.