

Chapter 4: Lettuce Production

Lettuce Production

This handbook is directed toward a daily production of 5 ounce (150 grams) heads of leaf lettuce. The production of the lettuce crop is separated into two growing areas. Seeds are started in a germination area where they germinate and grow for 11 days. They should be shaded from full sun on the first day after germination, but can then be exposed to full light ($17 \text{ mol/m}^2/\text{d}$) or slightly greater. On Day 11, the plants are transported to the greenhouse and transplanted into the pond area where they are grown until re-spacing on day 21 and finally harvested on Day 35.

Germination Area Stage

Germination Area stage is scheduled for Production Days 0-11 and may occur in a growth chamber or nursery area in the greenhouse.

Day 0 - Sowing

Production begins with the making of the germination media. The media fills 7 plug trays of 200 plugs each (1" rockwool cubes that are 10 x 20 cells per sheet). One lettuce seed is placed into each plug. This can be done with an automated seeding machine such as a drum seeder or a vacuum seeder. Rockwool should be moistened with nutrient solution that has a relatively low pH such as 4.5 to remove pockets of high pH contaminants.

The trays are placed into the germination area which may be an Ebb and Flood bench, a table, or on a float in the pond. Trays on an Ebb and Flood bench are sub-irrigated with RO water for 1/4 hour every 12 hours. For the initial 24 hours, lighting is maintained at $50 \text{ } \mu\text{mol/m}^2/\text{s}$ with a photoperiod (day length) of 24 hours to ensure good germination if a germination room is used. The temperature is set for 20C (68F) in the germination room. The seed trays may be covered with plastic humidity covers to ensure a high relative humidity which prevents desiccation.

Day 1 - Environmental Adjustment

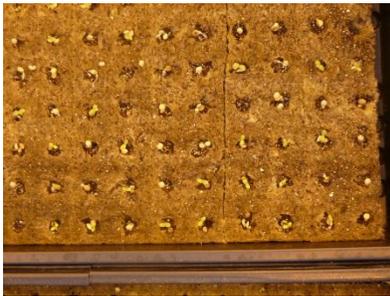


A fertilizer solution is added to the top or sub-irrigation water 24 hours after sowing. The EC of the water is maintained at $1200 \text{ } \mu\text{S/cm}^1$ above source water EC. The pH of the solution is

adjusted to 5.8 with possible addition of a base, potassium hydroxide (KOH) and nitric acid when it is too high.

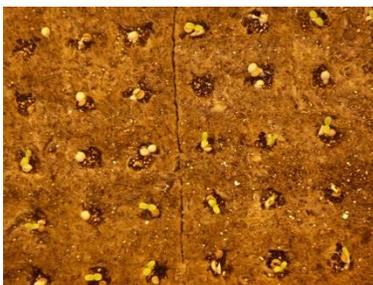
The temperature is raised to 25C and the lights increased to 250 $\mu\text{mol}/\text{m}^2/\text{s}$. These environmental factors are maintained for the remainder of the crops' time in the germination area. Sub-irrigation continues for 1/4 hour every 12 hours until Day 6. The photoperiod remains at 24 hours. If hand-watering is used the same watering frequency does not need to be used but care must be taken so that the media does not dry out.

Day 2 - Decreasing Humidity



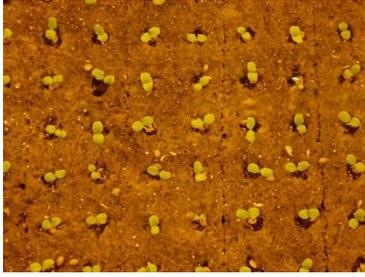
The humidity covers in place on Days 0 and 1 are removed on Day 2. At this time, the seed has germinated and the radicle has started to penetrate into the soil, as can be seen in the above photo. High humidity levels during the first two days of germination are to ensure the seed does not desiccate. Low light levels during the first 24 hours work in conjunction with the high humidity to prevent excessive seed drying.

Day 3 - Removing Double Seedlings



Any double seedlings should be removed from the plugs on Days 3 or 4 to ensure a uniform crop. Any seedlings that are particularly large should be removed so they do not suppress the growth of neighboring plants. Also, germination percentage can be determined to monitor seed quality and proper growing conditions at this stage. It is critical to have consistent environmental conditions and consistent plant growth during this stage.

Day 4



Day 5



Day 6 - Increasing Watering Frequency



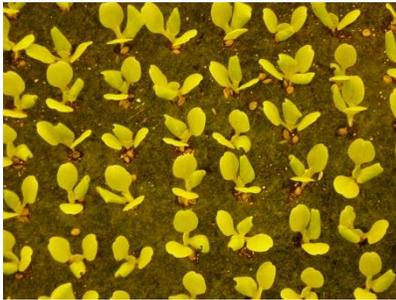
The lettuce seedlings have grown to such a size that they now require watering more frequently. The sub-irrigation system if using an ebb and flood table is scheduled for flooding four times per day, or every six hours, for 1/4 hr (15 min). If top watering with a breaker once a day should suffice.

The following is a series of photos showing the growth of an individual lettuce seedling over a 5 day period.

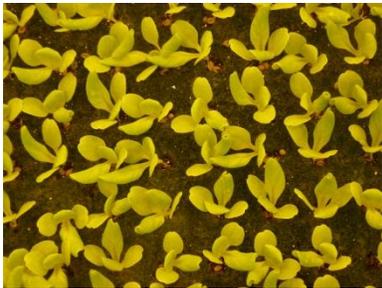
Day 7



Day 8



Day 9



Day 10



Day 11



At this time, the leaves are beginning to overlap. The roots of the seedlings have grown through the bottom of the plug tray. When transporting the plugs to the pond area, avoid damaging these exposed roots.



Day 11

This photo shows the plants just after transplanting into the floats.

Transplanting

On Day 11, the seedlings are transported to the greenhouse and transplanted into the pond. Prior

to transplanting, the seedlings are thoroughly sub-irrigated. Transplanting can be scheduled to follow normal sub-irrigation periods in order to prevent desiccation during transfer.

The seedling plugs float in the pond in Styrofoam floats. Each float is hand-drilled from 1” insulation. A wooden template placed over the Styrofoam board to be drilled hastens the drilling process. A drill press may be used if board geometry allows. Several holes can be drilled simultaneously if a clever drill press apparatus is created.

Styrofoam Floats



Day 21 – Transplant



Day 35 – Harvest



Post-Harvest



Styrofoam floats are cleaned between each growing cycle with a weak bleach (2%) solution.

Chapter 5: Packaging and Post-Harvest Storage

Packaging can be a significant cost depending on what materials customers demand. Often both a package for the product as well as a box to transport product in must be purchased.

Options:

In clamshell with or without roots

In lettuce bouquet with or without roots – clamshell or bag

Post-Harvest Storage

After being packaged, the lettuce should be stored at 40F.

Chapter 6: Crop Health

Disease

Maintaining a healthy crop is vital. Powdery mildew can be a problem during winter production of lettuce. A plan should be in place for the treatment of mildew and appropriate chemical controls should be obtained before the crop is planted.

The following are suggestions for maintaining a healthy greenhouse environment:

Keep the crop rapidly growing by providing adequate light, nutrients, and other environmental conditions at all times.

If root disease does occur, the ponds and solution tanks should be drained and the crop sacrificed. The ponds and tanks should be cleaned with a 2% bleach solution. Other sanitation products exist and are easily available such as Greenshield. It is possible the disease started in the Germination Area, and that area, including the benches and solution tanks, should be cleaned, as well.

Wash the Styrofoam floats, trays, and other equipment with a 2% bleach solution. The equipment should be washed between each use, to prevent the spread of disease.

Do not bring other plant material or soil into the greenhouse. This material may contain pests and pathogens likely to infect your crop. **Keep visitors to the greenhouse to a minimum** or allow them to view the production area from the outside of the greenhouse only.

Keep the solution tanks shaded in some manner. Algae flourish in wet, well-lit locations, and the solution tank is ideal for algal growth. Shading the tanks, input and output pipes, and other "wet" equipment will inhibit algal growth. The algae will not harm the crop directly, but may act to weaken the crop to potential disease.

Pests

Pests in hydroponic lettuce production can be a problem though they are not generally a major problem. Insect pests that may be found coupled with hydroponic lettuce production include shore flies, fungus gnats, thrips, and aphids. Fast plant growth rates make pest population establishment difficult. With continuous crop production, pest populations may have the opportunity to establish themselves. Precautions can be taken to exclude pests from the facility, such as screening potential entry points (ventilation inlets). Keeping the grass and weeds mowed outside the greenhouse or removing all vegetation entirely can reduce pest pressure inside the greenhouse. Few pesticides have been labeled for use on greenhouse vegetables. Biological insect control is a viable but less used alternative. The CEA group tried nicotine as an aphid deterrent but not only did it not control aphids, but it also left a discernible taste on the lettuce.