

## **Lettuce Production Systems in High Tunnels**

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Because lettuce can be grown in high tunnels 12 months of the year in many locations throughout the U.S., lettuce is the number 2 crop grown in high tunnels in the U.S. There are several lettuce types and several hundred lettuce varieties that are commercially available for growers and differ by color, texture, maturity and head size. They include the following types; Romaine - green and red, Bibb – green, Oakleaf - green and red, Butterhead - green and red, Summer Crisp (Batavia) - green and red and Baby lettuce mixtures including mild mesclun mix, spicy greens mix, braising mix. Depending on the location of the high tunnel, maturity of the lettuce variety is very important for scheduling production and implementing marketing strategies. Lettuce types range in maturity from 42 to 58 days for full size heads. Baby lettuce types are ready from seeding to harvest in 28 to 30 days. Cooler air temperatures, below 40°F will slow growth of lettuce plants and increase time to maturity 7 to 10 days.

### **Environmental Requirements for Seeding Lettuce**

Lettuce types are a hardy, cool season crop that can be grown in high tunnels 12 months of the year. Optimum growth occurs at temperatures between 60°F to 65°F. Seeds will germinate at soil temperatures as low as 40°F, but germinate very poorly at soil temperatures above 75°F. Successful and vigorous lettuce seed germination requires a firm seedbed and continuous soil moisture for germination.

### **Environmental Requirements for Lettuce Transplants**

Seed lettuce in 128 or 200 cell trays with shallow placement in the soil (an optimum seeding depth of 0.25" deep) and cover with fine vermiculite. If temperature in the greenhouse or high tunnel exceeds 75°F during the day, place a shade cloth above trays to keep the soil cool and maintain active germination of the lettuce seeds. Prior to transplanting the lettuce transplants in the high tunnel, harden the transplants for 2 or 3 days by reducing water application to the transplants (but don't let the soil cube dry out) or reduce the air temperature for 2 to 3 days before planting in high tunnel. Hardened transplants can survive air temperatures as low as 20°F in high tunnels after transplanting in the spring or fall. There are several techniques available that growers can use to grow lettuce in high tunnels.

**Conventional Production** in soil after bed preparation in the high tunnel. Either direct seeding or transplants can be used too establish the lettuce crop. Recommend use of transplants when planting in September and October. In most cases, the crop would be maintained with drip irrigation applied during the growing season. With this particular production system, a very dense plant population of lettuce can be grown (6" x 8" spacing) that would reduce volunteer weed problems, but may increase insect and disease pressure. Lettuce plants should be monitored weekly for aphid or whitefly problems and control measures applied as necessary. Certainly cool, damp soil is ideal for the development of Botrytis Gray Mold and Sclerotinia Drop.

**Annual Raised Beds** with plastic mulch and drip irrigation. Using a bed forming implement that produces an 18" wide bed 3" to 4" tall and applying the black plastic

mulch and drip tape placed 2" beneath the soil surface has been used for many years in both field and high tunnel production. Most growers would establish the lettuce crops as transplants either in double rows with an in-row-spacing of 8". The black plastic will help eliminate weeds in the row and reduce the incidence of both Botrytis Gray Mold and Sclerotinia Drop.

**Permanent Raised Beds** come in all sizes and orientation. Generally they are 12 " in height, but can be shorter or taller based on individual growers' needs. If common lumber is used to construct the raised bed, than 6-mil greenhouse plastic film can be used to line the sides and ends of the bed to prevent long term wood rot. Applying organic matter to the soil in the bed will eventually increase soil organic matter to 4.5% or higher value and increase the water holding capacity of the soil. If lettuce seeds or transplants are planted in the bed without a piece of polyethylene plastic film covering the surface of the raised bed, than both weed problems and Botrytis Gray Mold and Sclerotinia Drop infection may occur. Lettuce is generally watered with drip tape with this technique.

#### **Non-Circulating Hydroponic System**

Since June 1, 2007, Dr. Bernie Kratky from the University of Hawaii has been on sabbatical leave here at the Penn State Center for Plasticulture. One of Bernie's objectives here at Penn State was the production of lettuce in a non-circulating hydroponic system. The two tanks for the hydroponic system were constructed in the high tunnel and lined with 6 mil greenhouse-grade plastic. Each tank was 50" x 24' and 5" deep. When filled with water, each tank held 300 gallons of water. Blue, Styrofoam insulation board floats on top of the water and comes to rest on 2 plastic pipes supported by the tank floor when the nutrient solution level decreases as the crop grows. Holes are cut into the insulation board such that lettuce plants are spaced 8" x 12" – each tank will then grow 144 lettuce plants. Plastic net pots are filled with the lettuce transplants grown in soilless media and than placed into the holes cut into the Styrofoam board. Fertilizer is added to the water before the lettuce plants are placed into the Styrofoam boards and no additional water or fertilizer is added to the crop. Equal amounts of 2 stock nutrient solutions were added once per crop prior to transplanting such that the EC (electrical conductivity) of the nutrient solution in the raceways ranged between 1.5 to 2.0 mS. One nutrient stock solution consisted of 120 grams of soluble greenhouse grade calcium nitrate per liter of water, and the other stock solution consisted of a mixture of 72 grams of magnesium sulfate and 120 grams of Chem-Gro 8-15-36 Lettuce Formula (Hydro-Gardens, Colorado) per liter of water. The Chem-Gro formulation also contained micronutrients. Large batches of stock solutions (95 liters) were stored in 2 opaque plastic trash containers and mixed prior to use. One preparation of these stock solutions was more than adequate for these trials To date, Dr. Kratky has grown 4 lettuce crops that required 28 to 39 days from transplanting. Bibb, romaine and leafy lettuce types have been grown successfully in this hydroponic system without any disease problems and a minor insect problem – grasshoppers. At the High Tunnel Research and Education Center at Rock Springs, there must have been 100 grasshoppers per square yard at the peak of their population this summer, but screening the sides of the tunnel helped moderate the problem. This large grasshopper population ate everything from lettuce to cucumber and broccoli transplants. When harvested, the lettuce heads have averaged about 0.5 pounds in weight and were of excellent quality. There have been no incidence of diseases on the lettuce plants on either of the four plantings to date.

### **Winter Production?**

While lettuce transplants can be placed in the soil as late as October, cooler day and night air temperatures, below 40°F will slow growth of lettuce plants and increase time to maturity by at least 7 to 10 days. While temperature may not totally restrict lettuce growth, the short days of November, December and January also reduce the amount of photosynthetic light required by lettuce plants for optimum growth and development. If a major investment in supplemental lighting is not made, than for all practical purposes, a high tunnel becomes a cold storage facility during November, December and January.



Figure 1. Mature lettuce crop on left and juvenile crop on right growing in non-circulating hydroponic system (B. Kratky, Univ. of Hawaii – 2007) and grown on Styrofoam insulation boards floating on the top of water.