Low Tunnel Temperatures and Fall Greens Experiments – Preliminary Report

The following is a report of results from experiments conducted in 2011-2012 in Durham, NH.

These experiments were part of a larger project aiming to increase growers' capacity to produce and market local vegetable crops during winter months. We acknowledge financial support from Northeast SARE Project LNE 1027 – Expanding Winter Harvest and Sales for New England Vegetable Crops and the NH Agricultural Experiment Station. We appreciate the support and collaboration of our many grower partners and project collaborators at the University of Massachusetts, Communities Involved in Sustaining Agriculture, and Seacoast Eat Local.

Overall Goal: Evaluate best practices for overwintering greens in low tunnels in New England

Objective 1. Compare the effects of transplant date and variety on overall yields and quality for late fall and late winter/early spring harvests of hardy greens (brassica and spinach).

Methods and Results:

We established replicated plantings of six treatments likely to survive over winter ('Red Russian' and 'Siberian' kale, 'Space' and 'Spargo' spinach, 'Yellow' and 'Rhubarb' chard (combined), and mustard greens), and four genotypes were included for observation only ('Santo' cilantro, 'Winter Density' and 'Nevada' lettuce, and Sorrel).

Two seeding dates were used (EARLY - 7 Sept and LATE - 21 Sept). Plugs were transplanted into the ground approximately 4 weeks after each seeding date at a spacing of 6" between plants. Rowcover was established over the planting in late October, and plastic was applied in early December.

Just prior to Thanksgiving (17 Nov), half of each of the EARLY plots (18 plants) was harvested and weighed. The LATE plots were not ready for harvest at that time. The other half of the plot was left unharvested for overwintering.

Marketable biomass harvested on 17 Nov

Cultivar	**grams per plant**	**oz per square foot**
Mustard	71.9 a	10.1 a
Kale 'Siberian'	47.9 b	6.8 b
Kale 'Red Russian'	44.6 b	6.3 b
Spinach 'Space'	35.2 b	5.0 b
Chard 'Yellow' and 'Rhubarb'	34.9 b	4.9 b
Spinach 'Spargo'	28.4 b	4.0 b
Lettuce 'Winter Density'[x]	81.1	11.4
Lettuce 'Nevada'[x]	111.3	15.7
Cilantro[x]	4.4	0.6

[x] These three cultivars were not replicated, so cannot be compared statistically to the remaining varieties.

Of those cultivars that were replicated, mustard greens produced significantly more biomass than all other entries, with over 10.1 oz per square foot of bed space. The remaining cultivars (chard, spinach, and kale) all produced between 4 and 6.8 oz per square foot. While we only had single plots of each, it was noteworthy that the two lettuce cultivars produced very high yields in terms of weight. Cilantro produced relatively low yields by 17 Nov, and Sorrel was not yet ready to harvest.

By 15 December, the fall-harvested halves of EARLY plots had begun to regrow, and looked healthy, for all cultivars except lettuce (which had been harvested completely). The unharvested halves of EARLY plots were still large, but the older leaves showed some signs of damage and were less marketable than they had been on 17 November. For example, the lettuce leaves showed some necrosis and soft rot, likely as a result of freeze damage to small areas of tissue. The older leaves of kale, spinach, and chard were slightly chlorotic and were showing signs of cold stress. The LATE plots looked healthy, and could have been harvested, but were left intact for overwintering.

On 15 March, the fall-harvested halves of EARLY plots had begun to regrow, and looked vigorous and healthy, similar to the unharvested LATE plots. The unharvested EARLY plots looked chlorotic and stressed, and had a lot of dead older leaf tissue, particularly for spinach and kale. Lettuce experienced a high level of mortality, and was not marketable. Chard showed good survival, but was so heavily infested with aphids as to render it unmarketable. All plantings of cilantro looked healthy, vigorous and marketable. While we did not collect yield data in the spring, we characterized spinach, kale, mustard as marketable as large braising greens, and cilantro marketable in bunches. Without the aphid infestation, chard would have been marketable as braising greens.

Take home messages:

Results from this single-year experiment should be taken with a grain of salt. Growers' markets vary considerably, and market desires will determine what size and types of greens can be sold. Futher, with different fall weather conditions, rate of growth and survival may be quite different from what we saw in 2011-2012. With these disclaimers:

- For Thanksgiving markets, a early September seeding and late September transplanting produced harvestable crops of salad greens (spinach 'Space' and 'Spargo'), braising greens (chard), bunched greens (kale 'Siberian' and 'Red Russian', and mustard), and small heads of lettuce.
- Crops seeded in late September did not mature in time for Thanksgiving.
- Our observations suggest that fall harvesting prior to overwintering crops is beneficial, since it removes leaves that will die during the winter, therefore removing habitats for pests and pathogens and keeping the planting tidy.
- Chard, while relatively hardy, was particularly susceptible to aphid infestation in our experiment.

Objective 2. Compare the effects of seed date *and* variety on days to harvest maturity, number of possible harvests, overall yields and quality for late fall (and possibly spring) harvests of salad mix.

Methods and Results:

We established raised beds for direct-sowing at three different planting dates in the fall. We selected 11 genotypes suitable for harvest as mesclun mix (baby salad greens), plus cilantro to be harvested as young leaves. Species included were: arugula, mustard, chard 'rhubarb', spinach 'space' and 'spargo', claytonia, muzina, lettuce 'nevada', beet 'bull's blood', sorrel, cilantro 'santo', and kale 'red russian'.

Each plot was seeded with Johnny's 4-row seeder; 2 passes (8 narrowly spaced rows) per 30" bed, 5' long plus 1' between plots. After seeding, plots were checked twice weekly and harvests began when leaves were consistently over 8 cm (baby salad mix size).

Germination was particularly poor for both spinach cultivars ('Spargo', 'Space') for all three plantings. Germination of most other species was good, although we observed a few unexplained gaps in germination and a few small sections with yellow cotyledons suggesting nutrient deficiency, particularly for beet and chard. The variability and relatively small plot size prevented us from obtaining accurate yield data for different harvest dates. We were able to determine date to first harvest maturity, and to compare relative yields.

For the 18 and 21 September plantings, arugula, mustard, 'Red Russian' kale, and mizuna were all ready for harvest within **24 days**. Both spinach cultivars, lettuce, beet greens, and chard were ready for harvest as **45-50 days** after planting, and sorrel and 'Santo' cilantro were ready for first harvest **65 days** after planting. Claytonia never matured to a size that would permit harvesting.

For the 28 September planting, arugula, kale, mustard and mizuna were ready for harvest by **35-40 days** after seeding, on 2-7 November. Lettuce was ready for harvest as salad greens by **65 days** after seeding, on 2 December. The remaining species were not harvestable by the time the experiment was terminated in mid-December.

Species could be roughly characterized into groups based on relative yields per square foot:

- No yields: claytonia
- Low yields (0.5-2 oz/sq ft): spinach, beet greens, cilantro
- Moderate yields (1-3 oz/sq ft): chard, arugula, mizuna, sorrel
- High yields (2-6 oz/sq ft): mustard, kale, lettuce

Objective 1. Compare the temperature gain in different shaped low tunnels (high, narrow vs low, wide).

- Bare ground, no crop growing, measuring temperature and light throughout winter
- Set up low tunnels using metal conduit bent with both 4' and 6' hoop bender, 10' and 20' long.

Results

Each of the four small low tunnels were set up and covered with one layer of 1.25 oz/sq yd rowcover. We monitored temperature in each, as well as outdoors and in full length tunnels covered with 2 layers of rowcover (2XRC) and one layer of rowcover plus one layer of 6 mil polyethylene (RCGH). Light sensors were deployed under different types of coverings, but the sensors failed to record properly, so light data were not collected.

Throughout the winter, the temperatures in the four small tunnels were very similar, never differing by more than 2 degrees F, which is within the accuracy range for the sensors we used. To determine whether small differences over the length of the season could result in season-long differences that were not apparent at any single point in time, we calculated the growing degree days (GDD) using a base temperature of 50F, between the dates of 10 October and 14 March. The results follow:

Growing degree days (Mean daily temperature – 50F) between 10 October, 2011 and 14 March, 2012.

Covering	**Tunnel Size**	**GDD**
1.25 oz/sq yd rowcover (RC)	4' x 10'	34.7
1.25 oz/sq yd rowcover (RC)	4' x 20'	34.6
1.25 oz/sq yd rowcover (RC)	6' x 10'	34.0
1.25 oz/sq yd rowcover (RC)	6' x 20'	34.8
None	-	28.4
None	-	30.3
None	-	30.6
2 layers RC (2XRC)	4 x 40'	77.8
RC plus 6 mil polyethylene (RCGH)	4 x 40'	102.7

There was no evidence that the different small tunnel sizes showed meaningful differences in temperature accumulation throughout the winter. We did find that even a single layer of rowcover on these small tunnels provided slightly increased temperature as compared with outdoors. As we have found in other experiments (http://extension.unh.edu/resources/files/Resource004242_Rep6077.pdf), different types of coverings do result in warmer temperatures.

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