Effect of Direct Seeding Date on Yield of Overwintered Vegetables in Low Tunnels

INTRODUCTION

One tool for extending vegetable production in New England into the colder seasons is to direct seed crops in the fall, such that the seeds germinate and put on a small amount of growth before they are then protected from deep freezing under a low tunnel for the duration of the winter. As the days get longer in January and February, the environment in the low tunnel will receive more daylight and reach higher temperatures, which will cause the plants to initiate growth. Some crops could be ready for harvest and sale as early as March or April. One key to optimizing this system and getting the maximum marketable yield in the spring is to determine the optimum seeding date in the fall.

The goal of this project was to evaluate the effect of different seeding dates on the marketable spring yield of one variety each of carrots, beets, spinach, and kale grown using this overwintering low tunnel system. We found that beets did not produce any marketable yields, regardless of seeding dates. Spinach, kale, and carrots all produced marketable yields, but with no significant differences between dates, except in the case of the earliest and latest seedings of kale. The amount of bolting, however, was found to be significantly correlated to seeding date in the case of carrots, where the earlier dates had the highest number of bolted plants.

METHODS

On September 13, 2012, a research plot at the UMass South Deerfield Research Farm (zone 5a) was prepared for planting with a fertilizer application of pelleted chicken manure and disked. Seeds were purchased from Johnny's Selected Seeds. A randomized complete block design was used with 4 replicates of 4 ft. for each treatment (7 rows, 8" apart) within a single 5' bed, for a total of 48 treatments, with 6" spaces left unplanted between plots. Seeds of each crop were planted on 3 planting dates (see Table1). The plots were hoed immediately prior to seeding for seeding dates 2 and 3.

Table 1.

Crop	Variety	Jang JP1 Clean Seeder Settings			Seeds per treatment (approx.)*	Seeding Date 1	Seeding Date 2	Seeding Date 3
		Roller	Front	Rear				
Carrot	Napoli (pelleted)	F24	13	10	140	9/19/12	10/3/12	10/10/12
Beet	Red Ace	LJ12	9	14	168	9/19/12	10/3/12	10/10/12
Spinach	Space	F24	13	10	140	9/19/12	10/3/12	10/10/12
Kale	Red Russian	X24	13	10	140	10/3/12	10/10/12	10/17/12

* Calculated from Jang JP Seeder Spacing Chart and our row spacing.

Each replicate of randomized blocks comprised a discreet tunnel (tunnels A, B, C, D). Our hoop system consisted of 10' metal conduit, bent using a Quick Hoops High Tunnel Bender from Johnny's, and placed in the ground spaced 5' apart. Hoops were covered with row cover (Dupont 5131 1.25oz) on October 17, 2012. Six mil. greenhouse plastic was added October 26. Temperature sensors (onset HOBO data logger #UA-001-08) were set and placed inside protective housings, which were setup outside and in each of the 4 tunnels.

Plastic was removed on March 5, 2013, when outside temperatures reached 44°F, and maximum temperatures inside the 4 tunnels ranged from 72°F to 78°F, according to sensor data. Because temperature sensors were inaccessible until the project's end, the decision to remove the plastic layer at this point was made based on estimated data. The farm received 11" of snow on March 8, following this warm spell and removal of the plastic layer.

The tunnels were weeded once over successive days – March 13, April 2, April 3, April 5 – beginning with replicate tunnel A. On April 16, row cover was removed. Sample areas were 4' (entire length of plot) x 3' (1.5' from center in either direction, to control for variability due to snow load on edges of tunnel plastic). Plants in all replicate plots were counted to estimate overwinter survival (assuming consistent seeding and germination rates) and to determine yield per plant at harvest. All treatments of kale and spinach were assessed for bolting and clear-cut harvested. Harvested leaves were bagged, brought back to the lab, weighed for total harvest weight, sorted for marketable leaves, and marketable leaves re-weighed. Carrots and beets were too small to harvest on this date.

On May 22, carrots were harvested from 4' x 3' sample areas. Beets in all replicates were too small for any appreciable harvest. Carrots were returned to the lab and weighed for total harvest (with greens on). Bolted carrots were counted.

RESULTS

Beets – The second planting date had the highest survival based on number of plants (see table 2), but the plants in all treatments bolted in the spring and did not develop a good root.

Table 2.

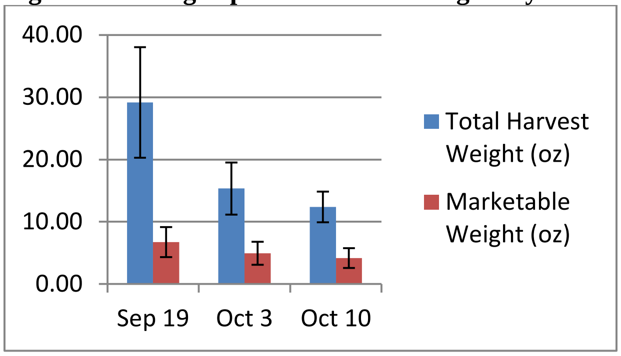
Overwinter Survival of Beets	
Seeding Date	**# of Plants**
Sep 19	34
Oct 3	105
Oct 10	31

Spinach – The latest seeding date had the highest overwinter survival, based on number of plants (see table 3), though this was found not to be statistically significant ($p=0.07$), and overwinter survival was low overall in this crop. The earliest seeding date had the highest average harvest weights, but with high variability between replicates there were no significant differences across seeding dates in either total harvest weight ($p=0.15$) or marketable weight ($p=0.66$) (see figure 1). Marketable weight consisted of loose leaves greater than 1 inch in length. Many of the oldest plants had very large outer leaves, some undiagnosed rot in the center of the plant, and new growth with yellowing edges. Many leaves, across all seeding dates, showed signs of what was presumed to be cold and/or wind damage, which had not been observed upon an inspection before removal of the plastic layer. No bolting was observed in spinach from any treatment, though on May 22 when plants were checked for harvestable regrowth, some plants were beginning to bolt.

Table 3.

Overwinter Survival of Spinach	
Seeding Date	**# of Plants**
Sep 19	23
Oct 3	26
Oct 10	39

Figure 1. Average Spinach Harvest Weights by Seeding Date

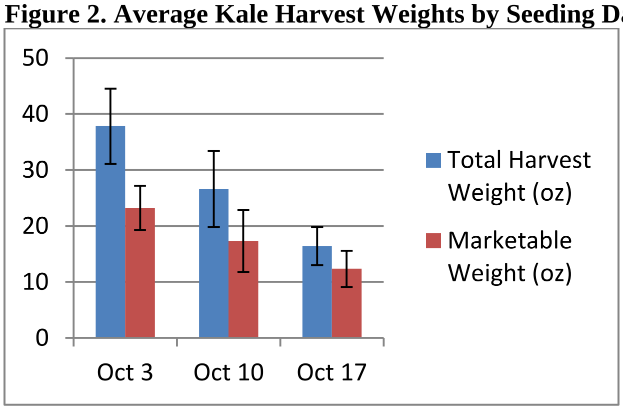


Kale – All three kale treatments survived the winter well, based on number of plants at harvest, though from a third to over a half of the plants had bolted (see table 4). As with spinach, the earliest seeding date yielded the highest total and marketable weights, though replicate variability meant that these differences were again not statistically significant (p=0.08 and 0.26, respectively). There was a significant difference, however, in total yield between the earliest and latest seedings (p=0.03). Also as with spinach, cold and/or wind damage was observed on leaves across all treatments.

Table 4.

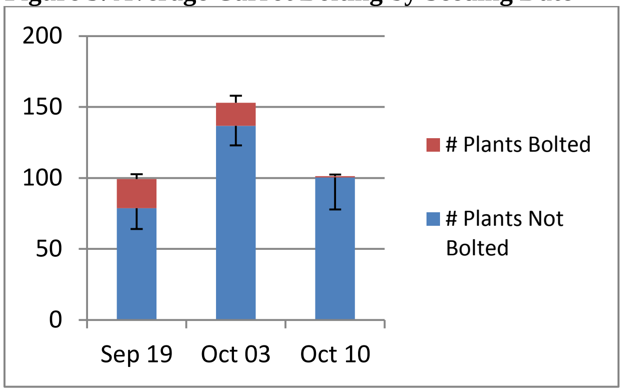
Overwinter Survival of Kale		
Seeding Date	**# of Plants**	**% Bolted**
Oct 3	98	55
Oct 10	85	37
Oct 17	106	30

Figure 2. Average Kale Harvest Weights by Seeding Date



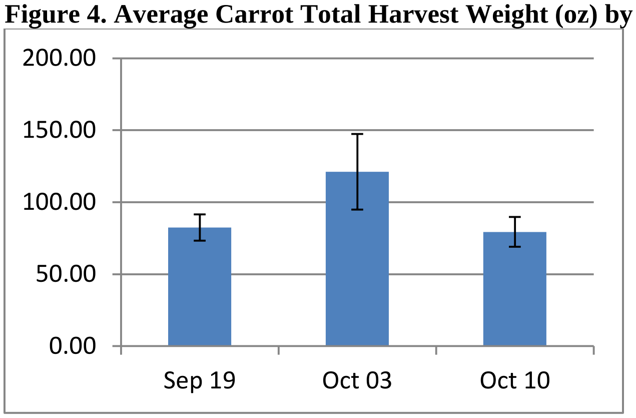
Carrots – Overwinter survival was good across all three seeding dates, and highest with the October 3 treatments, with statistical significance between only the first two dates (p=0.04). The number of plants that had bolted at harvest corresponded to seeding date, with the latest treatment having the lowest bolting (p=0.02) (see figure 3). Bolted plants were found to have a marketably-sized root, but the root was generally woody and bitter-tasting. All carrots were considered marketable, except for these bolted plants.

Figure 3. Average Carrot Bolting by Seeding Date



The treatments seeded on October 3 also produced the highest yields (though again, not significantly; p=0.21, see figure 4). Given a sample size of 21 feet of row, this amounts to 0.25, 0.36, and 0.24 lbs/row' respectively for treatments 1, 2, and 3.

Figure 4. Average Carrot Total Harvest Weight (oz) by Seeding Date



CONCLUSIONS

Though we did see moderate survival in beets, we were not able to harvest any roots after overwintering them in low tunnels. It is possible that a different variety would have yielded better. Further trials should be done to determine whether beets could be a viable overwintering crop under these conditions.

Though the number of spinach plants that survived the winter was fairly low, many of those that did survive had robust growth and large leaves, and bolting was not an issue in this crop. Had this been a commercial situation it is possible these plants, or at least outer leaves, could have been harvested earlier, and early signs of rot removed to better maintain them for multiple harvests. Also, the plastic layer was removed just prior to a late-season snow storm, which very likely reduced marketable yields. Although the earliest seeding date produced the greatest overall yields, these plants showed the most signs of disease and/or deficiency. Using a later seeding date may mitigate this.

Kale seemed to be an excellent candidate for low tunnel overwintering, with the earliest seeding date producing significantly higher yield than the latest, even with the higher rate of bolting in the earliest treatment. Kale flowers might also be marketable themselves. The snow storm in March also likely damaged a large number of leaves, decreasing marketable yields.

There was no correlation of seeding date with yield in carrots, though bolting was significantly lower the later the carrots were seeded. Given that bolting tended to make the carrot root inedible, the later date yielded the most marketable yield per area.

More trials should be conducted to further investigate the effects of seeding date on not just marketable spring yield, but also flavor, ease of harvest, and pest pressure – all factors which will contribute to the economic viability of this system. Particular farm micro-climates and seasonal variability also make determining optimum seeding dates difficult to assess.