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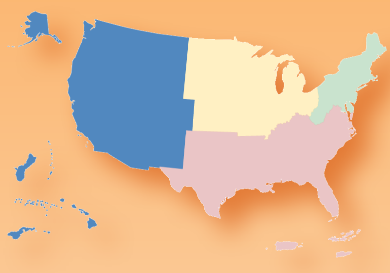

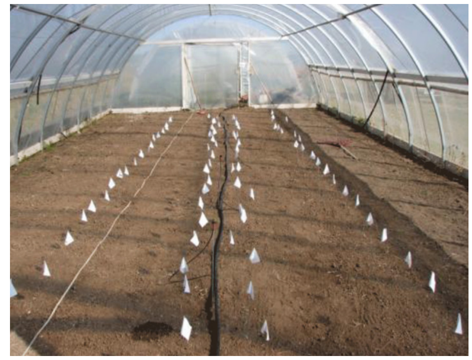

Organic Winter Production Scheduling in Unheated High Tunnels in Colorado

SARE FUNDING FOR THIS PROJECT

Project Number
OW10-325

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2010

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On-Farm Research

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Written by SARE staff and reviewed by Extension specialists.

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Project Summary

Colorado State University (CSU) researchers and five collaborating farmers explored winter production scheduling for hardy organic vegetable crops in unheated high tunnels. The objective was to establish optimal timing for the greatest yield of marketable produce during the winter and early spring. The participating farms represent a diversity of climatic regions around Colorado, ranging in altitudes of 5,000 feet to more than 6,200 feet above sea level. Vegetables tested include lettuce, spinach, mache, carrot and radish. Planting occurred on a monthly basis for five months starting in October 2010.

Top Findings

- Project participants concluded that all of these crops will generally survive Colorado winters in unheated high tunnels when a single layer of floating row cover is applied over hoops, and that late fall and late winter seeding dates were the most productive and potentially the most profitable of the five planting dates.
- All of the crops sown in December and January were so delayed that mid-winter planting provided little advantage over late winter sowing dates. Also, extremely cold temperatures (minus 10 to minus 20 degrees) in January killed December-sown crops.
- The high tunnels offered nearly 20 degrees of protection in cold weather.

COVER PHOTOS: A shielded data logger (left) was used to monitor air and soil temperatures, and an example of the plot design used during the reseach. *Photos courtesy Frank Stonaker, Colorado State University*

Materials and Methods

The farmers selected for this project are well-established market farmers with several years of experience as high tunnel growers. The farms are located in areas of the state where there is a relatively high concentration of market farmers and high tunnel growers. These sites provide a cross section of climates found in Colorado—ranging from the high desert of southwestern Colorado to the mesas flanking the Colorado River, the fruit producing valleys of western Colorado and the piedmont of the Rockies in northern Colorado's Front Range (Figure 1).

Individual tunnels varied somewhat in design, but are reflective of what is commonly used in the industry.

The crops and varieties grown in this project were: spinach (Tyee cv.), lettuce (Winter Density cv.), mache (Vit cv.), radish (Crunchy Royal cv.) and carrot (Napoli cv). All of these crops had been grown in high tunnels at CSU in a 2009 pilot project evaluating their winter hardiness when fall planted; all crops selected had survived near a zero degree temperature inside the tunnels.

Soil samples from the high tunnels were collected and analyzed, and amendments were made using composted dairy manure at application rates to achieve similar fertility levels among all the sites before the trials were initiated.

The collaborating farmers received specific instructions for their high tunnel planting design, and CSU researchers visited each of the sites to review the design details and assist the farmers with initial set up.

The five crops were sown on a monthly basis for five months using a six-row seeder from Johnny's Selected Seeds. The plots were 3 feet wide, and the width of the six-row seeder was 1.25 feet. The plots were irrigated using Dramstix misting heads and covered with Agribon 19 floating row covers draped over wire hoops. Soil and air temperatures were monitored outside of the high tunnel, inside of the high tunnel and under the floating row cover with shielded Sensitech TempTale4 data loggers.

Harvest parameters were discussed with the collaborators, and the uniform standards listed below were agreed upon. When the crops achieved these standards, they were harvested. Salads were weighed, and individual carrots and radishes were counted. Yields were converted to pounds or roots per square foot of growing area.

- Carrots roots would be harvestable when the root cross section was equivalent to a dime's diameter.
- Radishes would be harvested when the root cross section was equivalent to a quarter's diameter.
- The salad crops were to be grown to "baby greens" size:
    - Lettuce: 5-6 inches (average length of longest leaves)
    - Mache: rosette diameter of 4-5 inches on average
    - Spinach leaf (petiole excluded): 4-5 inches (average length of longest leaves)

Detailed Results

For all available data sets, see the final report, which can be found by visiting www.sare.org/project-reports and searching for "OW10-325."

As expected, crop emergence and days to harvest were delayed significantly for all crops during December and January. Mid-winter plantings were also more susceptible to freezing than crops that had been well established before extremely cold temperatures arrived. Results by crop were as follows:

Mache

A very hardy salad green, mache was exceedingly slow to establish at all sites, and no measureable yield was obtained.

Carrots

Carrots sown in October were not harvestable until March. November through February plantings failed to reach harvestable size before the end of this study in early April.

FIGURE 1.. THE PARTICIPATING FARMS AND THEIR LOCATIONS

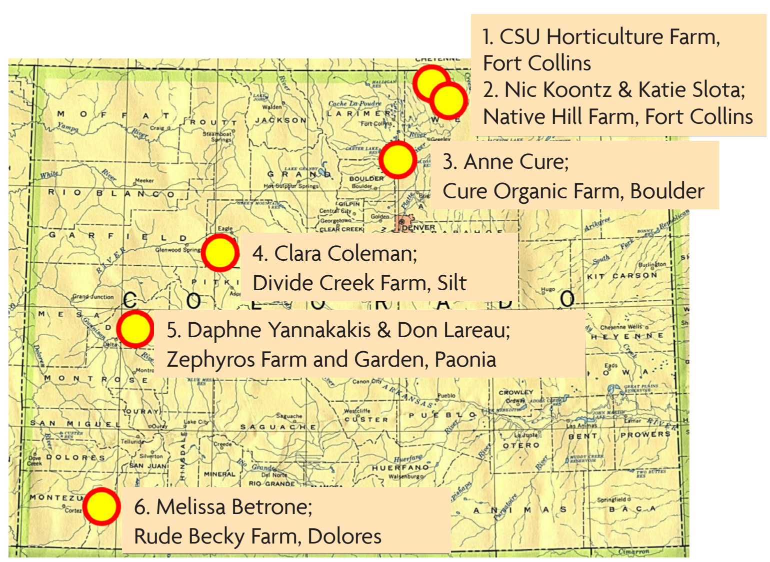
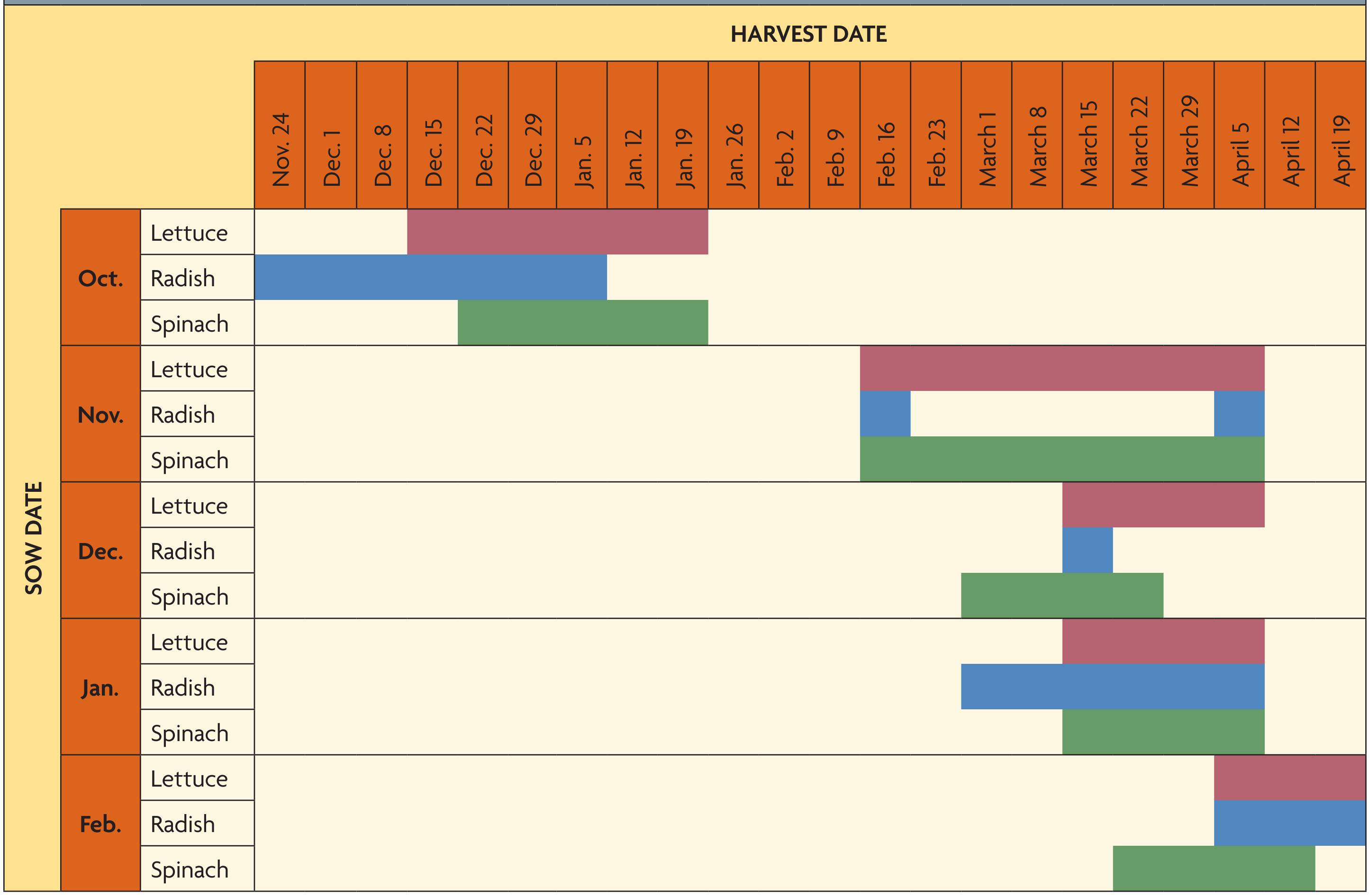


FIGURE 2. HARVEST DATES OF SELECTED CROPS, BY DATE SOWN



Radish

Radish was the quickest crop to reach harvestable size, with the October planting averaging 63 days to harvest across all sites. Time to harvest nearly doubled when sown in November. Farmers produced harvestable radish from December through March, but November and December sowings were killed in some locations during an extremely cold period in early January, when the ambient temperature was minus 20 degrees and the temperature under the floating row covers was 13 degrees above zero.

The experience with radish planted in each month was:

- October radish sowings produced reliable harvests from all locations between November and mid-December, with one location harvesting in mid-January.
- November sowings were frozen-out in all but two locations; these were harvested in mid-February and early April;
- December sowings were frozen-out in all locations but one, which was harvested in March.
- January sowing produced good harvests by late March and early April in all but one location.
- February sowings produced a harvestable crop at three locations from early to mid-April; two locations terminated the project before radishes reached a harvestable size.

Lettuce

Lettuce reached harvestable sizes in all but one sowing, in which it was killed during the aforementioned cold snap in early January. Lettuce was harvestable in December, March and April, with late plantings catching up with early plantings. Emergence was rapid for all planting dates.

The experience with lettuce planted in each month was:

- October lettuce sowings were harvested from mid-December (four locations) through mid-January (one location).
- November sowings were harvested from mid-February through the end of March.
- December sowings were frozen-out at three locations and harvested in mid-March and early April in the other locations.
- January sowings were harvested at three sites from mid-March through early April, and frozen-out at two sites.

- February sowings produced crops from early April well into May at three locations and failed to mature in time at two locations.

Spinach

Spinach reached harvestable sizes in all sowings, but some plantings were frozen-out. Spinach was harvested from December through April, with late plantings catching up with early plantings. Emergence was slower than lettuce, but consistent stands were produced for all planting dates.

The experience with spinach planted in each month was:

- October spinach sowings produced harvestable crops from mid-December through mid-January at all locations.
- November sowings were harvested from four sites between mid-February and mid-March and froze-out at one site.
- December sowings were harvested from two sites between early and late March. Three sites lost this planting to freezes.
- January sowings were harvested in mid-March to early April from three locations. Two locations froze-out.
- February sowings were harvested from three locations between early April and mid-May while two locations terminated the trial before harvest.

As illustrated in Figure 2, a mid-January and-mid-February harvest gap resulted from slow crop establishment and freezes in January.

Heavy snows and winds in mid-December collapsed one of the collaborator's high tunnels in Cortez, Colo., and no data was collected. Snow and wind loads on lightweight high tunnel structures are very real risks that need to either be mitigated by additional bracing and structural strength for winter production, or by vigilance to reduce the accumulation of snow loads. Of course, avoidance of these risks is not always possible.

Areas Needing Additional Study

This project included one year of research. It was not replicated again, but most of the growers involved have continued to crop through the winter without heat.

Two areas that should be explored further include earlier planting dates and the use of supplemental heat. It is expected that better established crops, i.e., earlier plantings, may mitigate hard freeze damage and reduce or prevent the mid-winter harvest gap illustrated by Figure 2. The lack of data presented for carrot and mache plantings was due to their slow establishment during short-day periods. This underscores the value of early establishment of these hardy but slow growing crops. Additionally, minimal heating could be used to maintain higher temperatures, thus protecting the more sensitive crops.

Finally, studies that are conducted at production-scale and are designed to fully evaluate the costs and returns of this production method are needed.

Updates on Colorado State University's high tunnel research will be made to the website which can be found at: www.specialtycrops.colostate.edu/.

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