Homer High Tunnel Data Comparisons, 2013-2014

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Alaska Stems
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This project was funded by a grant from the Western Sustainable Agriculture Research and Education Program. For more information on Western SARE see westernssare.org.

Executive Summary

This report summarizes the data collected under a Western Sustainable Agriculture Research and Education Grant (FW12-046). Complete details of the study can be found through the SARE Project Report on their website: (http://mysare.sare.org/mySARE/ProjectReport.aspx?do=viewProj&pn=FW12-046).

High tunnels are generally considered to add two to four weeks to a growing season, however there has been little research done in coastal Alaska to ground-truth or better understand this assumption largely developed in the Lower 48 states. Climate in the Homer-area is dominated by cool and wet summers, with dramatic microclimatic differences in temperature and precipitation at varying elevations. Air and soil temperature and relative humidity data were collected hourly inside and outside of 10 high tunnels around Homer, Alaska. Based on our data, we do not see support for the idea that high tunnels alone in this area add two to four weeks of growing season. Season extension activities should likely be concentrated in the fall, and regardless some additional heat source or other temperature control methods (low tunnels, row cover, etc) likely must be employed to protect crops from cold temperatures. Moisture control in the fall is also a challenge that must be addressed. Our data do suggest, however, that high tunnels alone provide a great amount of season 'enhancement' – increasing the growing degree days an average of 2,000 over field conditions. In our coastal, sub-arctic climate this is a huge advantage and collective experiences have anecdotally confirmed faster growth rates and increased yields of certain crops. Farmers at higher elevations will likely see greater positive impacts from double-poly tunnels, however added heat retention is likely greater and when using additional heat double-poly tunnels are likely advantageous regardless of the elevation.

Data Analysis

All temperature and RH data were uploaded using the HOBOware Pro software (v. 3.7.1). Data were then exported to Excel spreadsheets and trimmed for temperatures taken prior to or after the data loggers were set-up. All data summaries and analyses were done within Microsoft Excel 2010. Raw data from each tunnel is available as part of this report, and on the high tunnels website (described below, http://www.akhightunnels.org/resources/temp-rh-study.html).

Growing Degree Days (GDD)

Growing degree days (GDD) were calculated for each location in the study where data were available, both inside and outside of the high tunnels. We calculated GDD for spinach, using a maximum temperature threshold of 80F and a lower threshold of 32F. The base temperature was set at 32F. Therefore, the equation used to calculate GDD was:

$GDD = ((T_{max} + T_{min})/2) - T_{base}$, where T_{max} = 80F if the maximum temperature was above 80F and T_{min} = 32F if the minimum temperature was below 32F.

Daily Minimum/Maximum Temperatures and Differences

In order to better visualize the long time series of data, we looked at daily minimum and maximum temperatures inside and outside of each high tunnel. From these data, we calculated the difference in maximum and minimum temperature between inside and outside at each site by subtracting the outside temperature from the inside temperature. Thus, if the difference is positive, the high tunnel was warmer than outside. If negative, the high tunnel site was cooler than the corresponding outside site.

Close-up Views

In order to compare the finer resolution of collected data, we chose 48-hours, from September 17-18, 2014, to compare high tunnel and outside temperatures and relative humidity (RH). We also graphed soil temperatures both inside and outside of each high tunnel over the 24-hour period of September 18, 2014.

Spring 2014

To take a closer look at the potential for spring season extension in local high tunnels, we compared inside and outside minimum temperatures at each location from March 1 – May 31, 2014. On each graph we included two reference lines – a solid line indicating a “hard” frost (27F), and a dashed line indicating a “light” frost (31F).

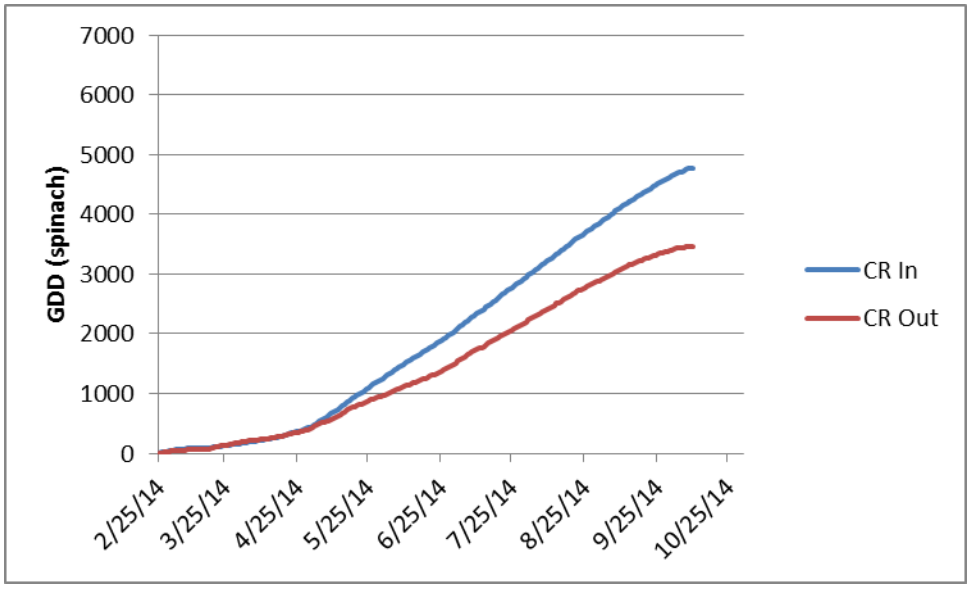
Table of Contents

High Tunnel: CR (High/Single)

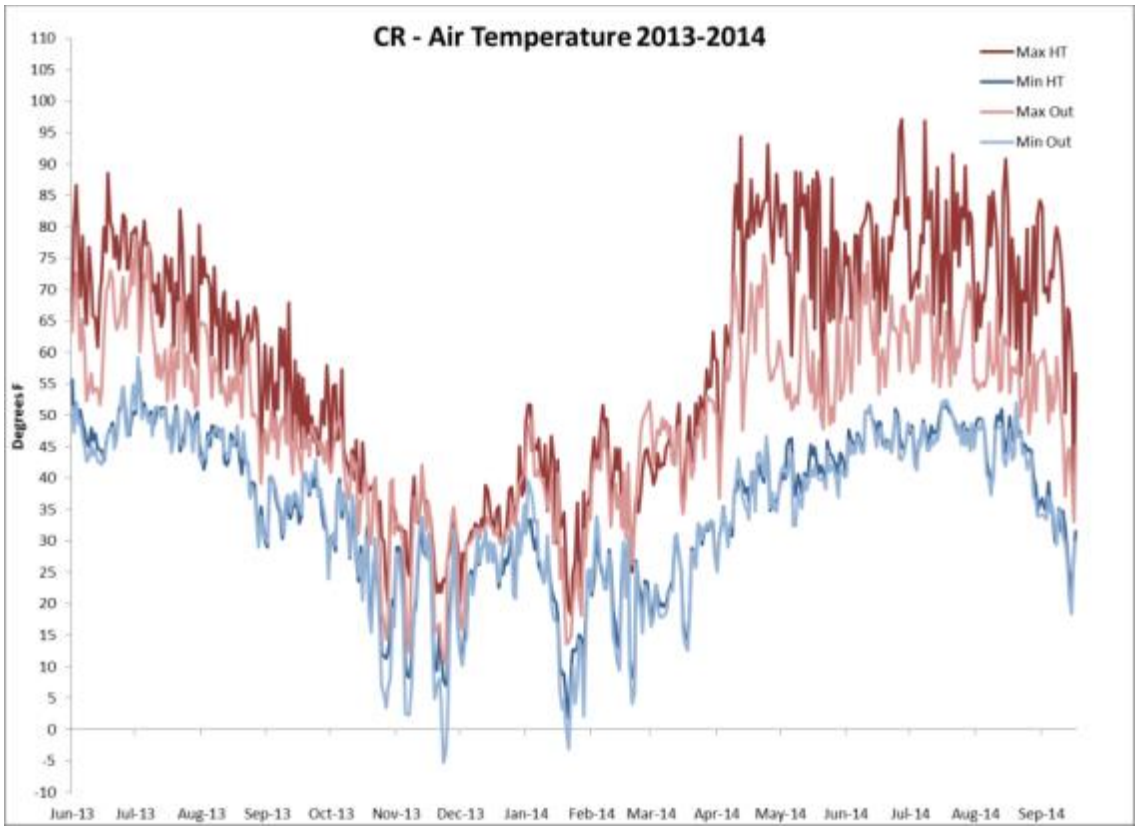
Location: East Skyline Dr., Homer, Alaska
Elevation: 1440'
Size: 35' x 60'
Glazing: single with polycarb endwalls
Ventilation Methods: roll up sides and opening doors on the ends
Inside Air Dates: 6/24/13-10/10/14 **Inside Soil Dates:** 6/24/13-11/8/13
Outside Air Dates: 6/24/13-10/10/14 **Outside Soil Dates:** none recovered
Notes: Outside soil logger couldn't be located during the fall/winter 2014 recovery efforts.



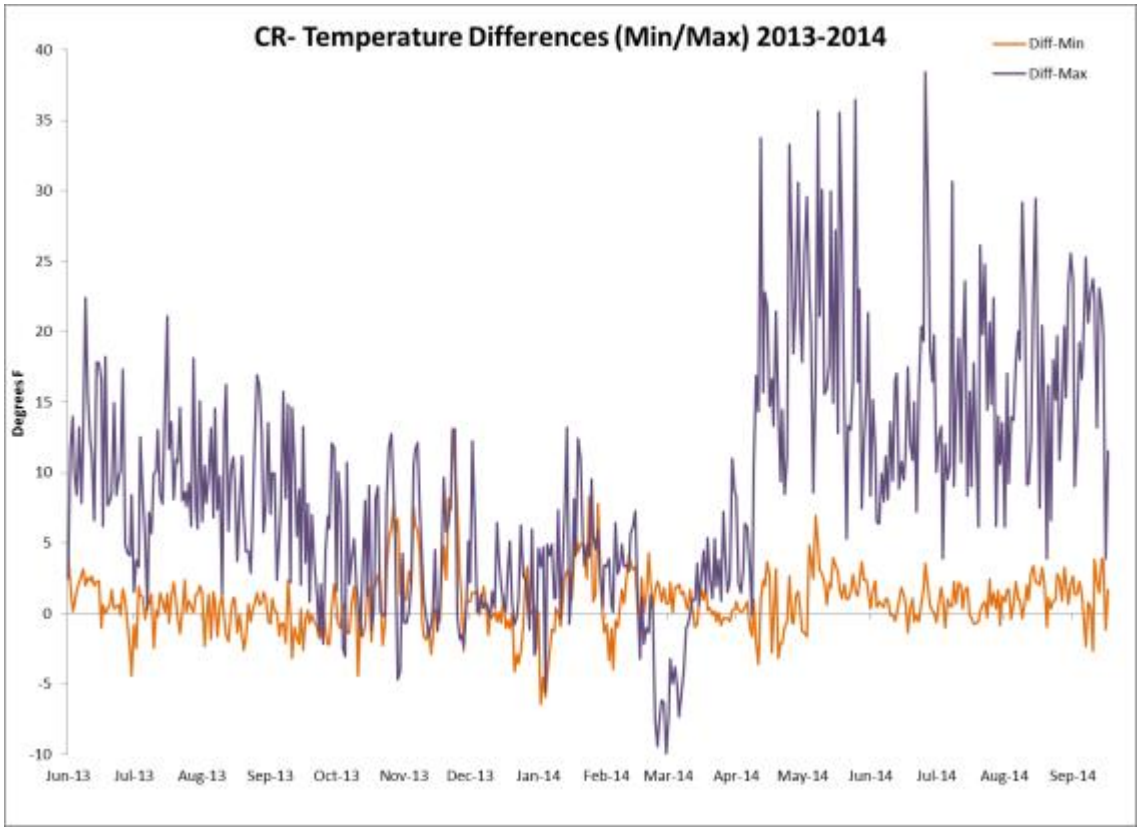
Growing Degree Days:



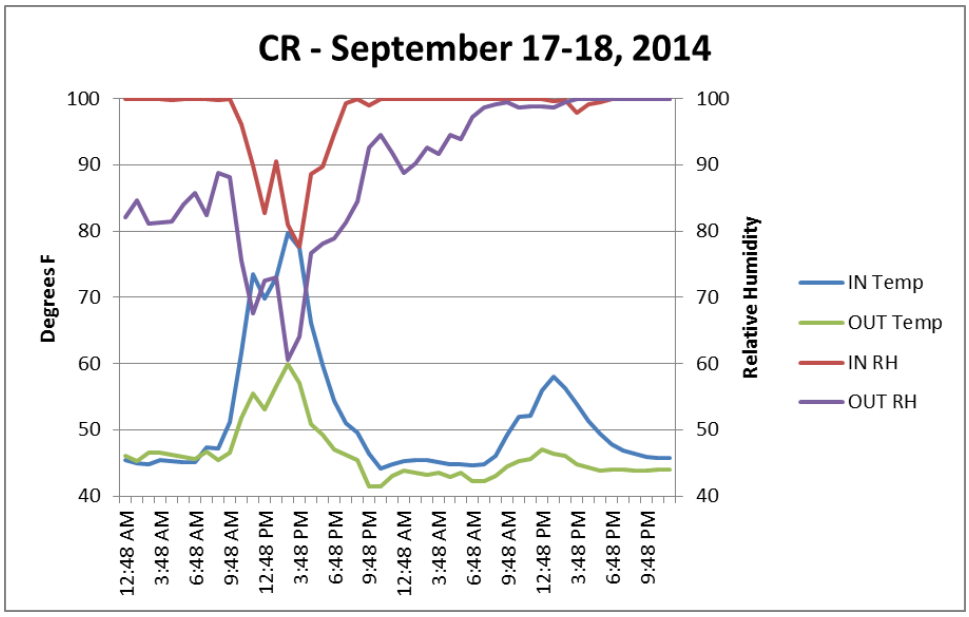
Daily Min & Max Temperatures:



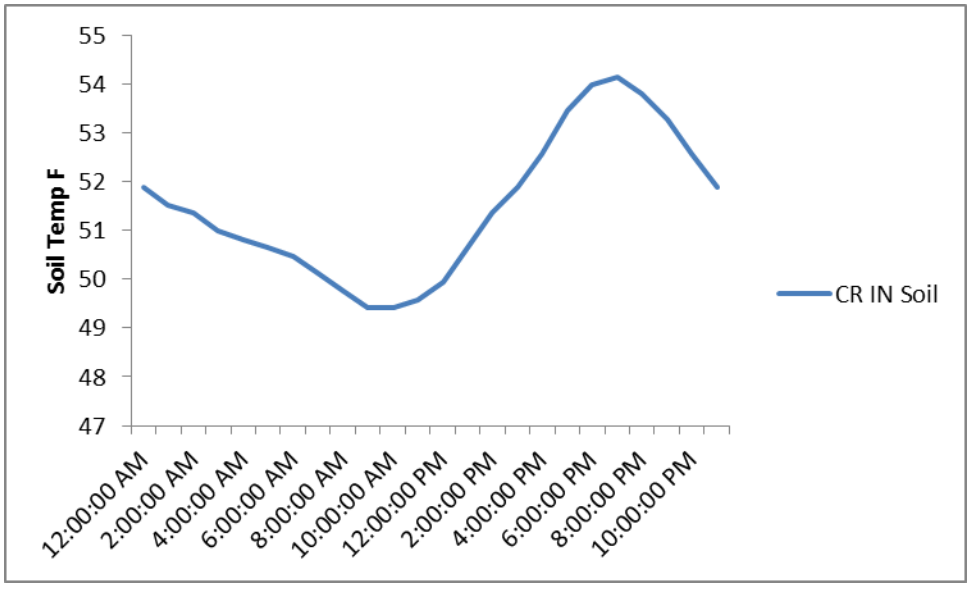
Temperature Differences:



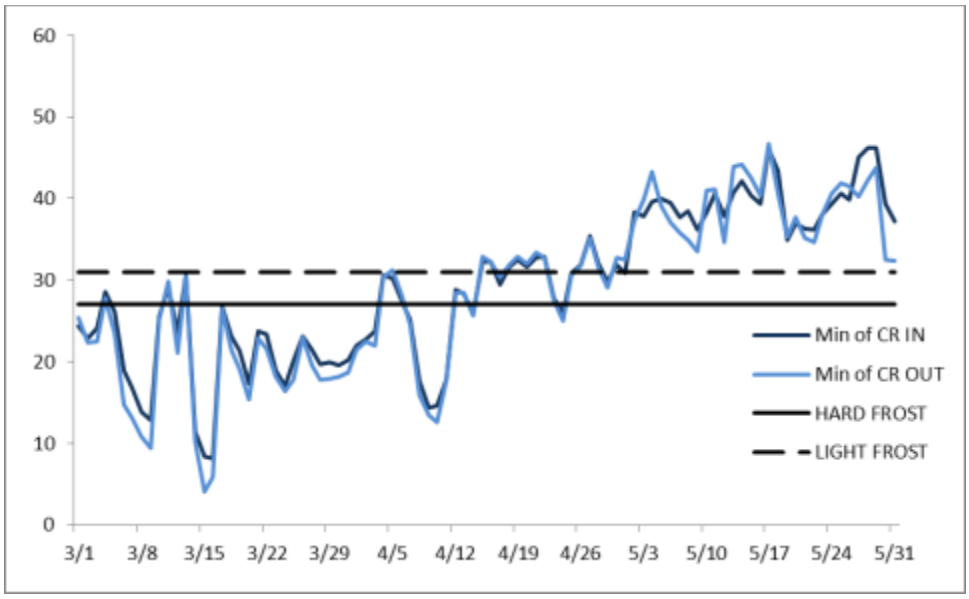
48-hour Close-Up:



Soil Temperatures, September 18, 2014:



Spring 2014: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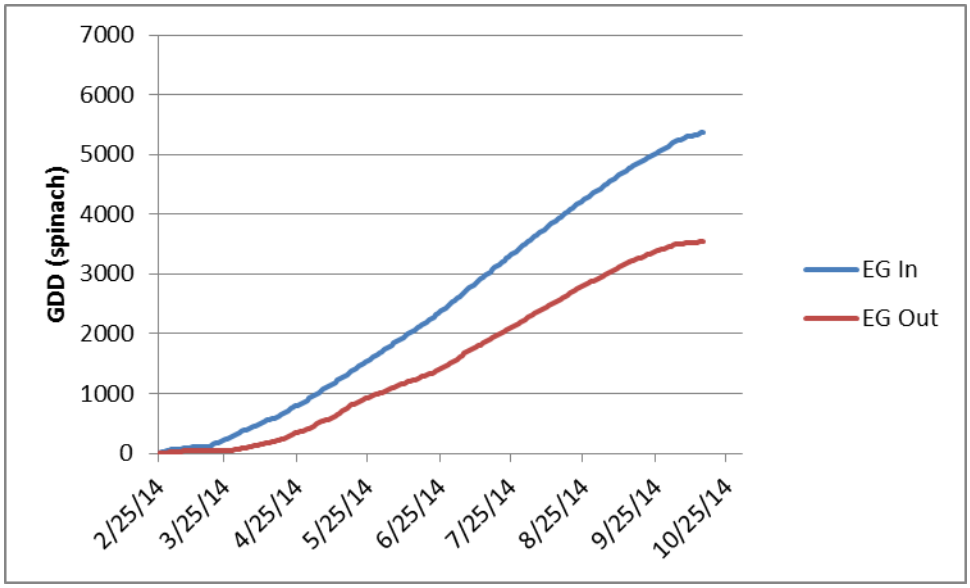
Min of CR IN
Min of CR OUT
HARD FROST
LIGHT FROST

High Tunnel: EG (High/Single)

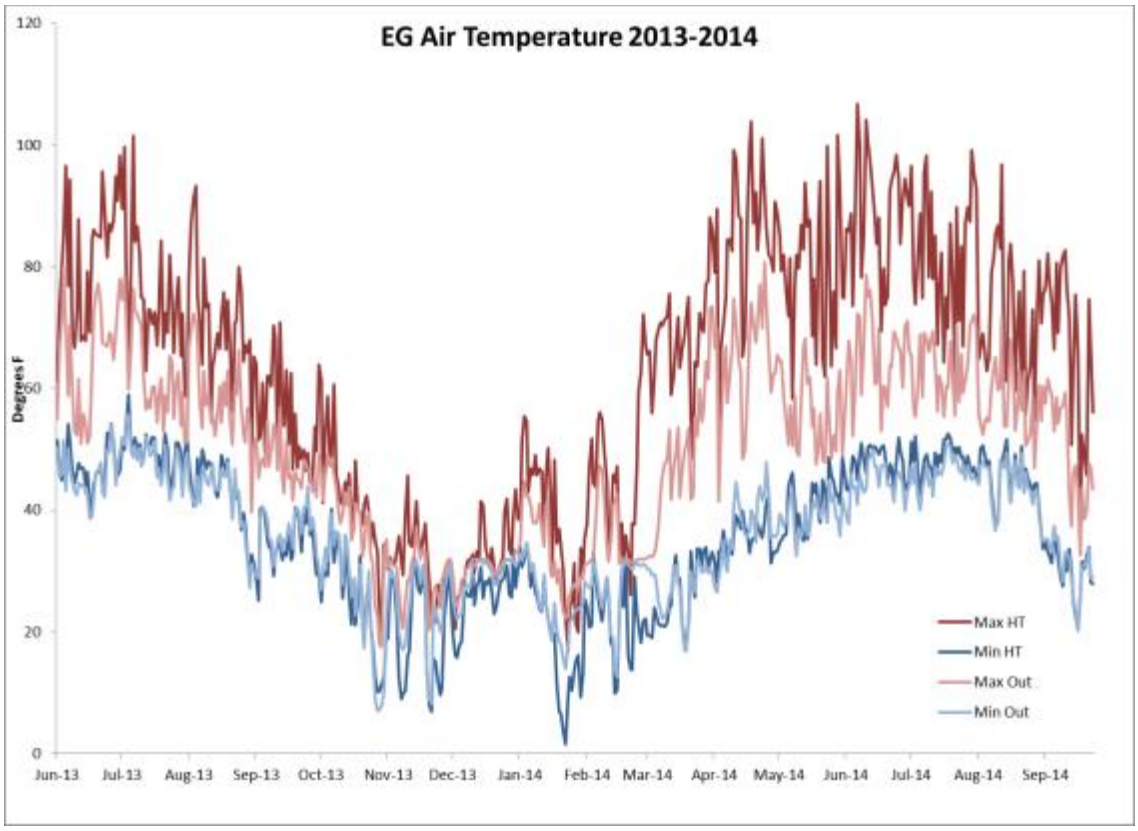
Location: Ohlson Mtn., Homer, Alaska
Elevation: 1295'
Size: 26' x 96'
Glazing: single with plastic endwalls
Ventilation Methods: Roll-up sides, only ever 2' or so. Large cut in glazing during part of summer 2013.
Inside Air Dates: 6/23/13-12/18/14 **Inside Soil Dates:** 6/23/13-11/2/13
Outside Air Dates: 6/23/13-12/18/14 **Outside Soil Dates:** 6/23/13-11/2/13
Notes: Inside soil logger was misplaced for some period of time.



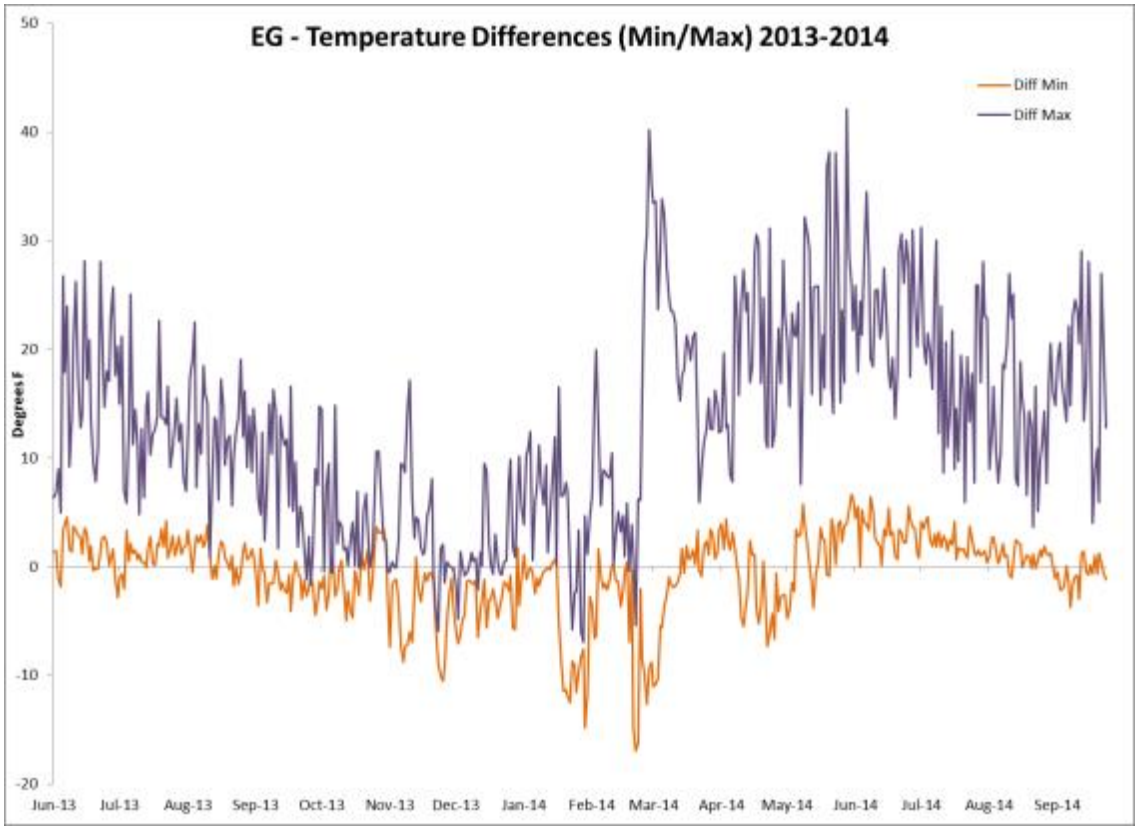
Growing Degree Days:



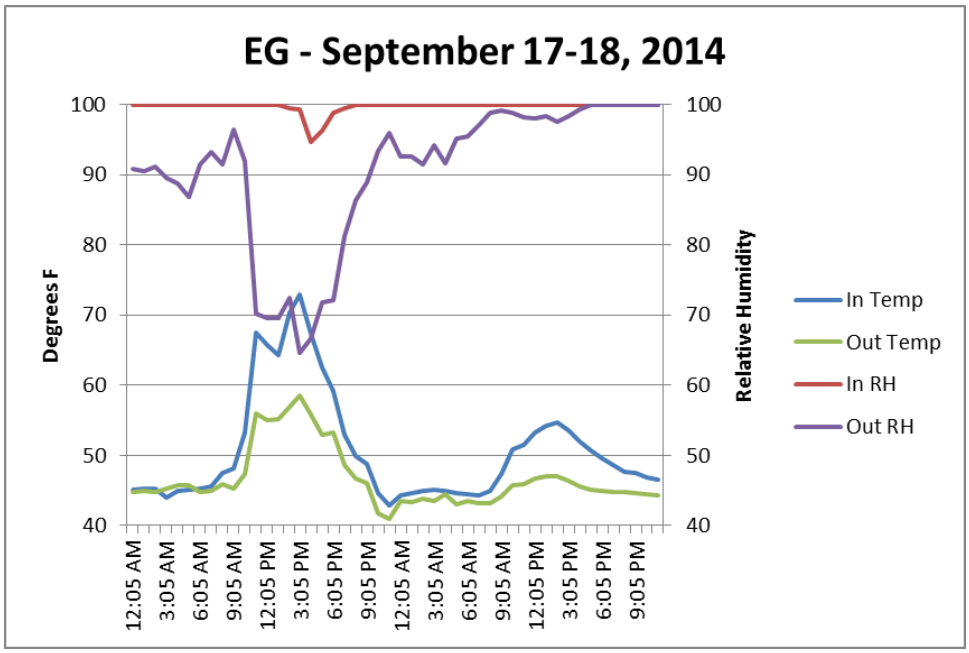
Daily Min & Max Temperatures:



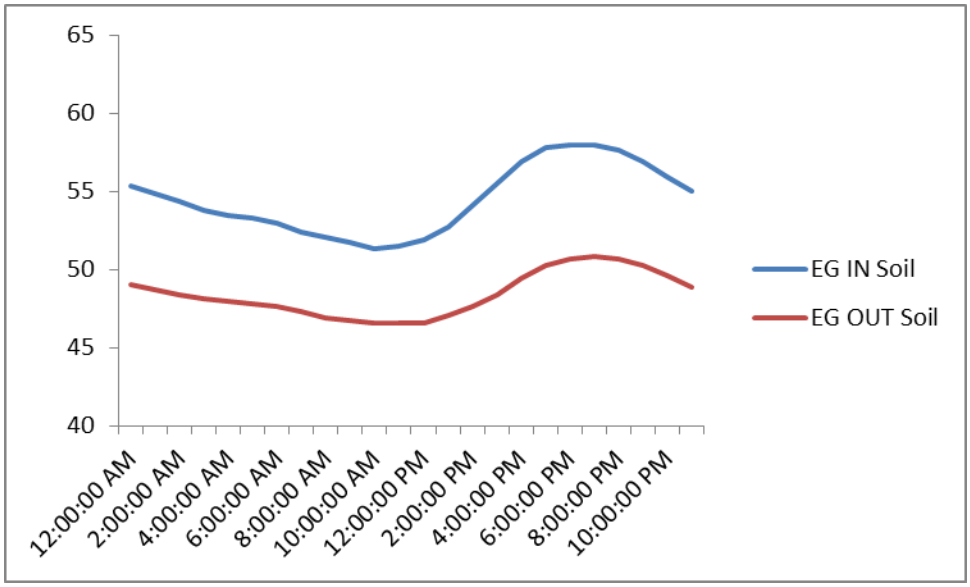
Temperature Differences:



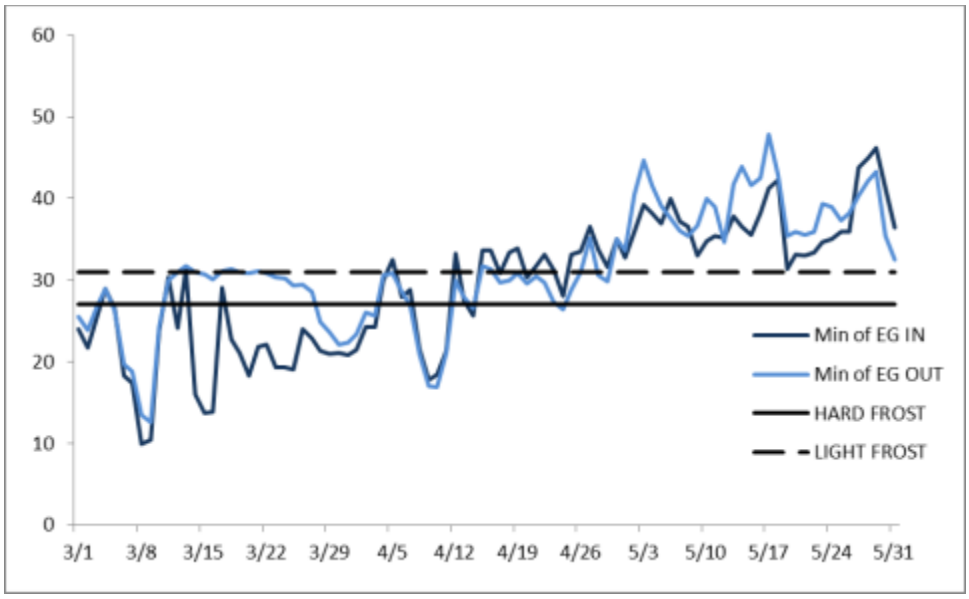
48-hour Close-Up:



Soil Temperatures, September 18, 2014:



Spring 2014: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Min of EG IN
Min of EG OUT
HARD FROST
LIGHT FROST

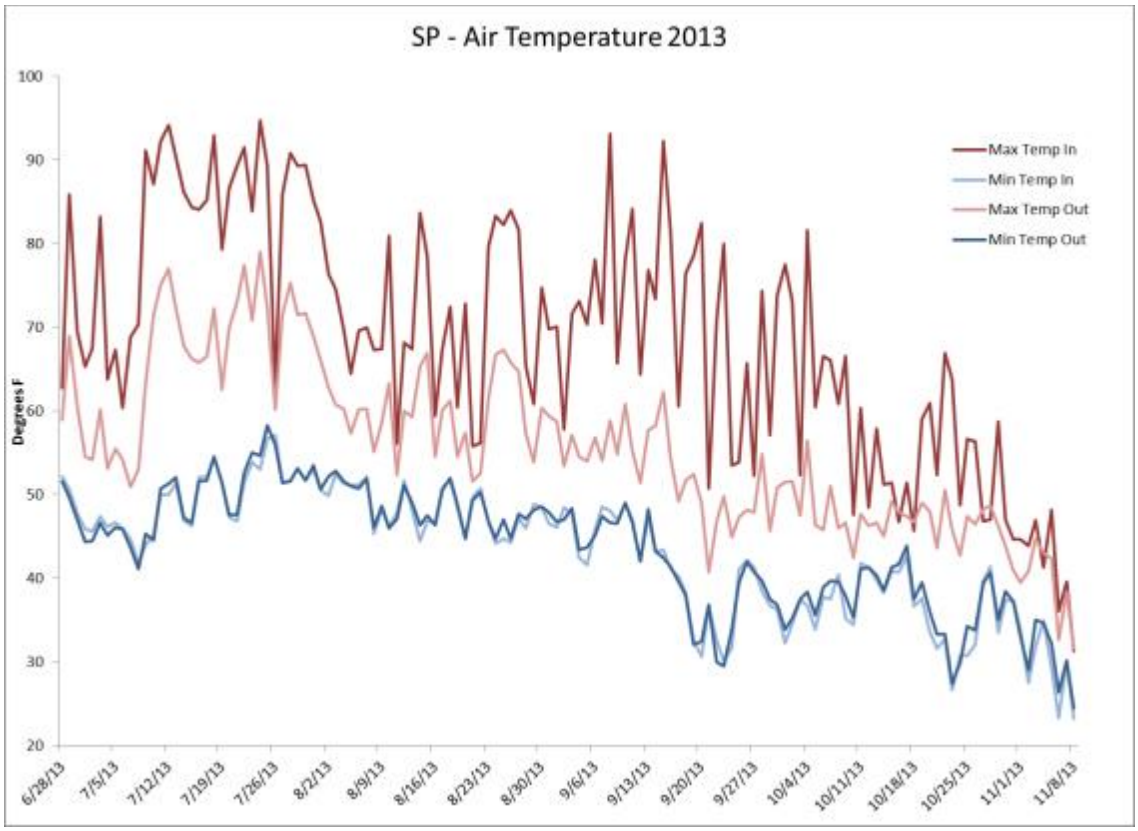
High Tunnel: SP (High/Single)

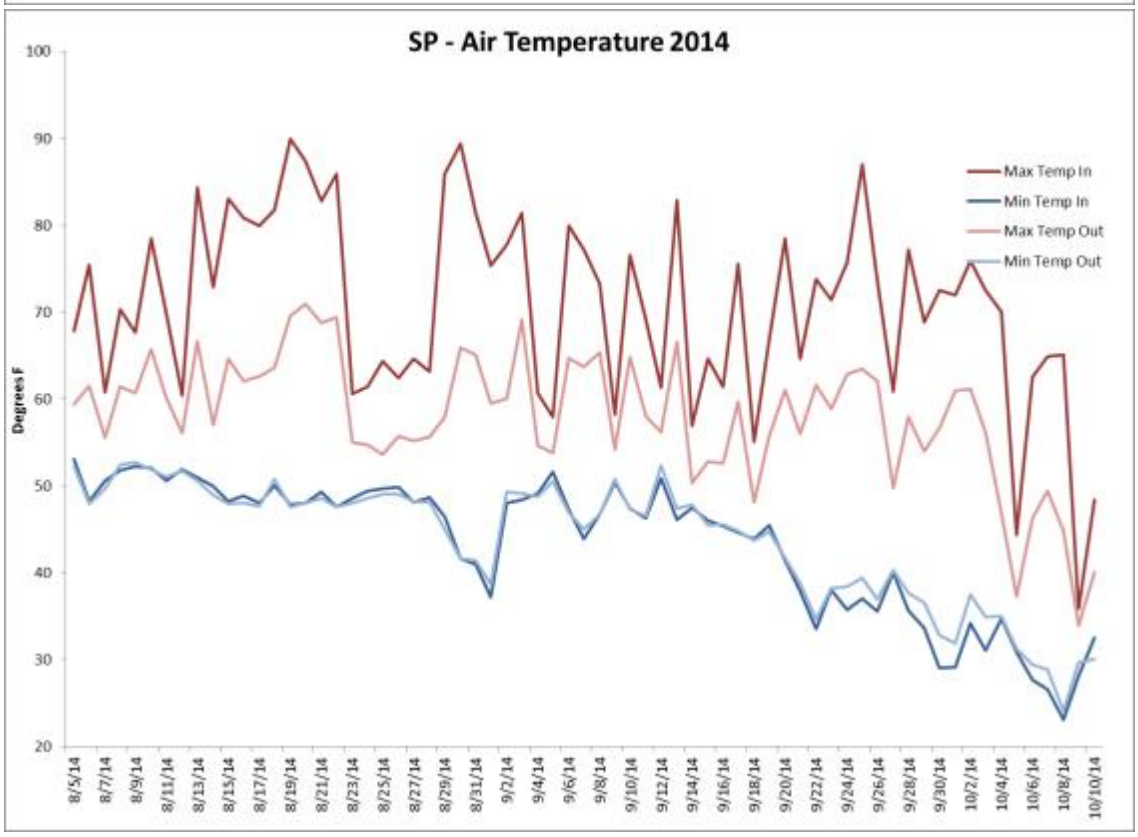
Location: East Skyline Drive, Homer
Elevation: 1044'
Size: 30' x 72'
Glazing: single
Ventilation Methods: box fans hanging and open end walls.
Inside Air Dates: 6/28/13-11/8/13; **Inside Soil Dates:** 6/28/13-7/27/14
Skip to 8/5/14-10/10/14
Outside Air Dates: 6/28/13-11/8/13; **Outside Soil Dates:** 6/30/13-3/18/14
Skip to 8/5/14-10/10/14
Notes: Corrupted data between 11/9/13 and 8/4/14. I have no idea what happened, but unfortunately we have no data for the air temperature or relative humidity for these dates either inside or outside.



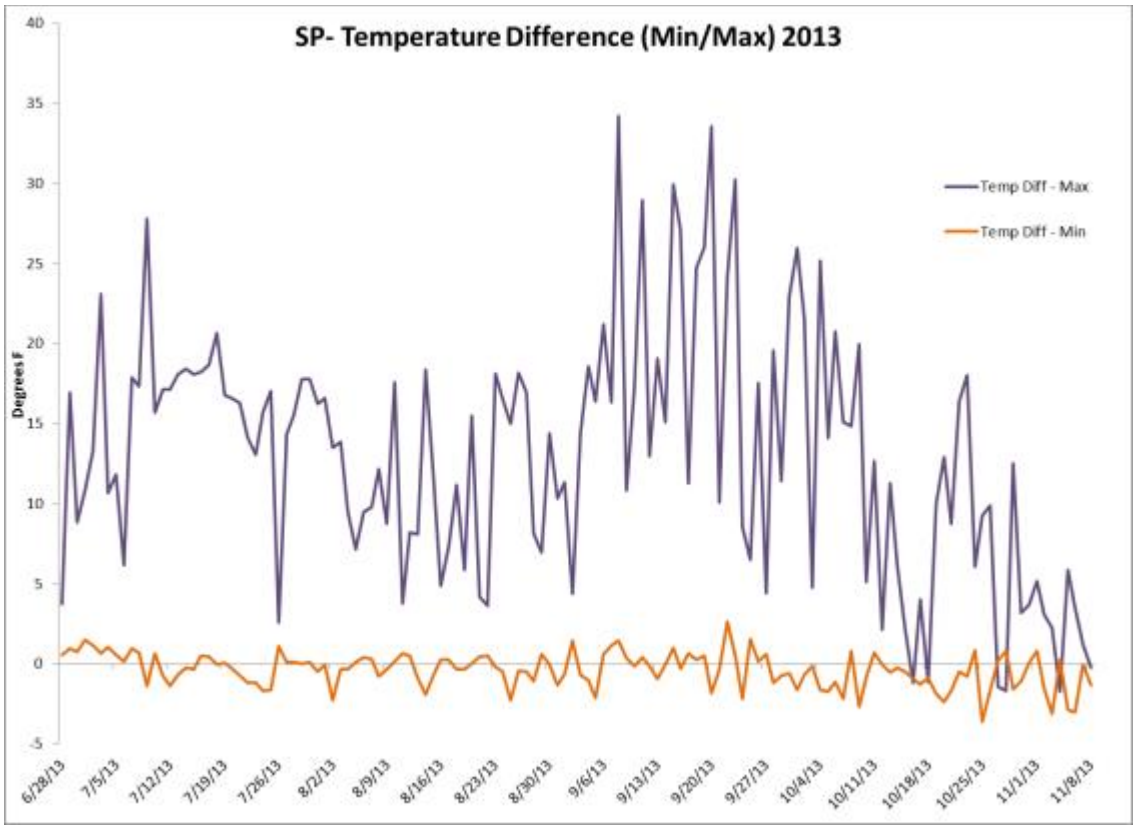
Growing Degree Days:
Unable to calculate, as we didn't have air temperature data for springtime in either 2013 or 2014.

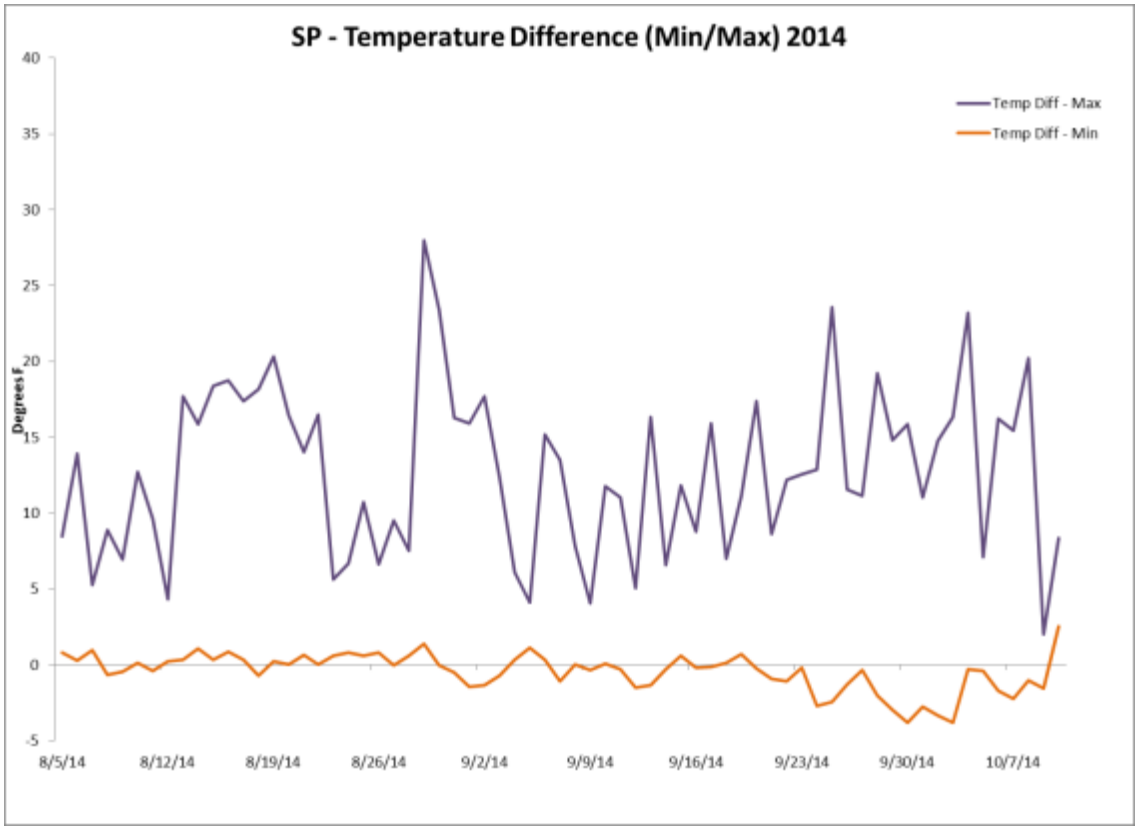
Daily Min & Max Temperatures:



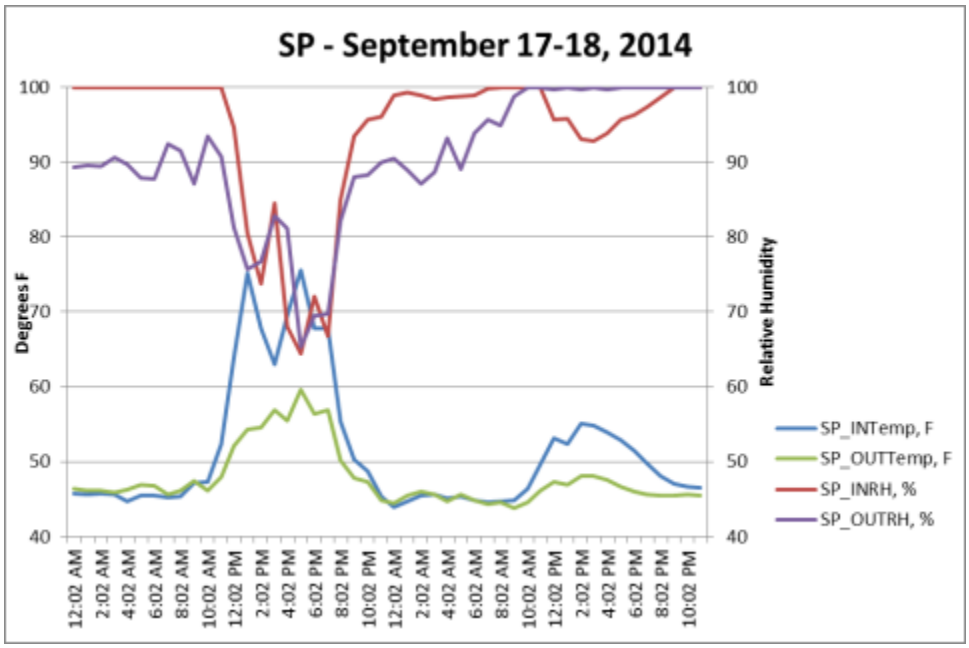


Temperature Differences:

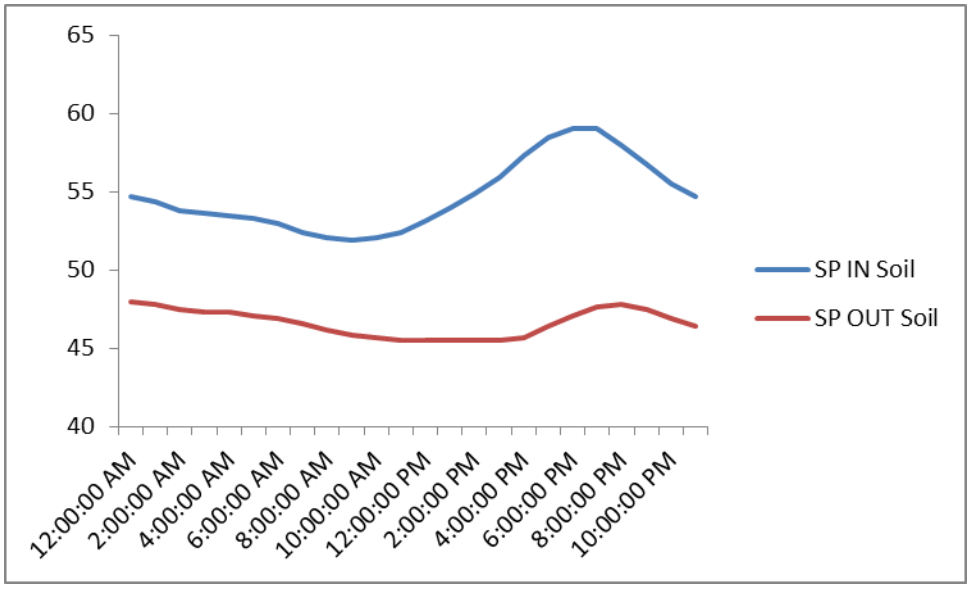




48-hour Close-Up:



Soil Temperatures, September 18, 2014:



Spring 2014:

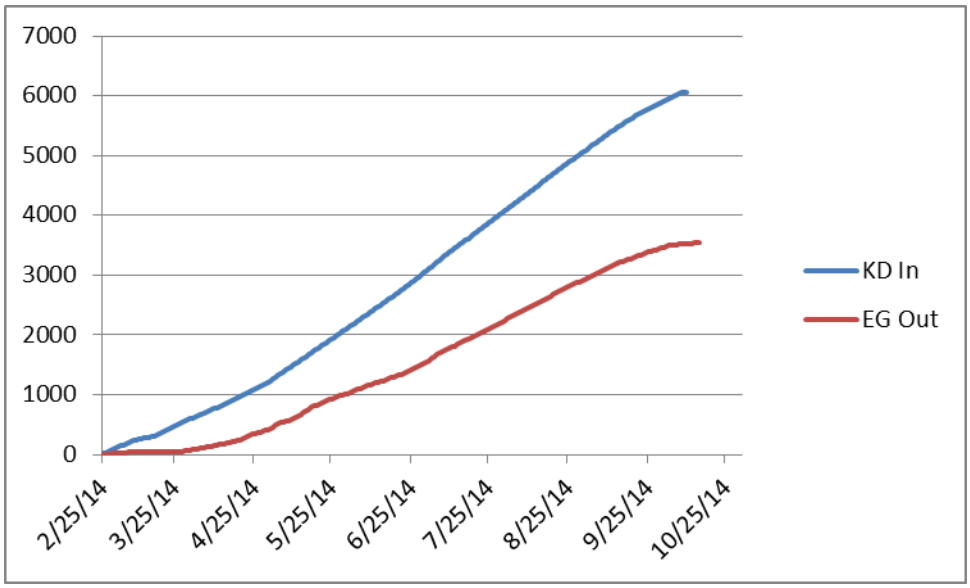
Unable to calculate, as we didn't have air temperature data for springtime in either 2013 or 2014.

High Tunnel: KD (High/Double)

Location: Skyline Dr., Homer, Alaska
Elevation: 1273'
Size: 30' x 72'
Glazing: double with polycarbonate end walls and an insulated pony wall on the north side.
Ventilation Methods: large ventilation fans at one end in the gable and 2 sm. Vents in other end wall with two additional 24" circular fans.
Inside Air Dates: 6/23/13-10/10/14 **Inside Soil Dates:** 6/23/13-3/11/14
Outside Air Dates: 6/23/13-10/10/14* **Outside Soil Dates:** 6/23/13-3/11/14
Notes: At some point in early-February 2014, the outside air logger came out of the solar shield and was on the ground until it was recovered in October.

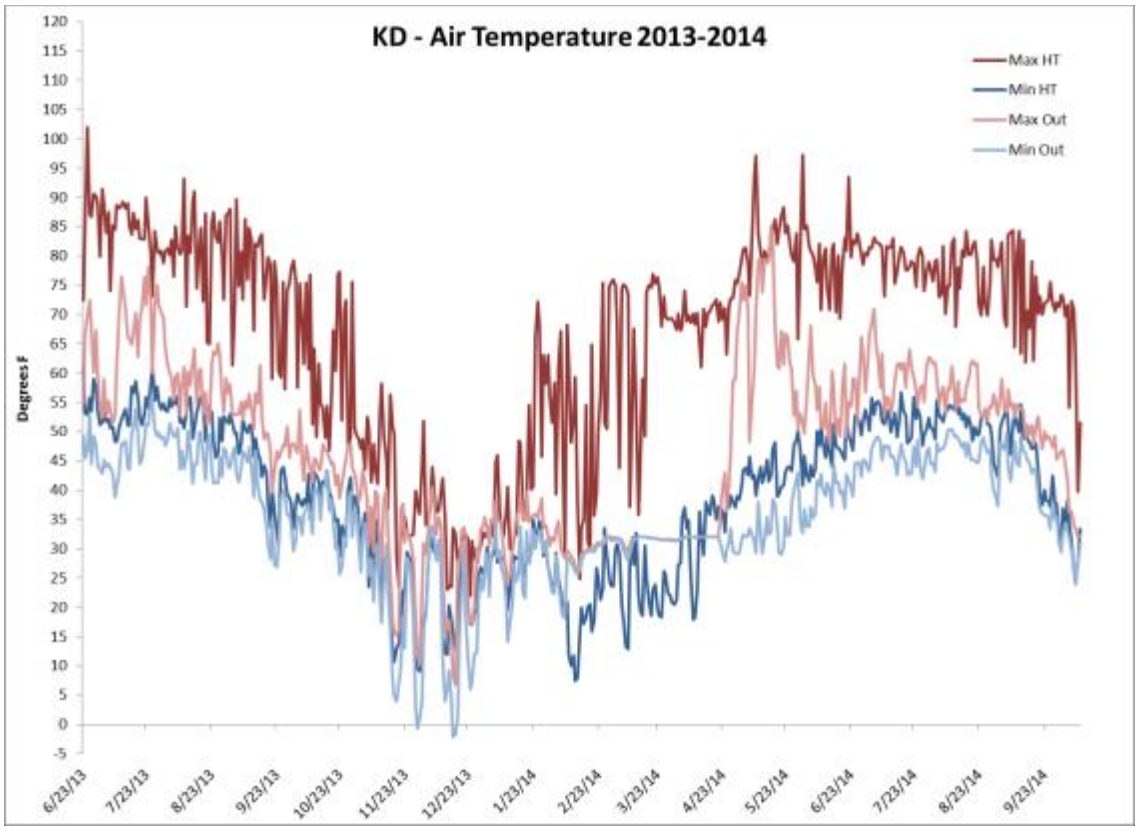


Growing Degree Days:

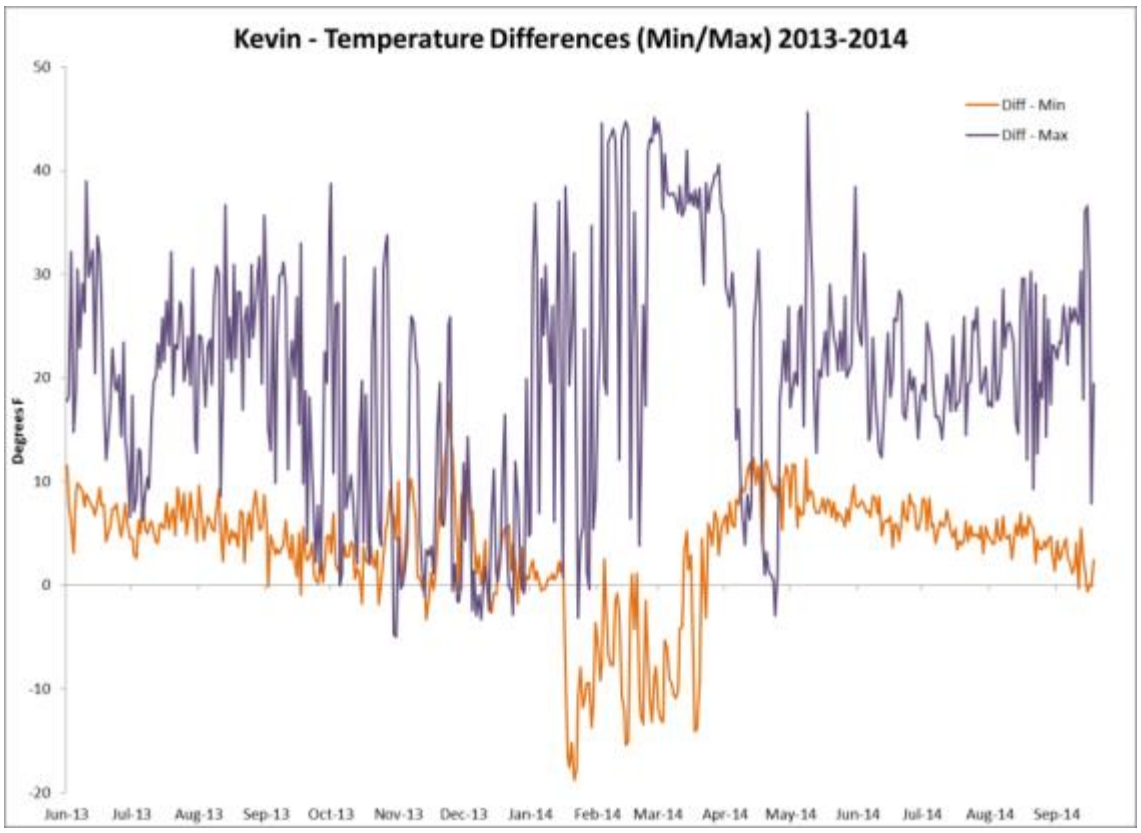


Because the air temperature logger fell onto the ground during the late-winter 2014, the outside air data were not considered valid for analysis. In order to compare inside and outside GDD, here we used the outside data from HT:EG as they are both at high elevations in Homer.

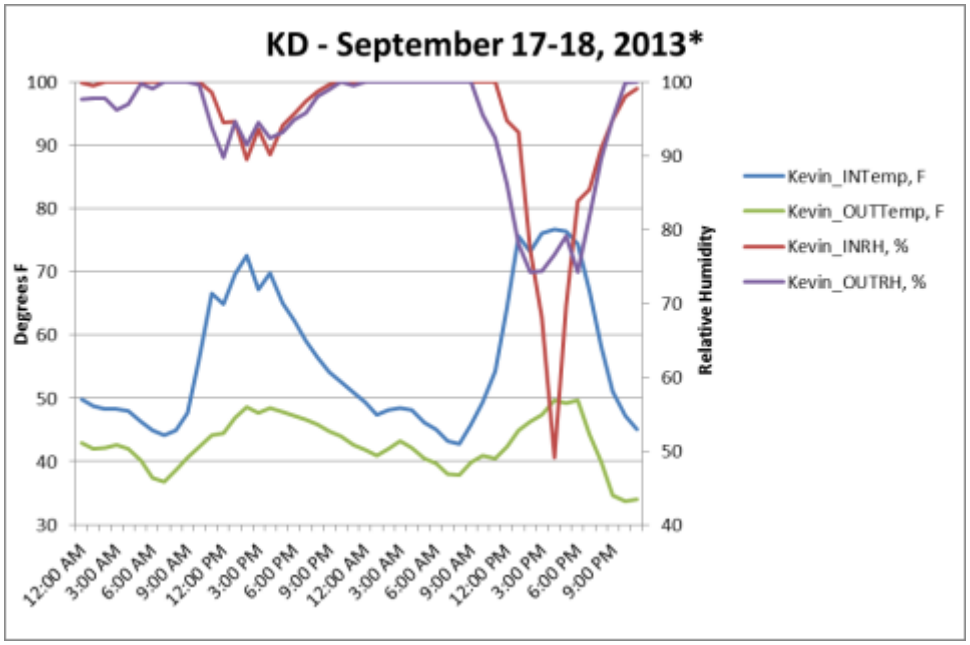
Daily Min & Max Temperatures:



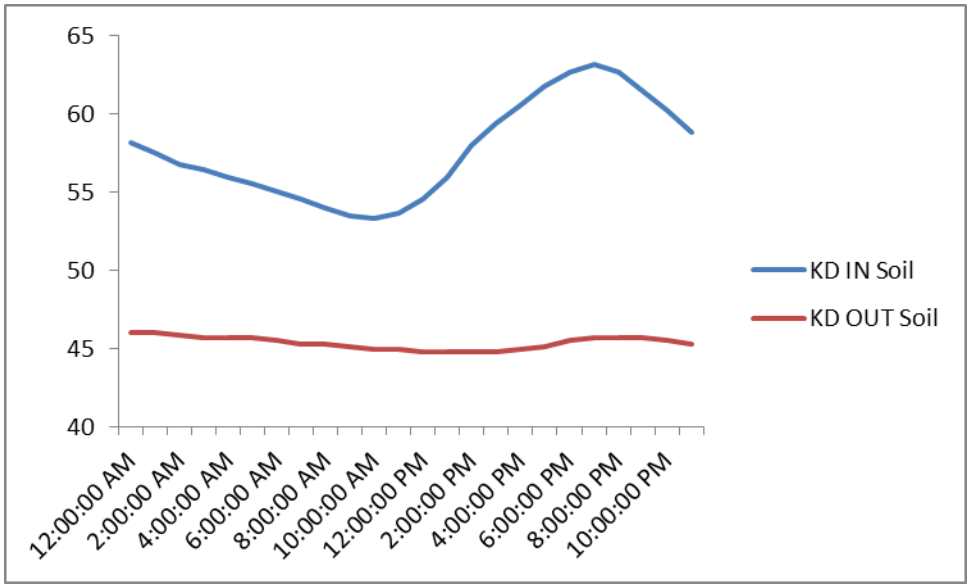
Temperature Differences:



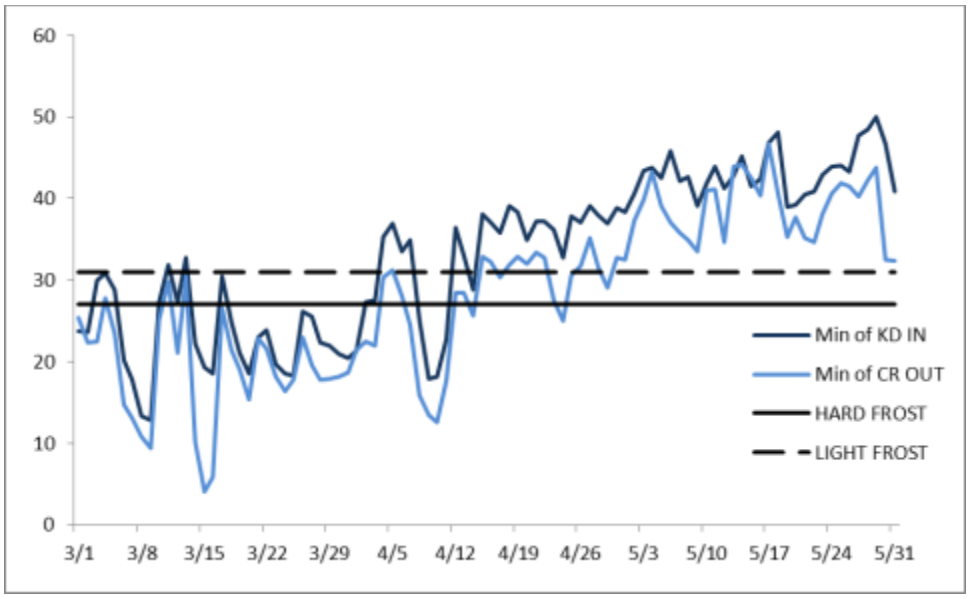
48-hour Close-Up:



Soil Temperatures, September 18, 2014:



Spring 2014: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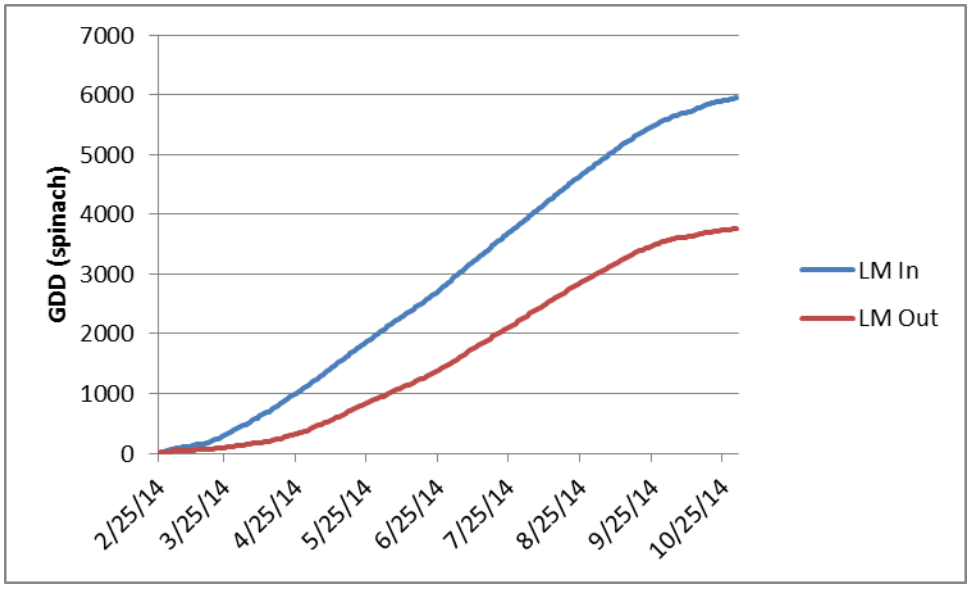
Min of KD IN
Min of CR OUT
HARD FROST
LIGHT FROST

High Tunnel: LM (Low/Double)

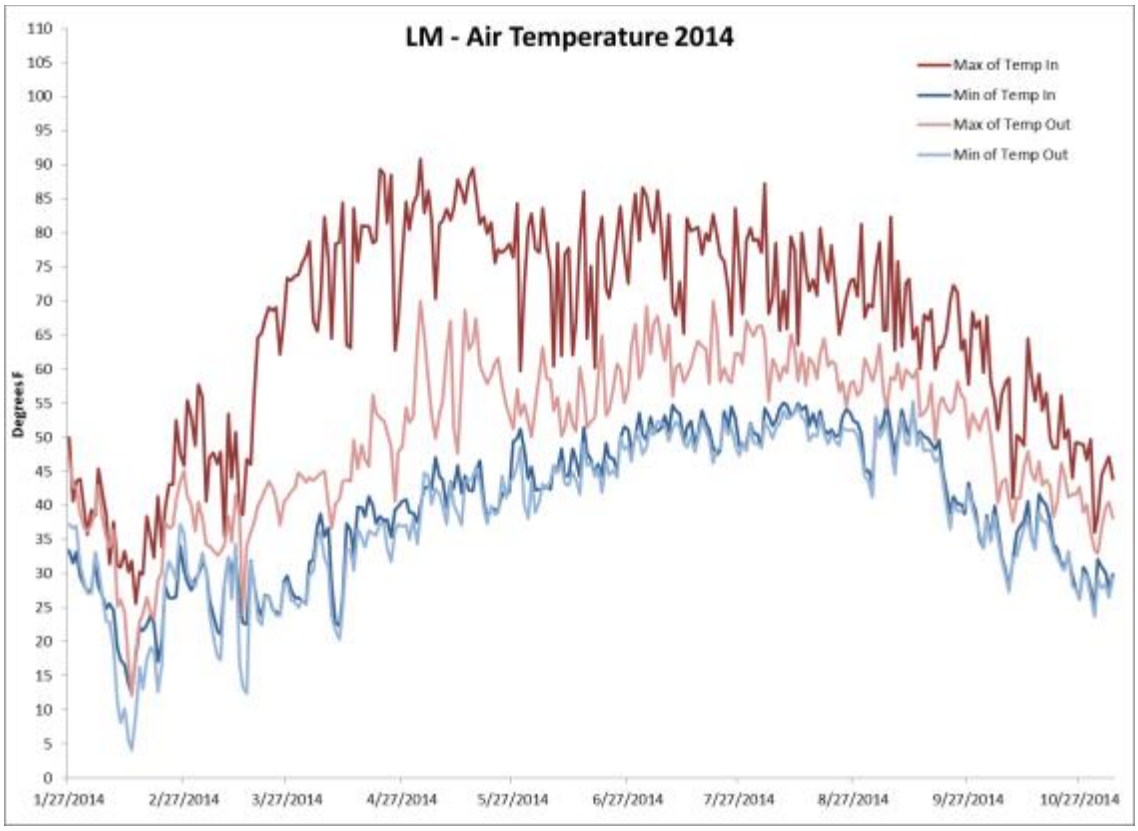
Location: Rangeview Dr., Homer, Alaska
Elevation: 285'
Size: 30' x 72x
Glazing: double with glass end walls
Ventilation Methods: fan midway overhead, garage doors on each end to open and solar gable vents on both ends.
Inside Air Dates: 1/27/14-10/28/14 **Inside Soil Dates:** 6/7/13-2/23/14
Outside Air Dates: 6/7/13-2/23/14 **Outside Soil Dates:** 6/7/13-2/23/14
Notes: The outside soil logger was placed in a stand of dense spruce trees. Soil temperature likely colder than in comparable growing area to inside the high tunnel.



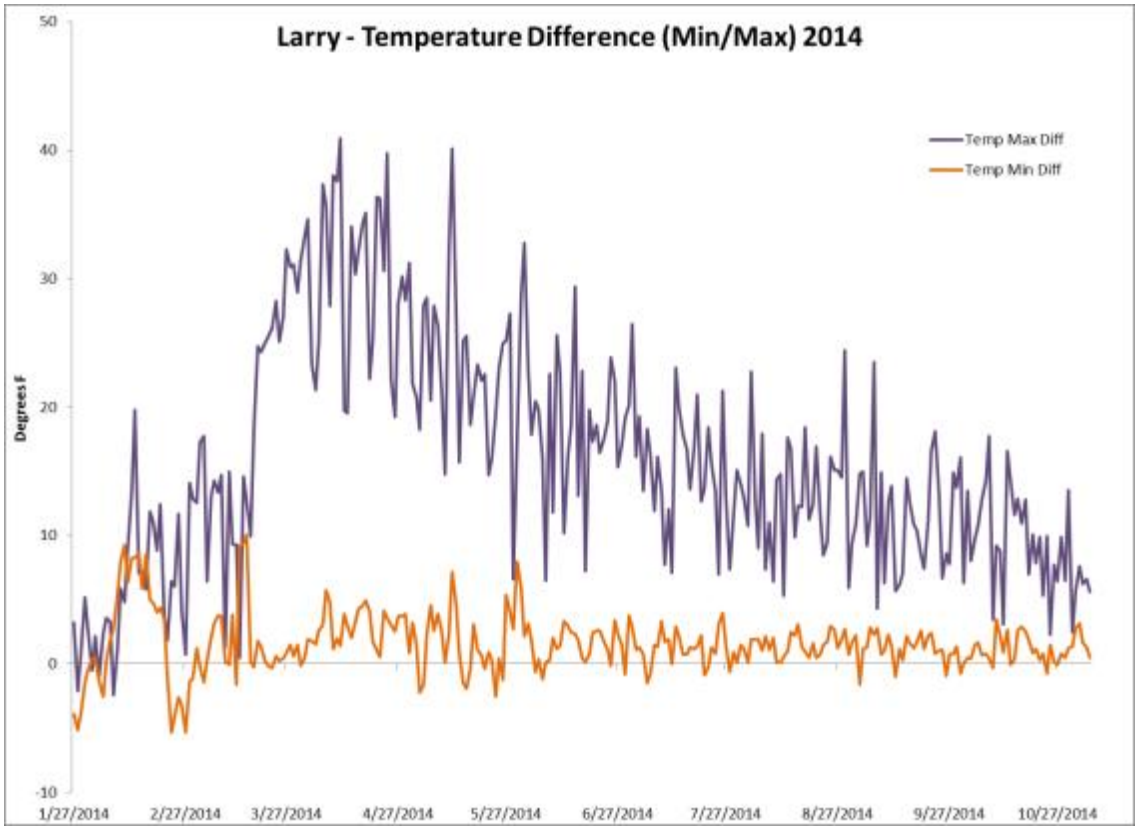
Growing Degree Days:



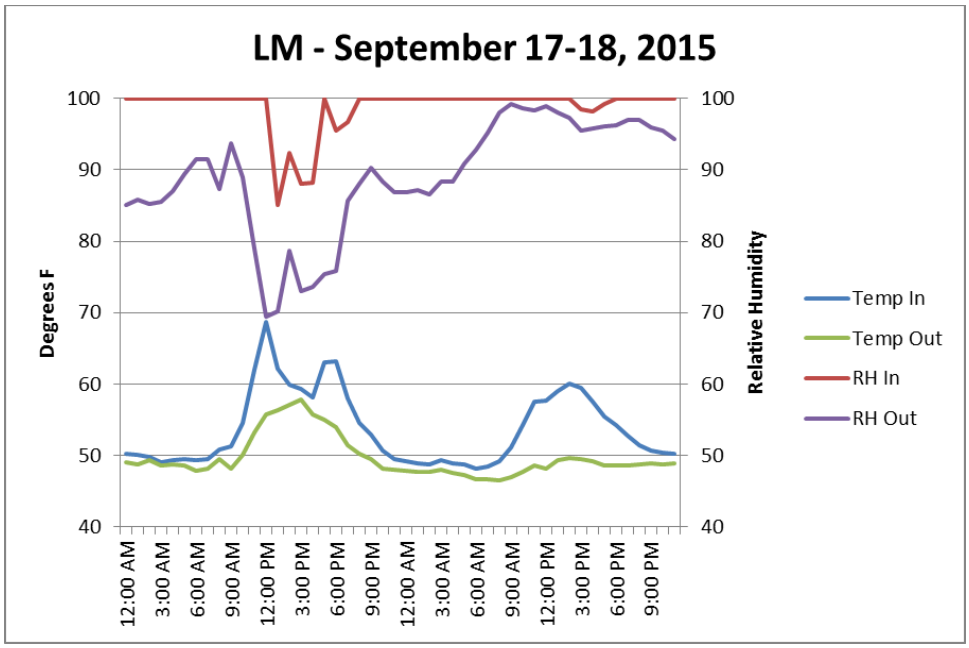
Daily Min & Max Temperatures:



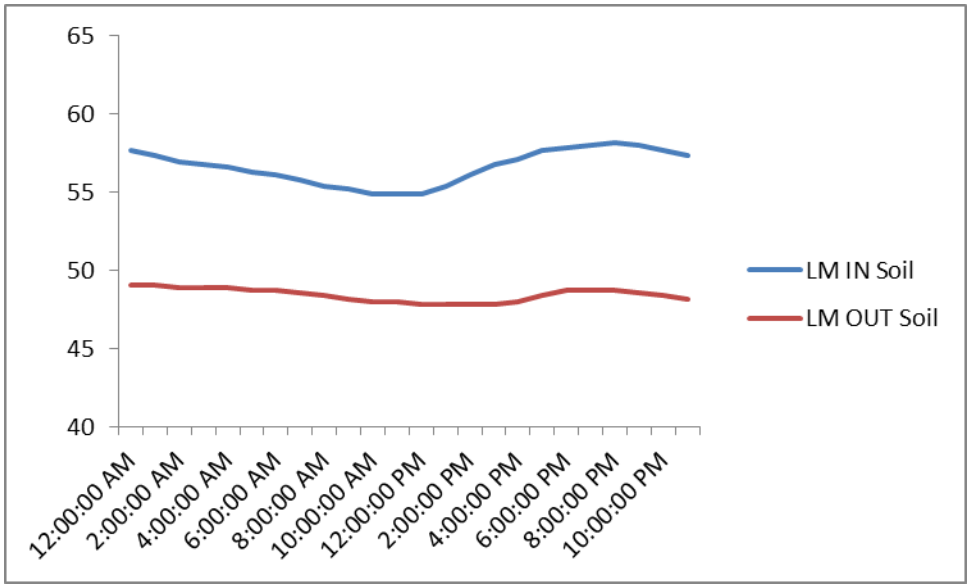
Temperature Differences:



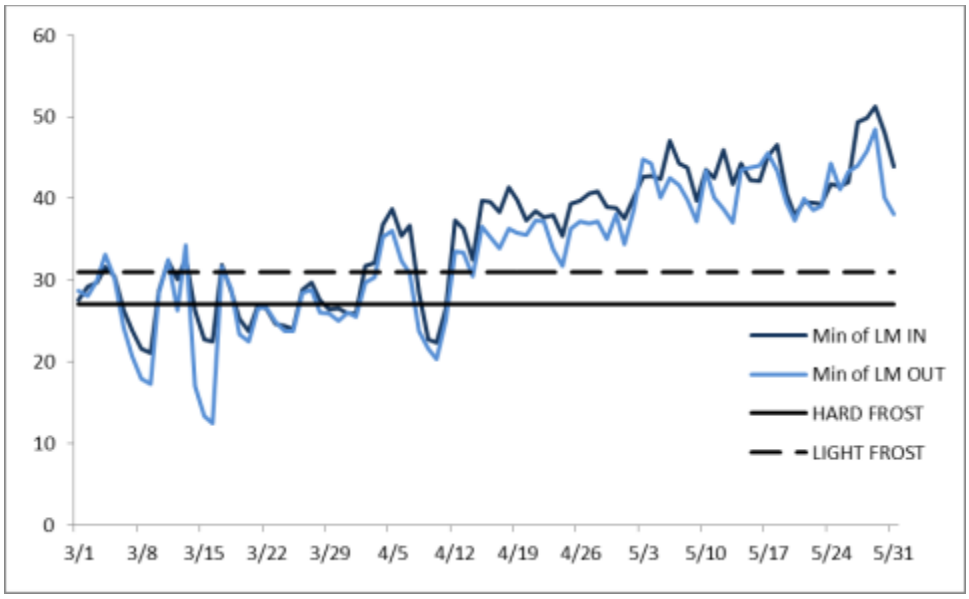
48-hour Close-Up:



Soil Temperatures, September 18, 2014:



Spring 2014: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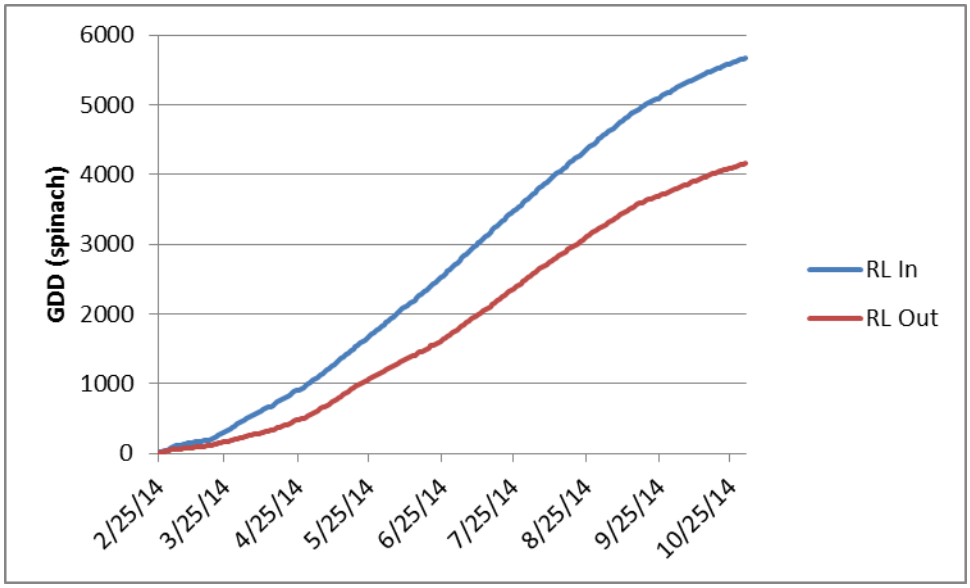
Min of LM IN
Min of LM OUT
HARD FROST
LIGHT FROST

High Tunnel: RL (Low/Single)

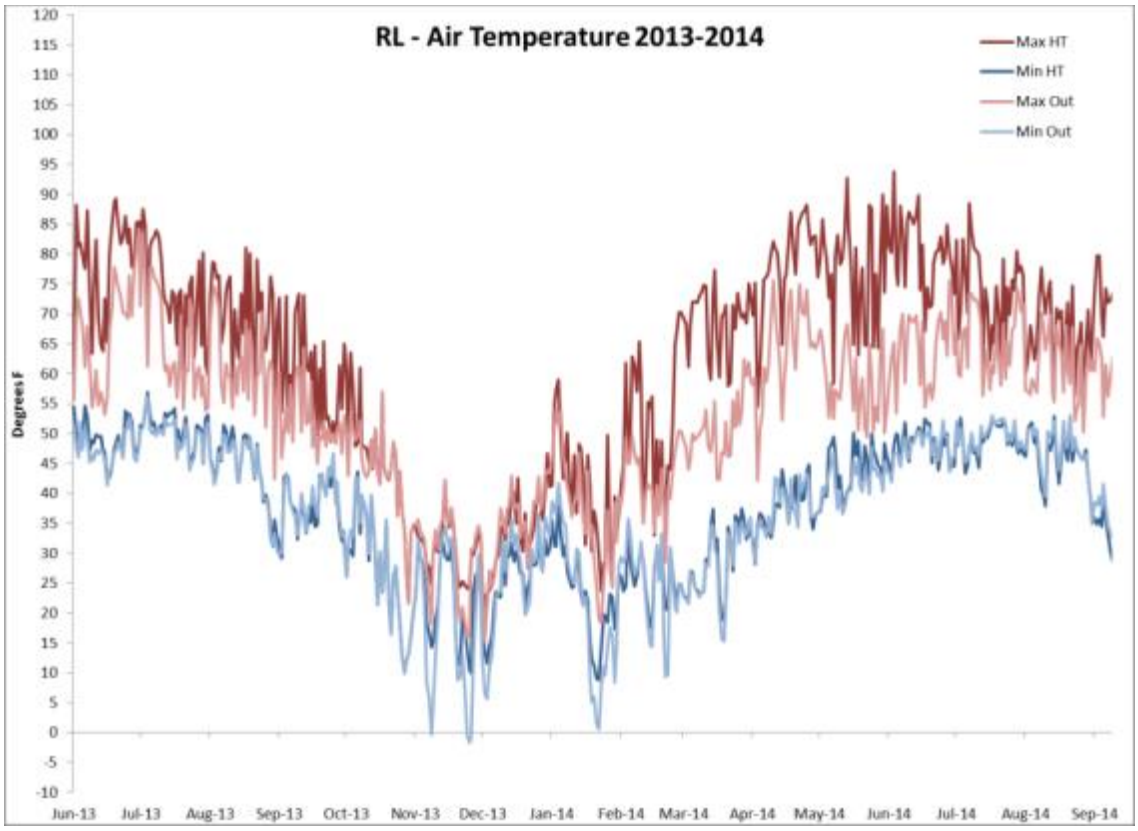
Location: Shellfish Ave., Homer, Alaska
Elevation: 430'
Size: 30' x 72'
Glazing: single with plastic endwalls
Ventilation Methods: Roll-down sides, passive gable end vent in one end wall, large fan at other end wall, 2-4 box fans inside along northern wall.
Inside Air Dates: 6/23/13-12/18/14 **Inside Soil Dates:** 6/23/13-11/2/13
Outside Air Dates: 6/23/13-12/18/14 **Outside Soil Dates:** 6/23/13-11/2/13
Notes: Soil loggers were accidentally not replaced after the first winter.



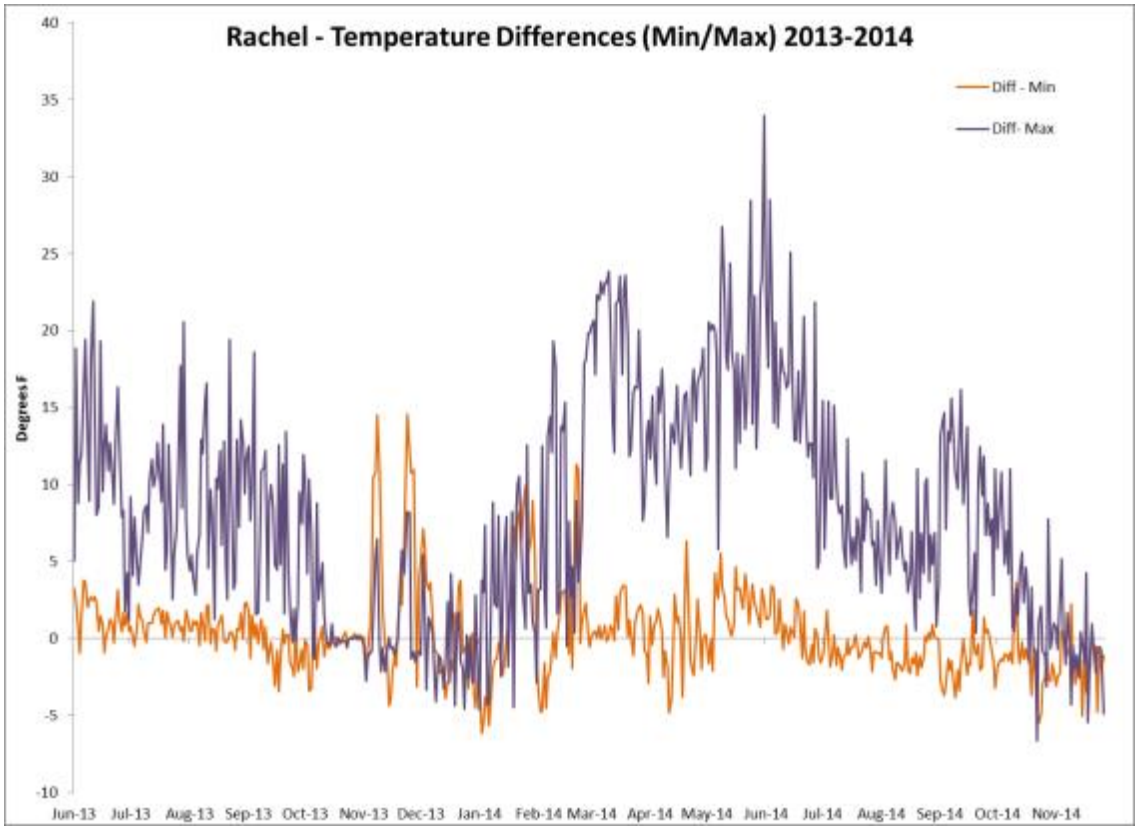
Growing Degree Days:



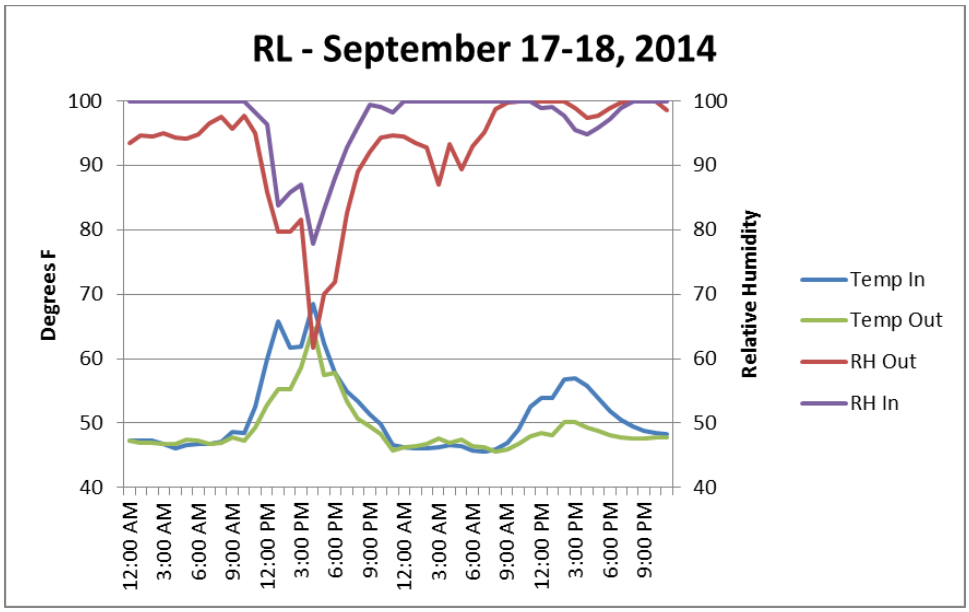
Daily Min & Max Temperatures:



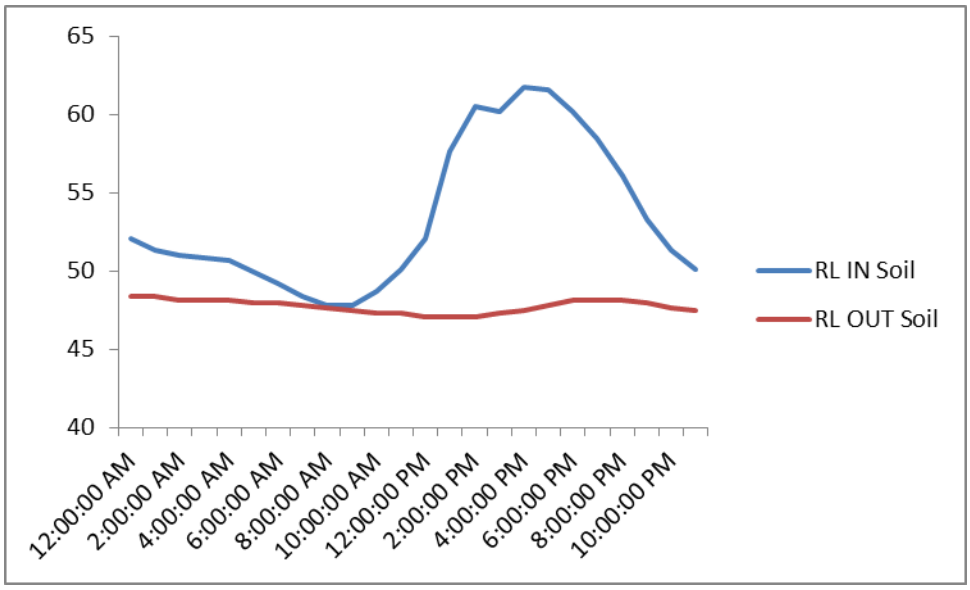
Temperature Differences:



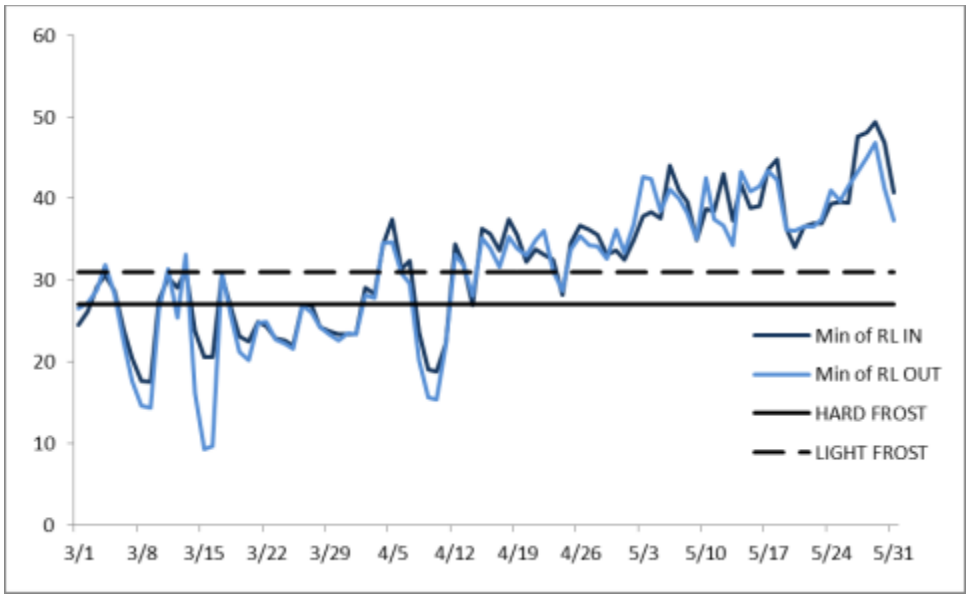
48-hour Close-Up:



Soil Temperatures, September 18, 2014:



Spring 2014: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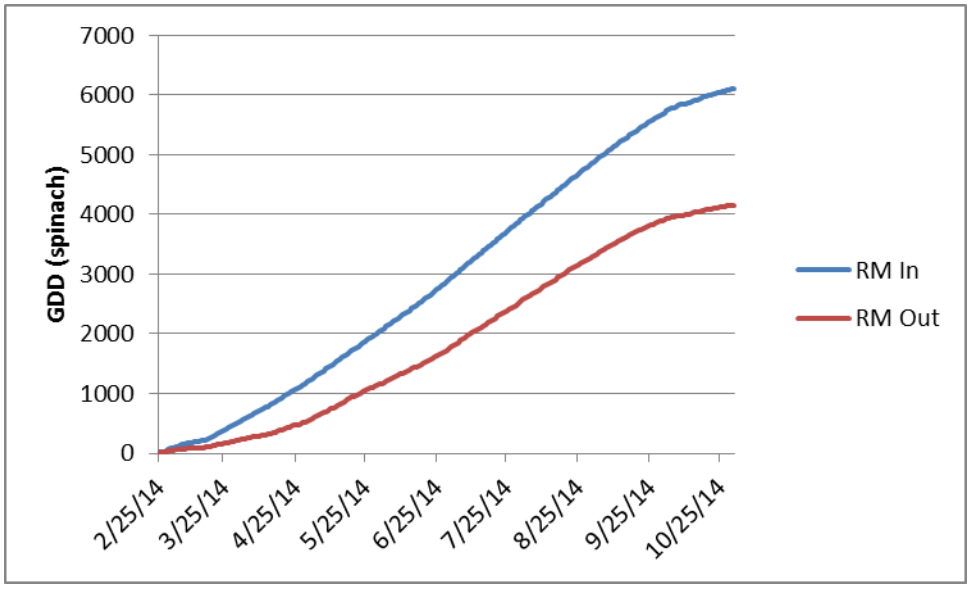
Min of RL IN
Min of RL OUT
HARD FROST
LIGHT FROST

High Tunnel: RM (Low/Single)

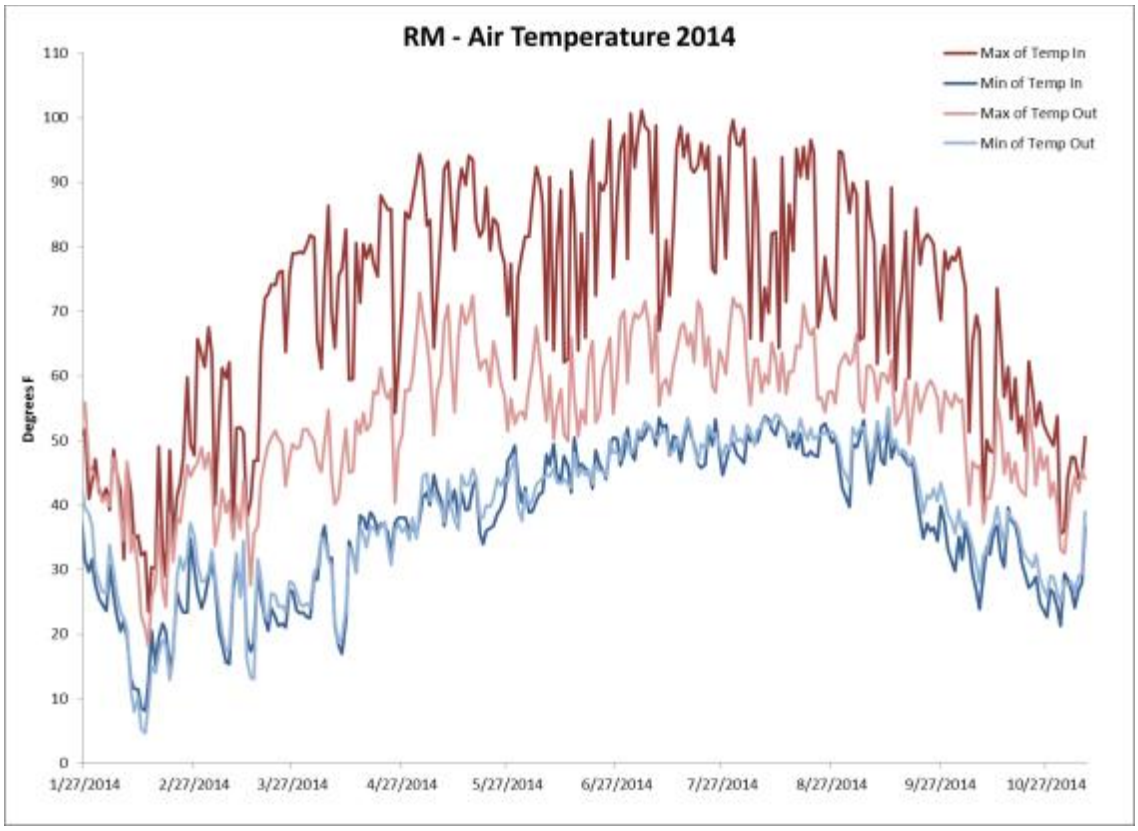
Location: Bayview Rd., Homer, Alaska
Elevation: 403'
Size: 20' x 92'
Glazing: single with polycarbonate endwalls
Ventilation Methods: Passive through end walls (no roll up/down sides)
Inside Air Dates: 12/18/13- 10/28/14 **Inside Soil Dates:** 6/7/13-2/23/14
Outside Air Dates: 12/18/13- 10/28/14 **Outside Soil Dates:** 6/7/13-2/23/14
Notes: The outside soil logger was set on a slight southern slope, possibly creating warmer temperatures than on the flat.



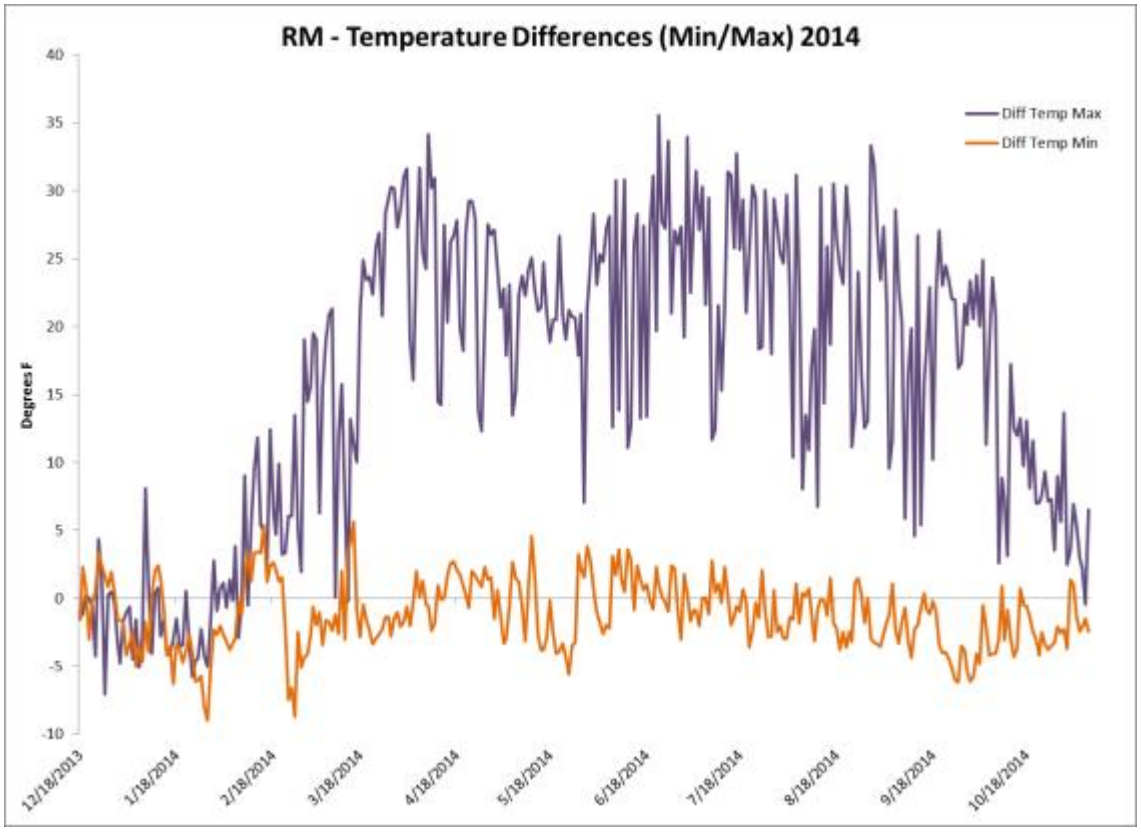
Growing Degree Days:



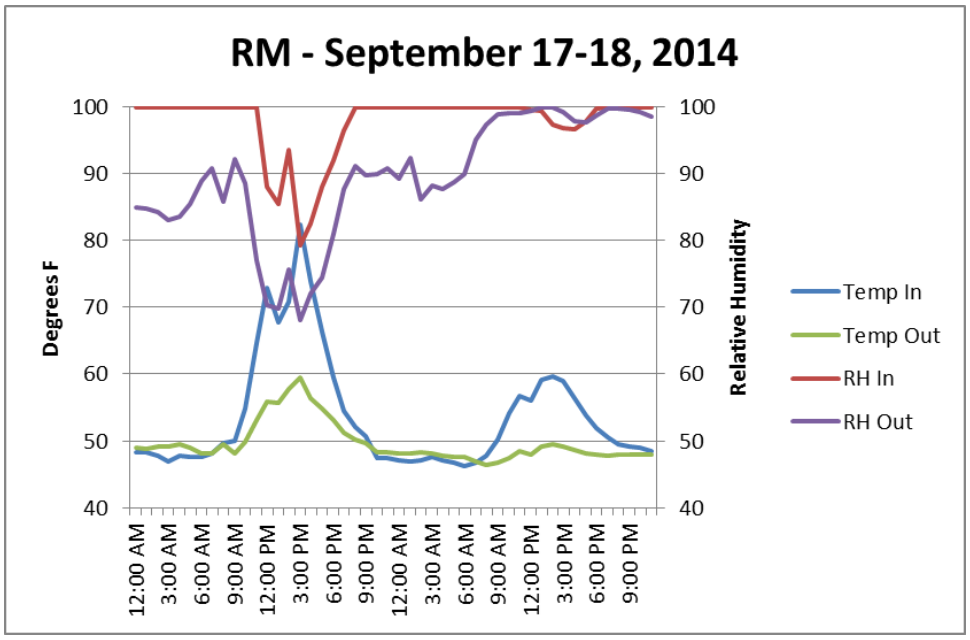
Daily Min & Max Temperatures:



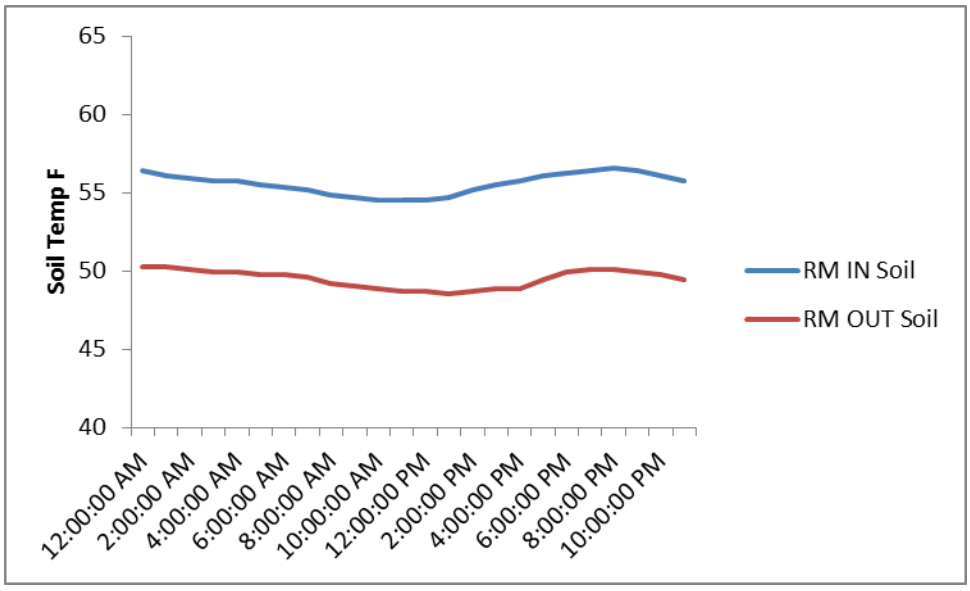
Temperature Differences:



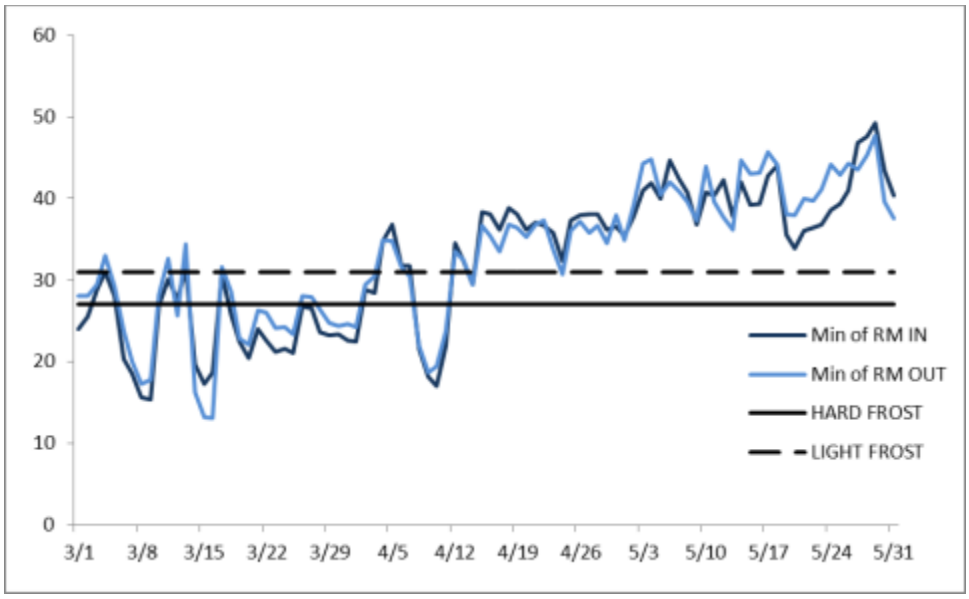
48-hour Close-Up:



Soil Temperatures, September 18, 2014:



Spring 2014: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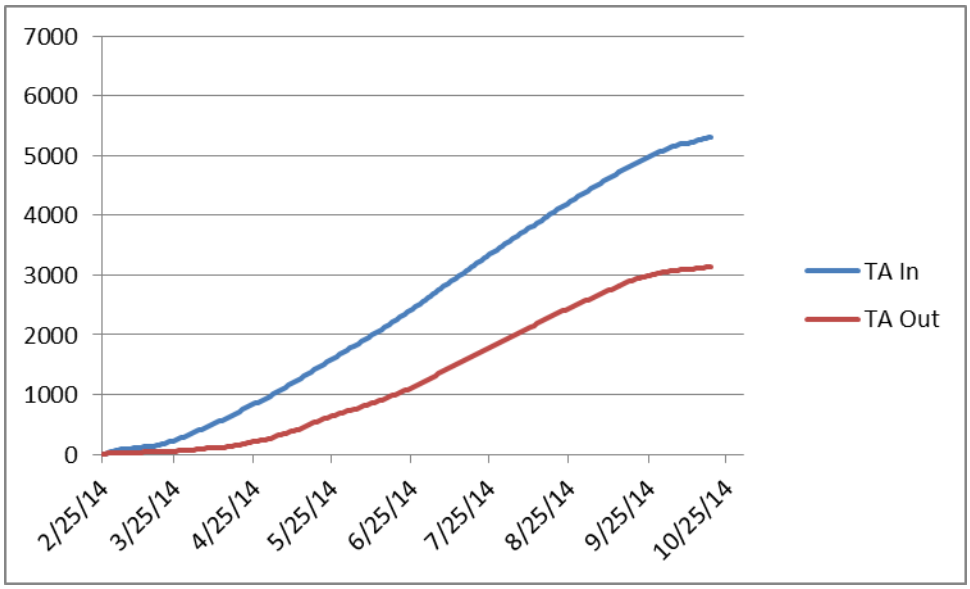
Min of RM IN
Min of RM OUT
HARD FROST
LIGHT FROST

High Tunnel: TA (Low/Single)

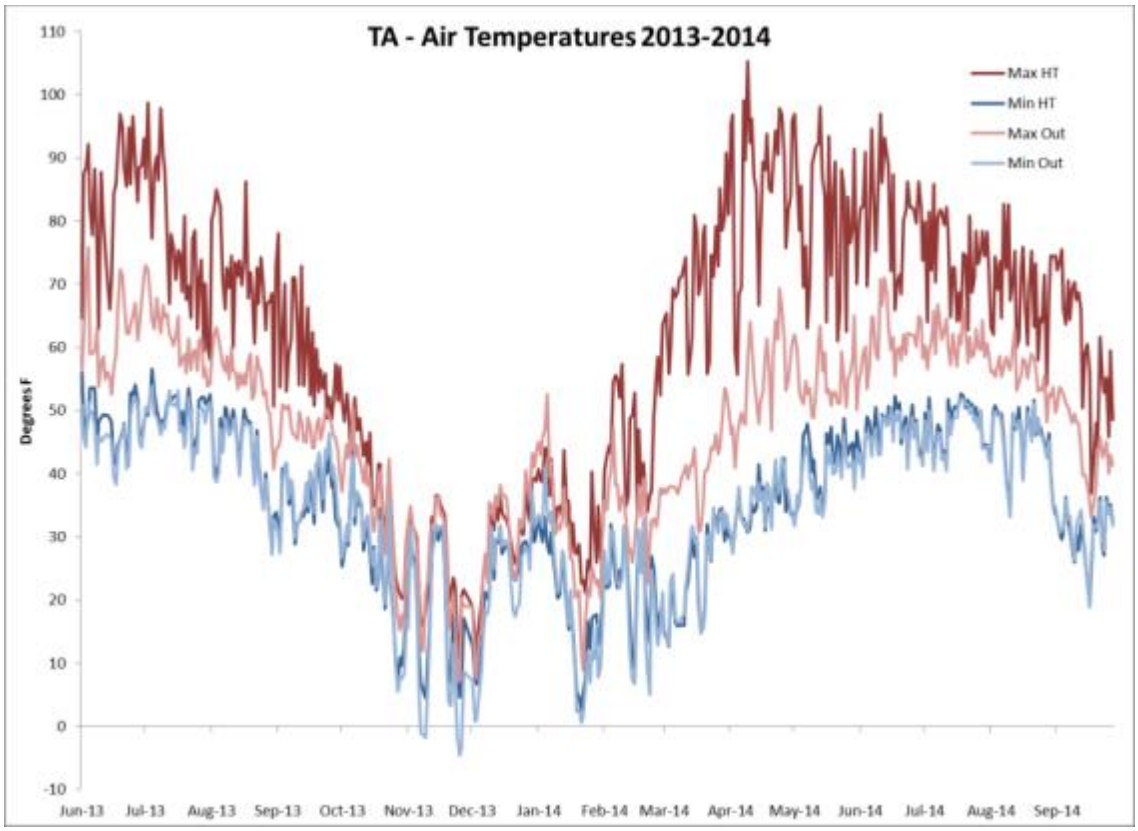
Location: South of Anchor Point near the Old Sterling Highway
Elevation: 428'
Size: 30' x 72'
Glazing: single
Ventilation Methods: roll up sides, end vents with passive solar arms, manually open end doors.
Inside Air Dates: 6/23/13-10/19/14 **Inside Soil Dates:** 6/23/13-3/11/14
Outside Air Dates: 6/23/13-10/19/14 **Outside Soil Dates:** 6/23/13-3/11/14
Notes:



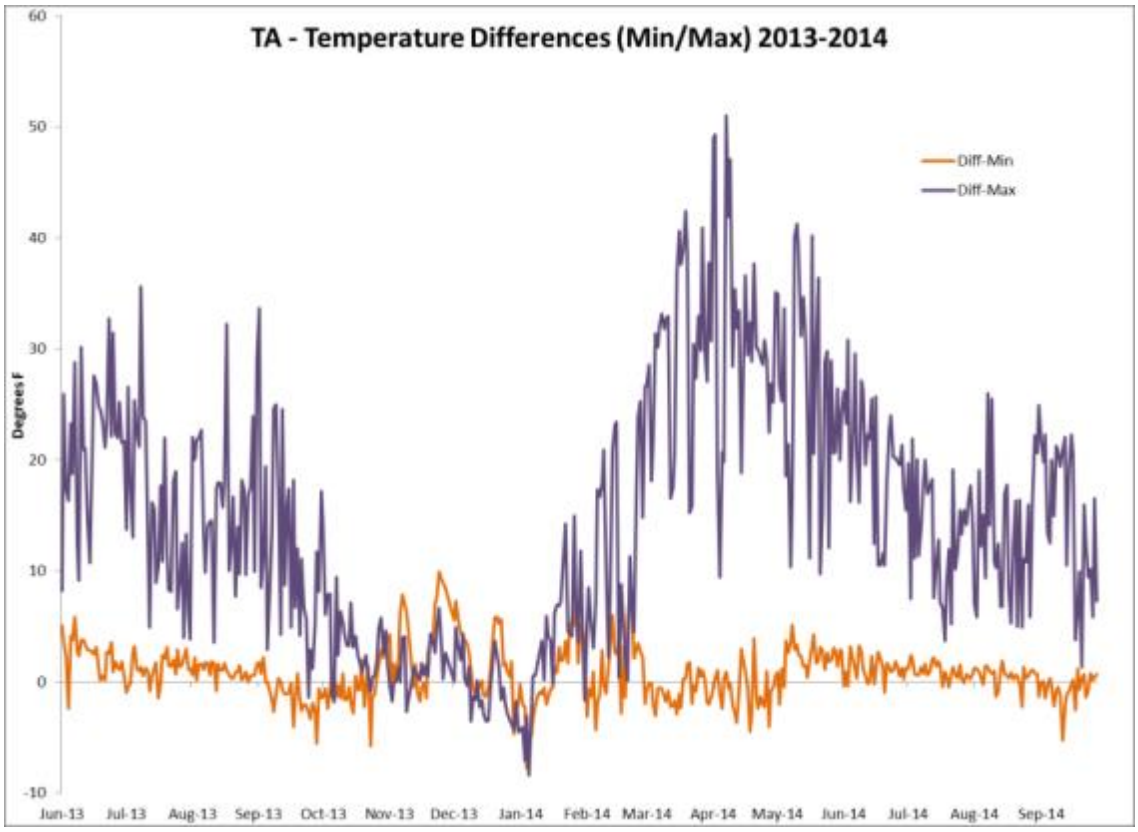
Growing Degree Days:



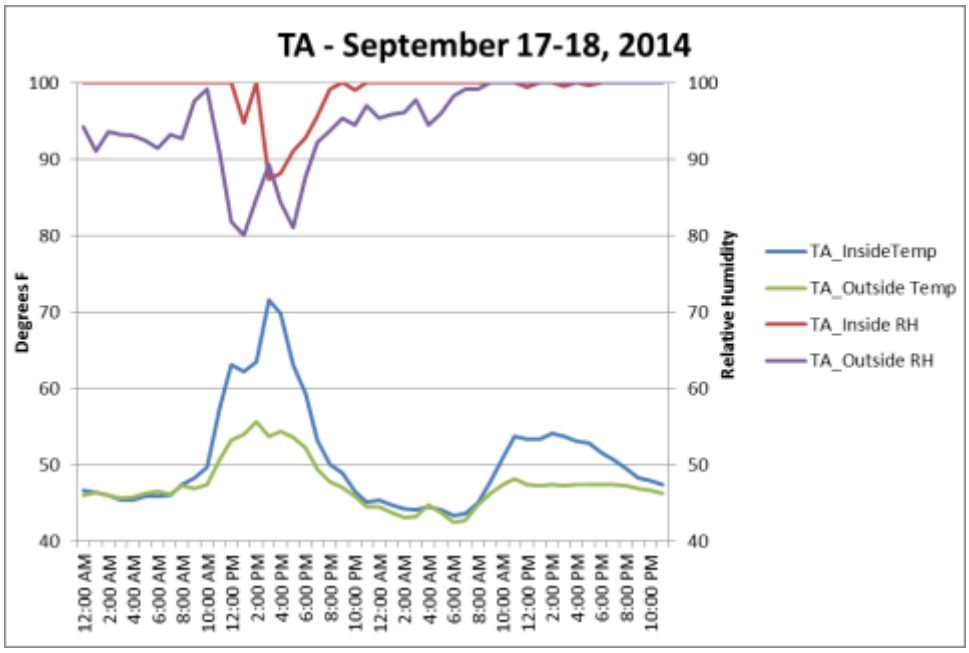
Daily Min & Max Temperatures:



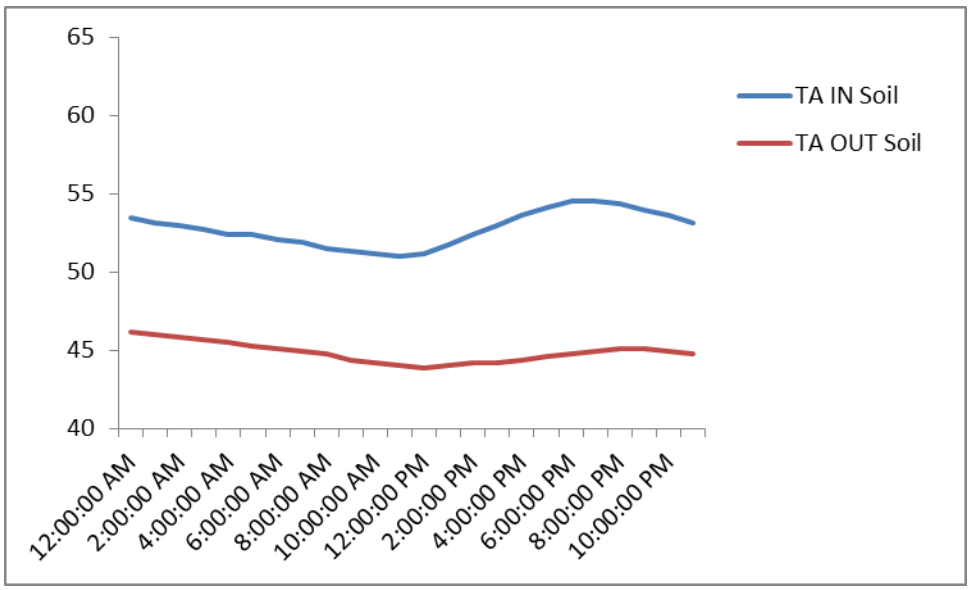
Temperature Differences:



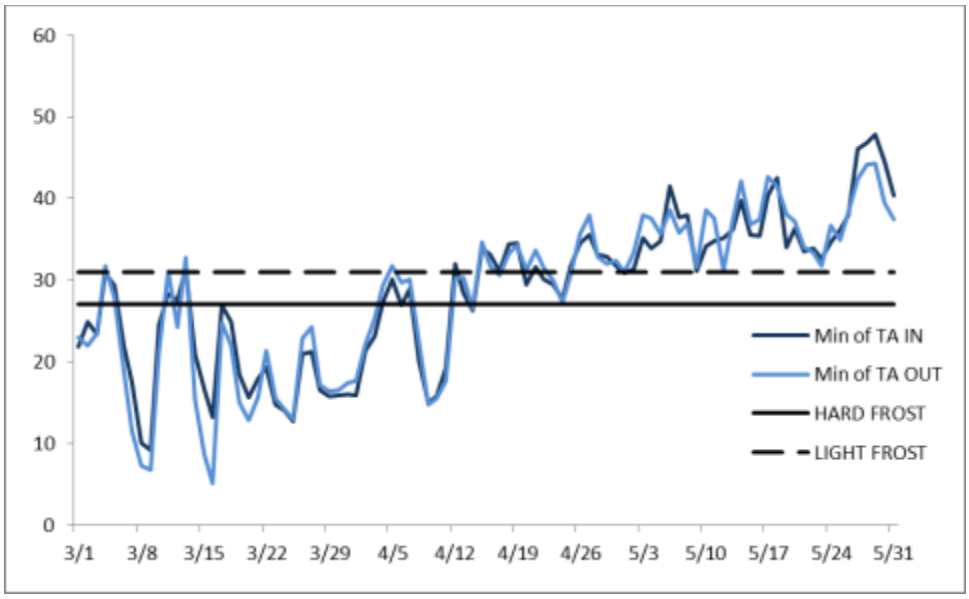
48-hour Close-Up:



Soil Temperatures, September 18, 2014:



Spring 2014: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Min of TA IN
Min of TA OUT
HARD FROST
LIGHT FROST

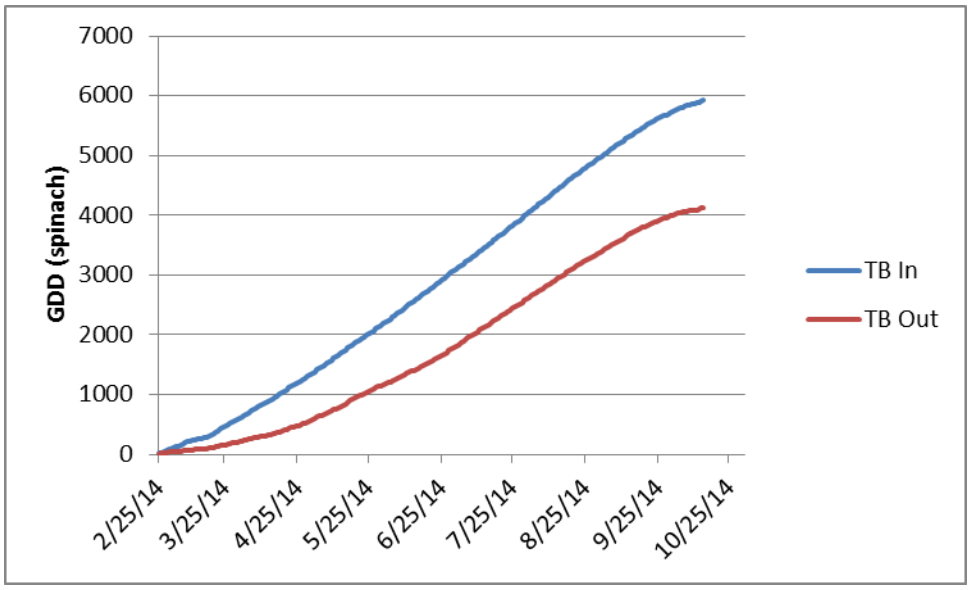
High Tunnel: TB (Low/Double)

Location: Meadow Drive, Homer
Elevation: 118'
Size: 30' x 72'
Glazing: double with polycarbonate end walls
Ventilation Methods: gable end vents and doors on either end wall.
Inside Air Dates: 6/28/13-11/8/13; **Inside Soil Dates:** not recovered
Outside Air Dates: 6/28/13-11/8/13; **Outside Soil Dates:** not recovered

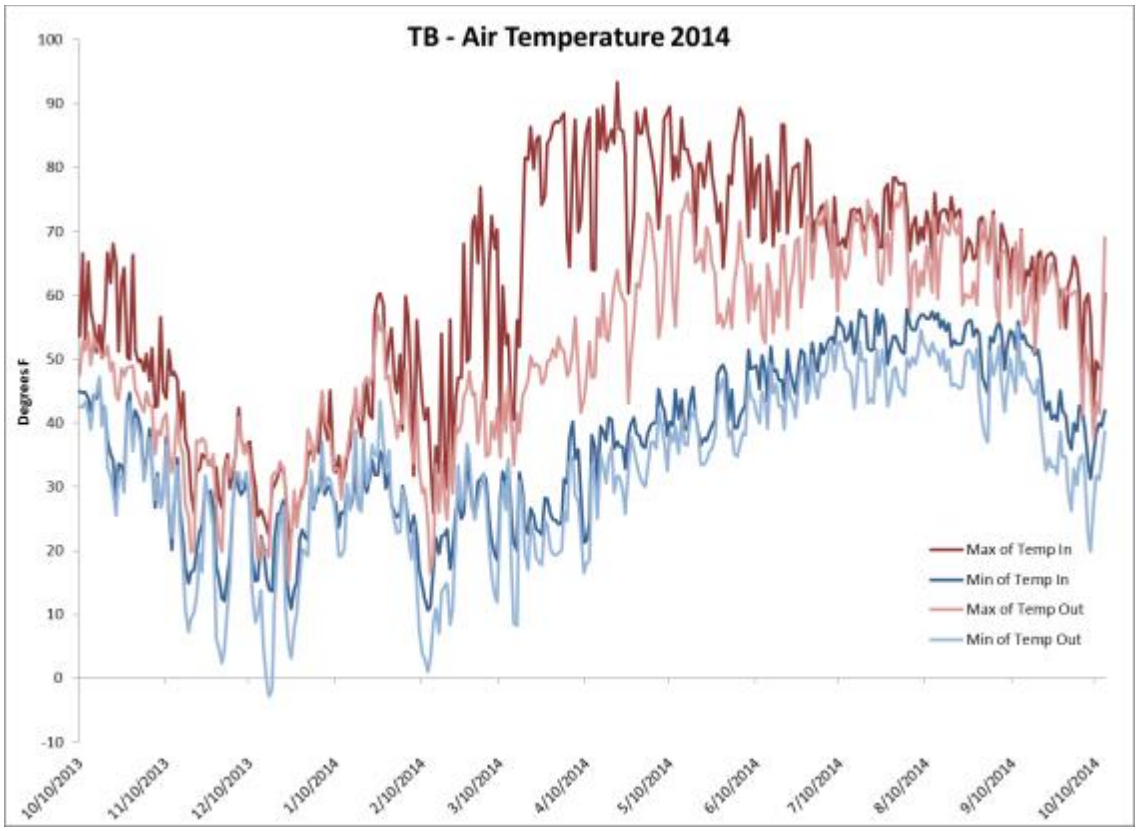
Notes: Data compromised by misplacement and internal logger corruption for soil temperatures at this site.



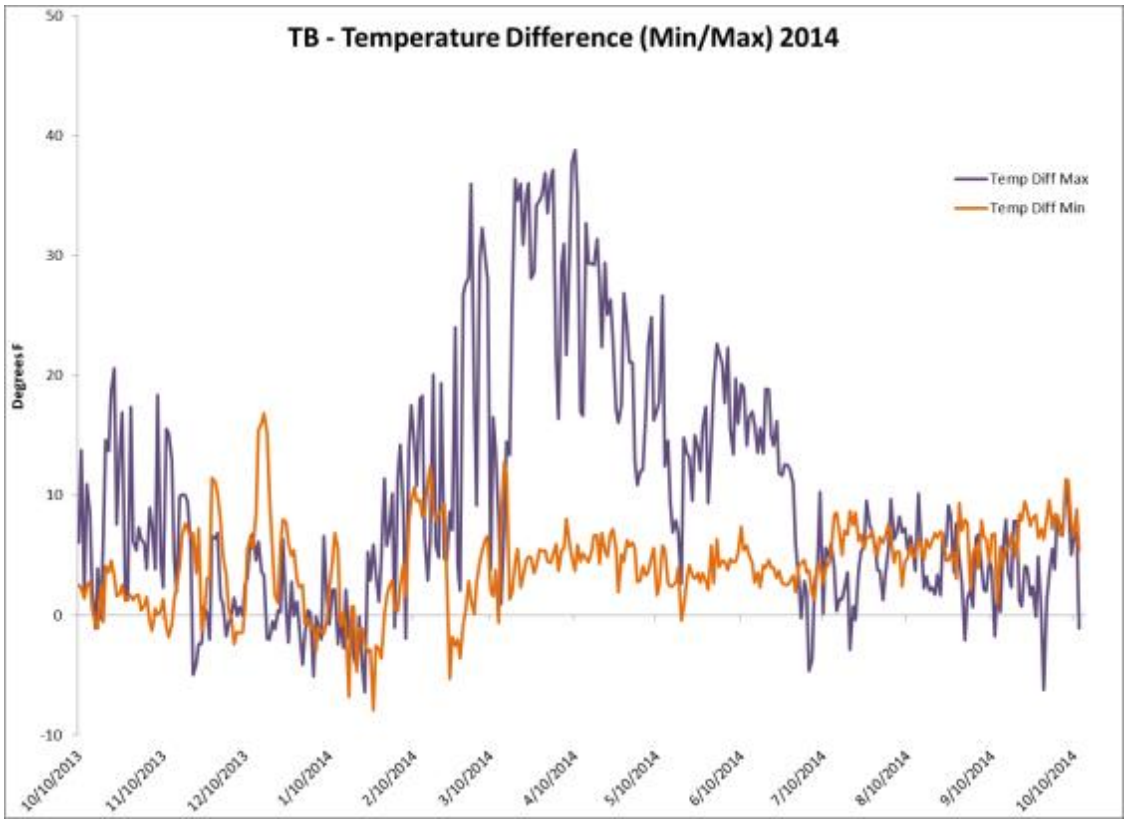
Growing Degree Days:



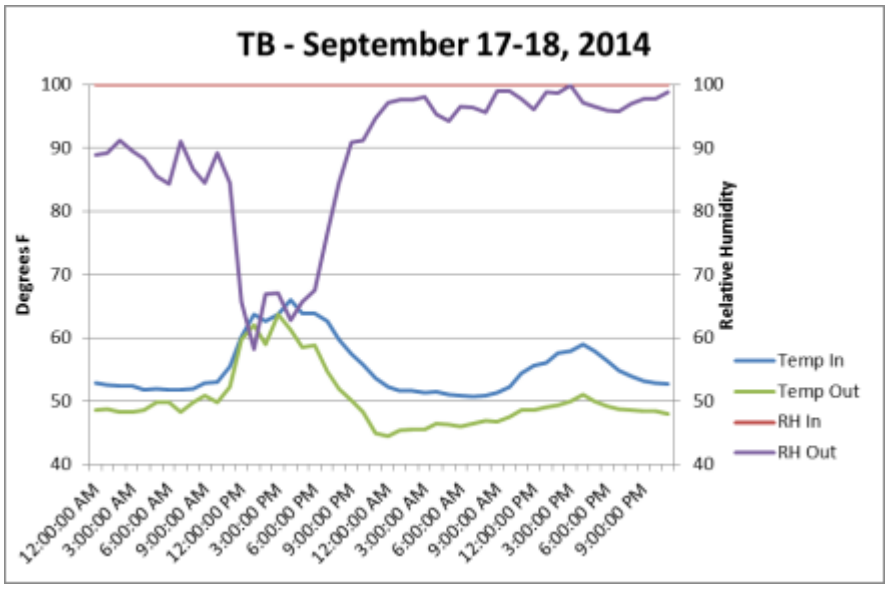
Daily Min & Max Temperatures:



Temperature Differences:



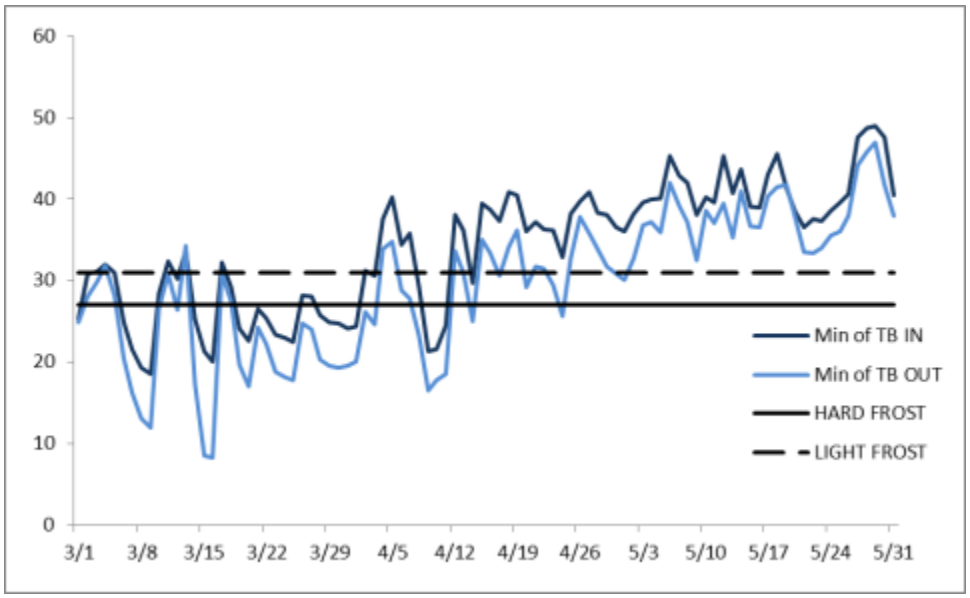
48-hour Close-Up:



Soil Temperatures, September 18, 2014:

No soil temperatures available at this site.

Spring 2014:

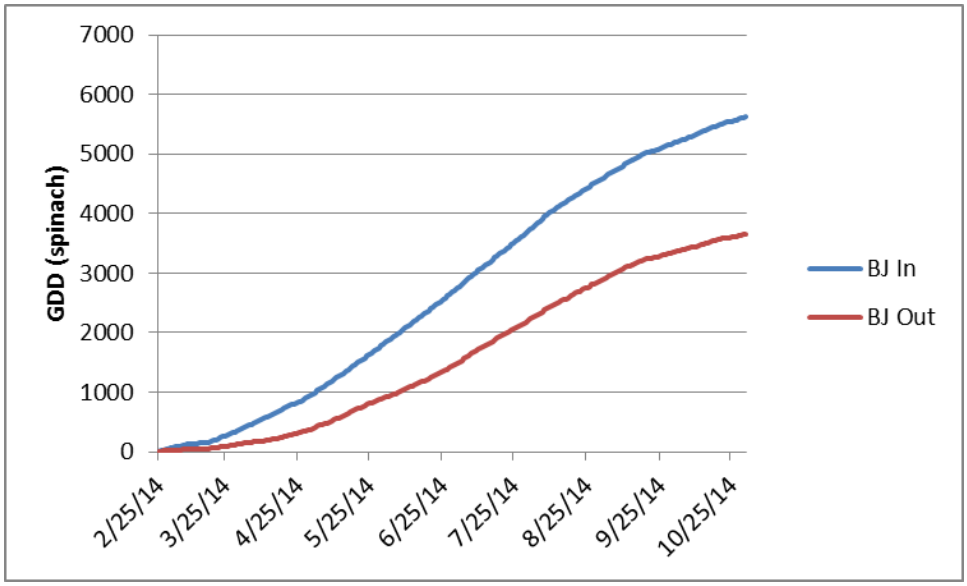


High Tunnel: BJ (Low/Double)

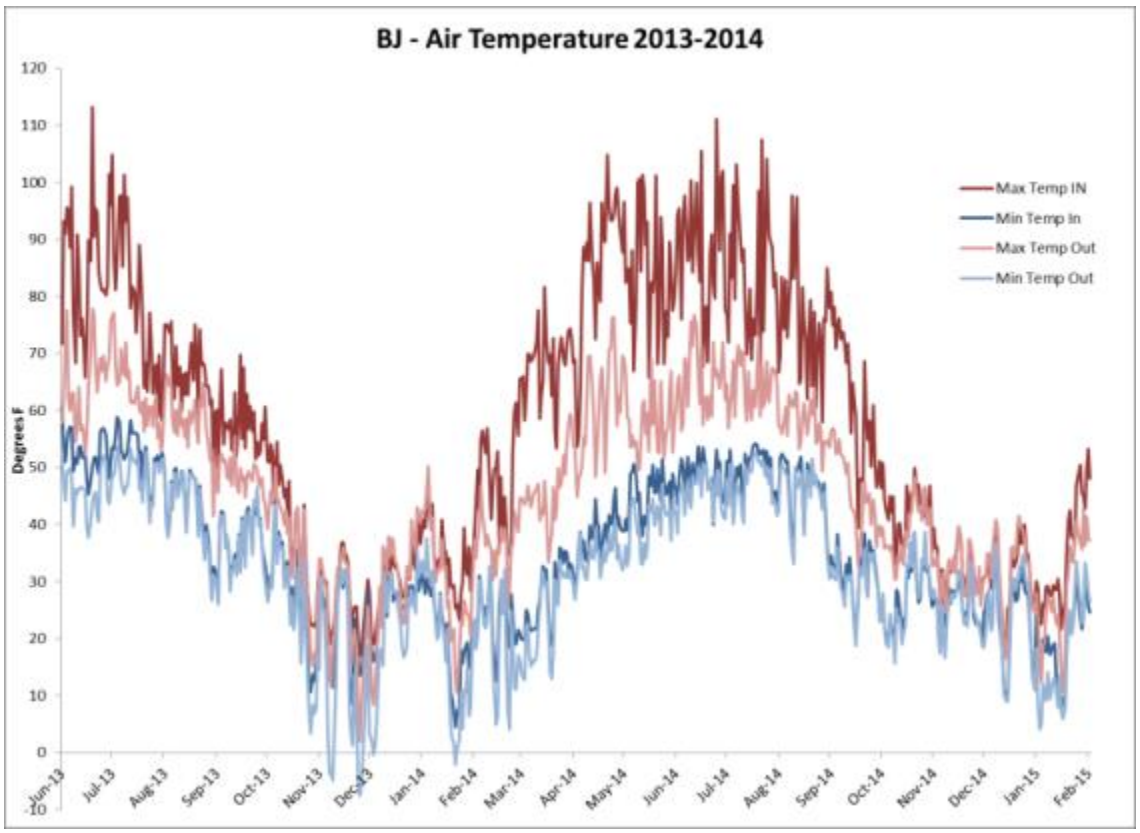
Location: South of Anchor Point, off of the Old Sterling Highway
Elevation: 384'
Size: 30' x 72'
Glazing: double
Ventilation Methods: passively vent by opening end wall doors.
Inside Air Dates: 6/23/13-2/25/15 **Inside Soil Dates:** 6/23/13-3/11/14
Outside Air Dates: 6/23/13-2/25/15 **Outside Soil Dates:** not recovered
Notes: Didn't recover the outside soil temperature logger.



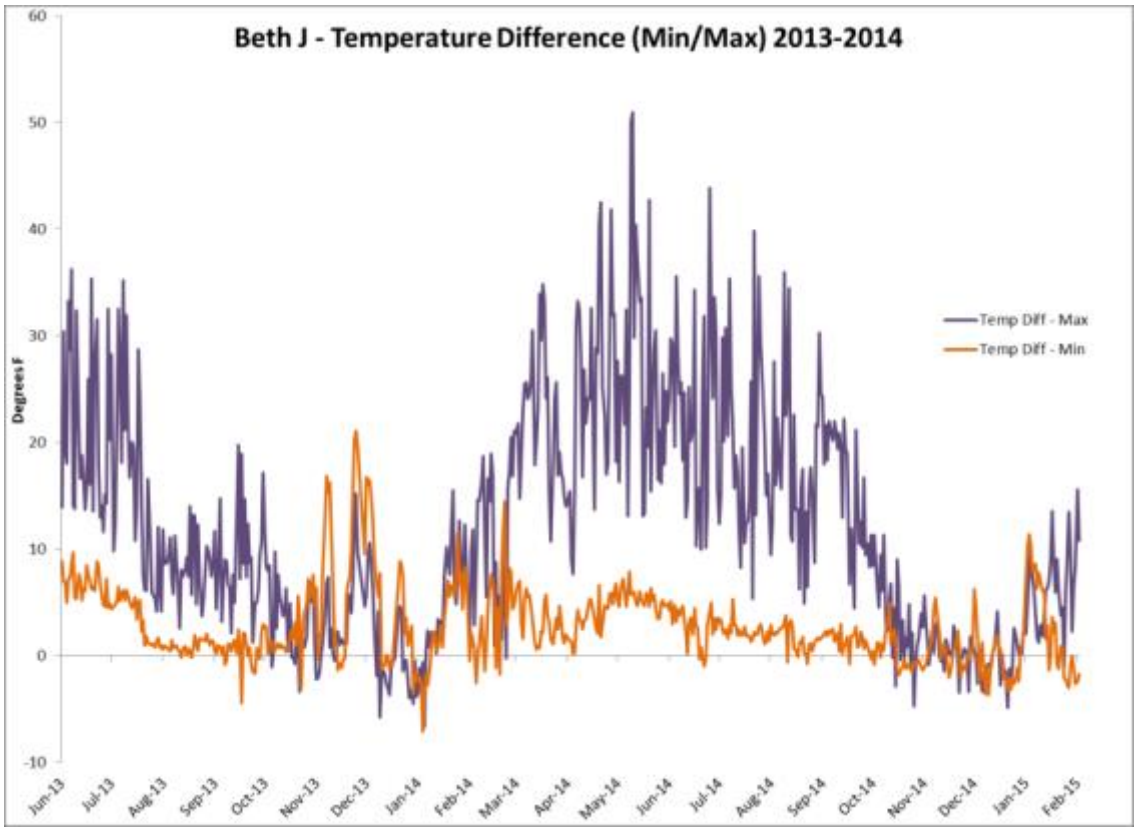
Growing Degree Days:



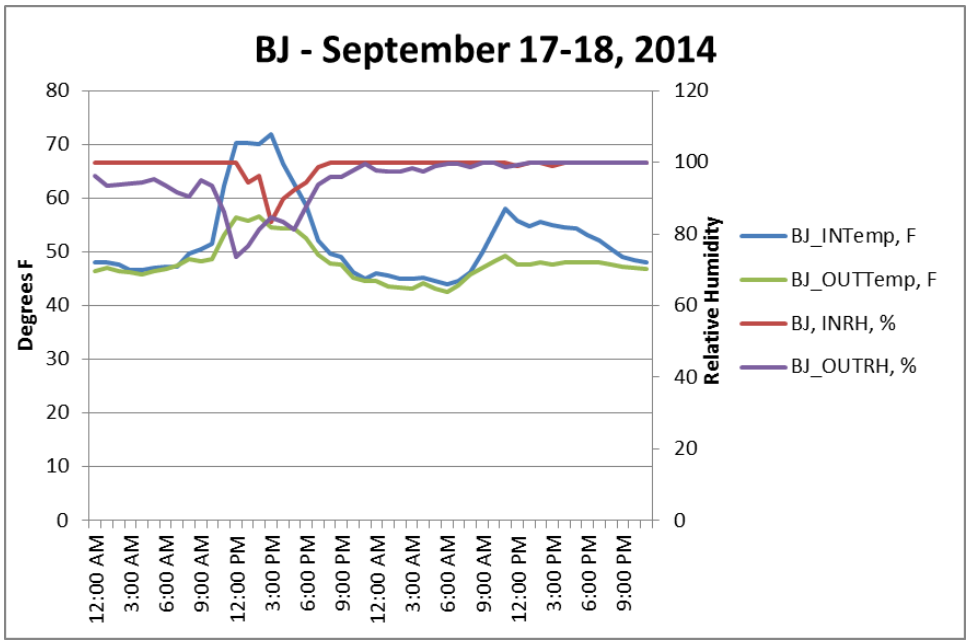
Daily Min & Max Temperatures:



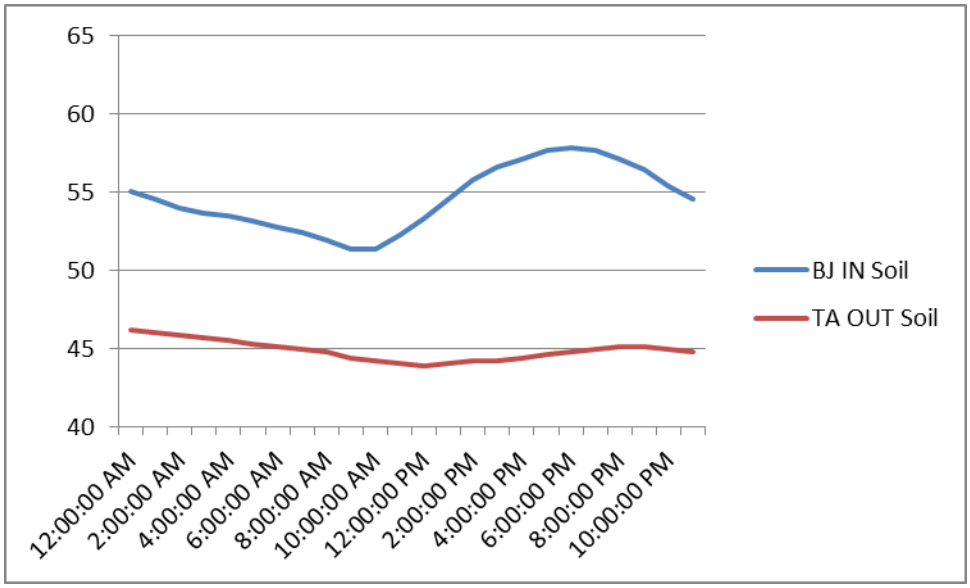
Temperature Differences:



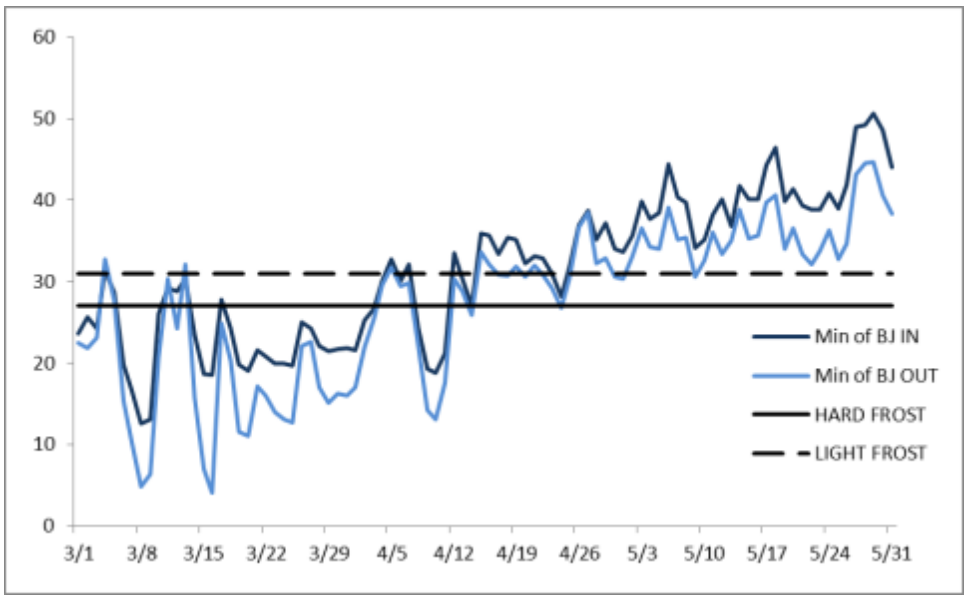
48-hour Close-Up:



Soil Temperatures, September 18, 2014:



Spring 2014: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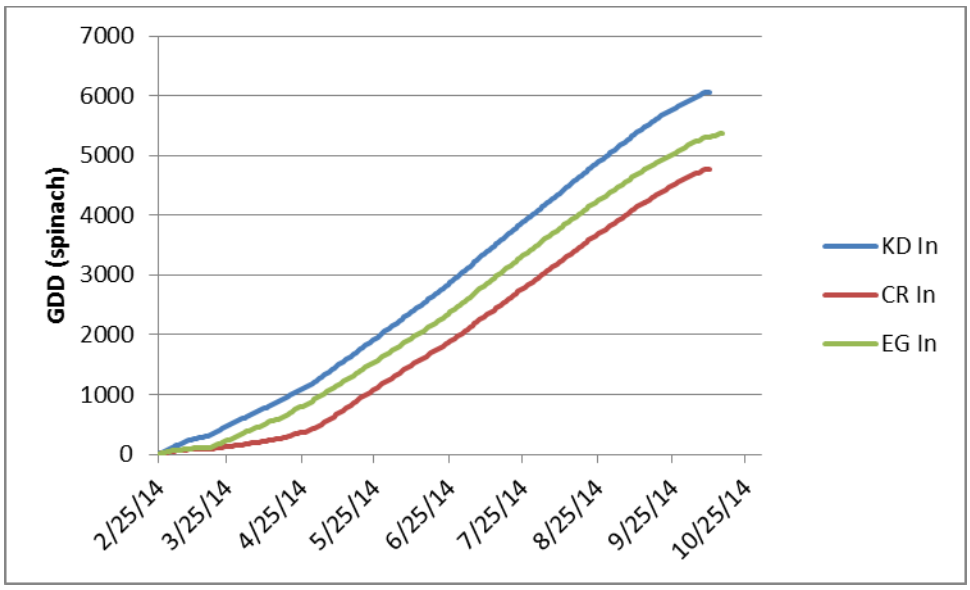
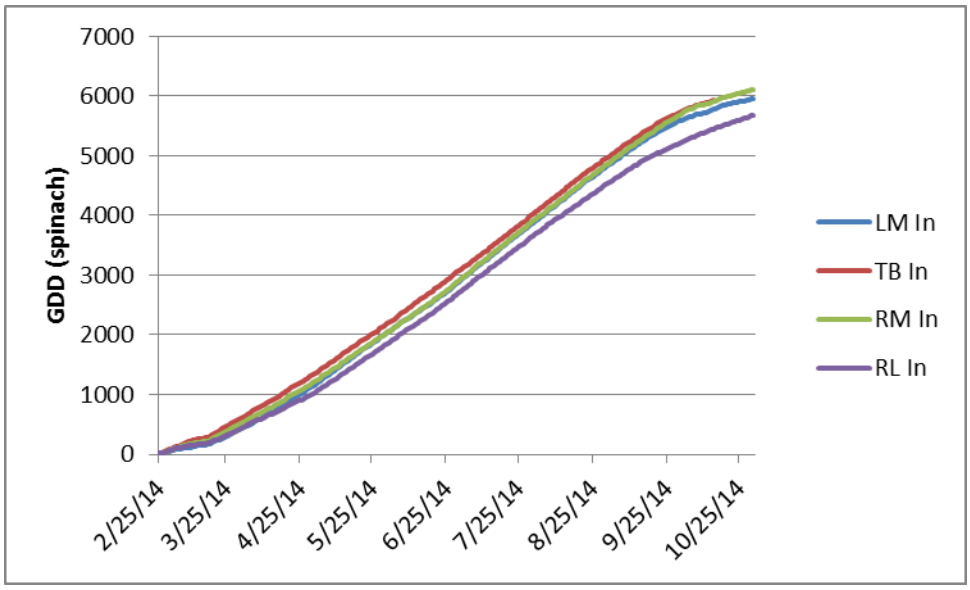
Min of BJ IN
Min of BJ OUT
HARD FROST
LIGHT FROST

GDD Comparisons

High Elevation GDD Comparisons (Single vs Double)



Low Elevation GDD Comparisons (Single vs Double)



Anchor Point, Low Elevation GDD Comparisons (Single vs Double)