Winter Lettuce Variety Trial

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Introduction

With proper variety selection, lettuce can be grown year-round in the Pacific Northwest. Mild winter temperatures and the use of season extenders such as hoop houses and cloches make growing lettuce for fall, winter and spring harvest a potential market niche for local farmers. Winter lettuce can be a good addition for direct market farmers who need additional crops during the off-season. In 2003 and 2004, we screened lettuce varieties for suitability for winter production in western Washington. Twenty-six varieties were grown in the field and in a hoop house, repeated in three successive plantings. For this study we selected a range of crisphead, leaf, butterhead, French and romaine lettuce types, and also included early, middle, and late maturing varieties. After harvest, lettuce was evaluated for yield and flavor.

Materials and Methods

The site used in this study is certified organic and was maintained accordingly. A succession of 3 plantings was conducted beginning in August of 2003, and completed in June 2004. Each planting was composed of two separate growing conditions: hoop house and field. The hoop house was unheated and unlit, and located on the same field as the 'field' plots. Lettuce was planted in beds in the hoop house and the field. Beds were 4 feet wide by 40 feet long. Varieties were planted in single row plots, 6 plants per plot. Cloches were utilized for the first planting in the field (November – January), and not used for the second and third plantings (March – June) as they were no longer necessary in the warmer months. Cloches were made by placing 8-gauge wire hoops over the beds in the field and covering them with Agribon AG-19, a thin spun-bonded polypropylene that lets in light and water, and provides up to 4^0 F of frost protection. This product has a weight of 0.55 oz/sq yd. Paper mulch was applied in the field and provided excellent weed control throughout the study. In the hoop house, paper mulch was not used as weeds were minimal, instead we hand weeded several times throughout the course of this study. Trickle tape was installed in the hoop house for irrigation, while beds in the field received natural precipitation. On October 28, Agribon AG-19 was installed inside the hoop house to cover plants during periods of freezing temperatures.

The first planting was seeded on August 13, 2003. 23 lettuce varieties were seeded into 72-cell seedling trays in the greenhouse. On October 15, the seedlings were transplanted into the hoop house and the field. Compost was applied before the first planting at a rate of 3-inches in the hoop house and in the field, and was tilled into the soil. The second planting included three additional varieties, for a total of 26. They were first seeded on December 22, but these seedlings were lost in the collapse of a snow-laden greenhouse. The second planting was re-seeded on

January 20, and then transplanted to the field and hoop house on March 16. The third planting included the same 26 varieties. It was seeded on February 27, and transplanted into the field and hoop house on April 12.

Lettuce was harvested when ready. Immediately after harvest, total plant weight (kg), trimmed weight (kg), bunched circumference (cm), and bunched length (cm) were measured for each plant. After total head weight was measured, damaged, unmarketable outside leaves were removed, and lettuce was reweighed to measure trimmed or marketable weight. A rubber band was placed around the lettuce head to replicate how lettuce is sold at a grocery store, and the circumference was measured. The length of the bunched head was also measured.

After harvest of the first and third plantings, a sampling of each variety was evaluated for flavor. Flavor quality was rated on a scale of 1 to 5, where 1=poor and 5=excellent.

Temperatures in the hoop house and field were measured using a HOBO H6 soil temperature probe. In the field, temperatures were measured both on the surface of the paper mulch and below the paper mulch at the soil level. Temperatures in the hoop house were measured near soil level.

Results and Discussion

In the first planting, lettuce was harvested from the field and hoop house once a week from November 18 until December 16. Lettuce in the second planting was harvested from the hoop house on May 6 (2004) and from the field on June 7. The third planting was harvested from the hoop house on May 27, and from the field on June 7. Lettuce grown in the hoop house was consistently ready for harvest earlier than lettuce planted at the same time in the field.

Yield. Average head weight ranged from 0.032 to 0.448 kg, with an overall mean of 0.177 kg (Table 1). Total head weight was highest on average for Bronze Arrowhead, Trout's Back, and Cardinale, and lowest for Yugoslavian Red, Tom Thumb, and Sanquine Ameliore. Trimmed head weight represents marketable weight, and in this study ranged from 0.025 to 0.375 kg, with an overall mean of 0.149 kg (Table 2). Trimmed head weight was highest on average for Bronze Arrowhead, Trout's Back, and Forellenschluss, and lowest for Yugoslavian Red, Tom Thumb, and Kweik. Low head weights are expected for Tom Thumb and Kweik, as these are small-headed lettuce varieties.

The varieties which produced the largest average marketable head weights differed slightly between the field and hoop house (Table 3). Trout's Back and Romaine Dark Green produced the largest marketable heads in the hoop house, and both showed above average marketable weights in the field. Forellenschluss and Bronze Arrowhead produced the largest average trimmed head weight in the field, but in the hoop house Forellenschluss showed below average trimmed head weight, while Bronze Arrowhead was above average. In the first planting, lettuce grown in the hoop house field was harvested at the same time, resulting in significantly greater total and trimmed weights in the hoop house than in the field. In the second and third plantings, lettuce was harvested as it was ready in the hoop house and the field, resulting in a one month delay in

the field harvest in the second planting and a 20 day delay in the third planting. This delayed harvest in the field resulted in slightly higher average weights in the field than the hoop house.

Throughout the three plantings and two locations, most varieties consistenly produced either above, below, or near average marketable head weights (Table 3). Varieties that consistently produced above average marketable head weights were Bronze Arrowhead, Trout's Back, New Red Fire, Austrian Greenleaf, Romaine Dark Green, Oaky Red Splash, Cardinale, Blushed Butter Oak, and Winter Density. Varieties that produced near average marketable head weights were Brown Golding, Reine Des' Glaces, De Morges Braun, and Brunia. The varieties that consistently produced below average head weights were Outredgeous, Bijou, Roger, Sanguine Ameliore, Kweik, Tom Thumb, and Yugoslavian Red.

Lettuce varieties exhibited significant differences in bunched length and circumference (Tables 4 and 5). The results generally show consistency within varieties in successive plantings, but there were differences within varieties between plants grown in the hoop house and those grown in the field. Varieties with the greatest head length overall were Craciovensis, Oaky Red Splash, Bronze Arrowhead, and Brunia in the hoop house, and Bronze Arrowhead, Oaky Red Splash, and Brown Golding in the field. Varieties that produced the greatest head circumference in the hoop house were Victoria, Cardinale, and New Red Fire. In the field Simpson Elite, New Red Fire, and Austrian Greenleaf had the largest average head circumference.

Flavor. Samples of each lettuce variety from the first and third harvests were rated based on flavor on a scale of 1 to 5, where 1 was very bitter and 5 was excellent. Overall flavor was found to be 'good' (2.92), ranging from bitter (1.0) to very good (4.0) (Table 6). Lettuce from the first planting had better flavor overall than lettuce from the third planting. Lettuce from the first planting received an overall rating of 3.42, indicating good to very good flavor. Lettuce from the third planting had an overall rating of 2.43, indicating slightly bitter to good flavor. Varieties exhibiting the best and worst flavor in the first planting generally corresponded with those in the third planting. Flavor ratings of individual varieties were consistent between the hoop house and the field, that is, varieties that were the most flavorful in the hoop house were generally the most flavorful in the field as well. Varieties that received the highest average flavor ratings were Oakleaf Redder Ruffled, Winter Density, Yugoslavian Red, Sanquine Ameliore, Winter Density, Brown Golding, and Romaine Dark Green. Varieties with the lowest flavor ratings were Brunia, Cardinale, Trout's Back, and Simpson Elite. It is important to note that lettuce was evaluated for taste by Kath Sherman, Washington State University Vancouver Food Service Director. She found all of the varieties acceptable and served them all in her salad bar.

Temperature. Outside field temperatures during the course of this study ranged from –5° C (23° F)**,** to 41° C (105.8° F) (Figures 1 & 2). The Hoop House was consistently warmer than the field, with a minimum of -3° C (26.6° F), and maximum of 47° C (116.6° F). In the field, the paper mulch exhibited an insulating effect, causing less temperature fluctuation below the mulch than above. High temperatures under the paper mulch were consistently lower than those in both the hoop house and field, and low temperatures under the mulch were generally higher than the field and hoop house. The minimum temperature under the mulch was -1° C (30.2° F) and the maximum was only 34° C (93.2° F). The period of the first planting was significantly colder

than that of the second and third plantings, and only during the first planting were there below freezing temperatures.

During the first planting, the mean outside temperature (under the field cloches) was 7.0^0 C (44.6° F). The minimum temperature was -3^0 C (27^0 F) and the maximum was 20^0 C (68^0 F). Temperatures in the hoop house were warmer, with a mean of 9.7° C (49.5 °F), a minimum of 1° C (34° F), and a maximum of 31° C (88° F). Temperatures under the mulch were less extreme than above the mulch or in the hoop house, with a minimum of -2° C (28° F) and a maximum of 25° C (77° F).

During the second and third plantings, the field temperature above the paper mulch reached a minimum of 3° C (37° F) and maximum of 41°C (106° F). Under the mulch, the minimum was 4° C (39° F) and the maximum was 34° C (93° F). The hoop house minimum temperature was 7° C (45° F) and the maximum temperature was 47° C (117° F).

Conclusions

Winter lettuce is well-suited for production in western Washington and can be successfully grown in field, cloche, or hoop house systems. An unheated and unlit hoop house can be used to produce higher yielding lettuce, and a shorter growing season. There appears to be no significant difference in flavor between lettuce grown in a hoop house versus a cloche or open field environment. Varieties that produced the best results overall in both yield and flavor were Romaine Dark Green, Winter Density, Bronze Arrowhead, and Brown Golding. Blushed Butter Oak and Forellenschluss also showed strong results in both size and flavor. Roger and Kweik proved to be the least successful varieties overall. Bijou, Outredgeous, and Brunia also showed below average results in size and flavor.

In this study, the number of plants per plot did not differ between varieties. If planted at a higher density, lettuce varieties that produced smaller head sizes would be higher yielding than they were in this study. This would be especially true for Tom Thumb and Kweik, which are known to be small-headed varieties that are well suited to be sold as ‘baby’ lettuce.

Table 1. Mean total head weight (kg) for lettuce varieties grown in three successive plantings in the hoop house and field at WSU Vancouver from August 2003 through June 2004.

	Hoop House				Field				
Variety	Harvest 1	Harvest 2	Harvest 3	Avg	Harvest 1	Harvest 2	Harvest 3	Avg	Overall Avg.
Austrian Greenleaf	0.204	0.240	0.180	0.208	0.08	0.393	0.170	0.214	0.211
Bijou	0.064	0.127	0.052	0.081	0.056	0.260	0.197	0.171	0.126
Blushed Butter Oak	0.188	0.130	0.247	0.188	0.064		0.380	0.222	0.205
Bronze Arrowhead	0.184	0.204	0.185	0.191	0.096	0.448	0.393	0.312	0.252
Brown Golding	0.124	0.210	0.220	0.185	0.045	0.260	0.276	0.194	0.189
Brunia	0.176	0.280	0.120	0.192	0.116	0.327	0.070	0.171	0.181
Cardinale	0.212	0.273	0.128	0.204	0.084	0.527	0.167	0.259	0.232
Cracoviensis	0.232	0.260	0.120	0.204	0.108			0.108	0.156
De Morges Braun	0.188	0.247	0.120	0.185	0.04	0.393	0.217	0.217	0.201
Forellenschluss		0.177	0.132	0.154		0.360	0.246	0.303	0.229
Kweik	0.212	0.193	0.120	0.175	0.056			0.056	0.116
Little Leprechaun		0.092	0.104	0.098		0.220	0.155	0.188	0.143
New Red Fire	0.156	0.268	0.253	0.226	0.096	0.320	0.212	0.209	0.218
Oakleaf Redder Ruffled	0.2	0.170	0.183	0.184	0.084	0.115	0.140	0.113	0.149
Oaky Red Splash	0.24	0.160	0.224	0.208	0.052	0.320	0.296	0.223	0.215
Outredgeous	0.116	0.128	0.156	0.133	0.036	0.185	0.150	0.124	0.129
Reine Des' Glaces	0.272	0.163	0.130	0.188	0.064	0.140	0.200	0.135	0.162
Roger		0.170	0.073	0.122		0.160	0.100	0.130	0.126
Romaine Dark Green	0.252	0.158	0.276	0.229	0.064	0.213	0.315	0.197	0.213
Sanquine Ameliore	0.088	0.220	0.248	0.185	0.032			0.032	0.109
Simpson Elite	0.18	0.136	0.120	0.145	0.052	0.368	0.395	0.272	0.209
Tom Thumb	0.116	0.197	0.133	0.149	0.055			0.055	0.102
Trout's Back	0.284	0.268	0.250	0.267	0.064	0.260	0.276	0.200	0.234
Victoria	0.24	0.240	0.237	0.239	0.092	0.090		0.091	0.165
Winter Density	0.216	0.217	0.100	0.178	0.068	0.320	0.284	0.224	0.201
Yugoslavian Red	0.128	0.000	0.153	0.094	0.036			0.036	0.065
Overall Mean	0.186	0.190	0.164	0.177	0.067	0.290	0.232	0.177	0.177
P Value	0.0000	0.0000	0.0000		0.0000	0.0017	0.0671		

Table 2. Mean trimmed head weight (kg) for lettuce varieties grown in three successive plantings in the hoop house and field at WSU Vancouver from August 2003 through June 2004.

	Hoop House				Field			
Variety	Harvest 1	Harvest 2	Harvest 3	Avg	Harvest 1	Harvest 2	Harvest 3	Avg
Austrian Greenleaf	0.192	0.220	0.180	0.197	0.076	0.333	0.150	0.186
Bijou	0.060	0.097	0.040	0.066	0.048	0.213	0.177	0.146
Blushed Butter Oak	0.160	0.117	0.227	0.168	0.048		0.340	0.194
Bronze Arrowhead	0.178	0.172	0.160	0.170	0.060	0.360	0.333	0.251
Brown Golding	0.112	0.190	0.213	0.172	0.020	0.140	0.196	0.119
Brunia	0.164	0.220	0.100	0.161	0.078	0.240	0.060	0.126
Cardinale	0.188	0.263	0.124	0.192	0.068	0.333	0.127	0.176
Cracoviensis	0.200	0.253	0.100	0.184	0.072		0.000	0.036
De Morges Braun	0.148	0.200	0.087	0.145	0.020	0.180	0.187	0.129
Forellenschluss		0.150	0.112	0.131		0.315	0.232	0.274
Kweik	0.176	0.133	0.120	0.143	0.025			0.025
Little Leprechaun		0.084	0.100	0.092		0.159	0.140	0.149
New Red Fire	0.144	0.220	0.213	0.192	0.080	0.360	0.184	0.208
Oakleaf Redder Ruffled	0.168	0.150	0.173	0.164	0.076	0.100	0.060	0.079
Oaky Red Splash	0.216	0.152	0.212	0.193	0.048	0.230	0.252	0.177
Outredgeous	0.108	0.120	0.148	0.125	0.032	0.130	0.100	0.087
Reine Des' Glaces	0.240	0.143	0.117	0.167	0.052	0.130	0.185	0.122
Roger		0.157	0.073	0.115		0.120	0.070	0.095
Romaine Dark Green	0.236	0.170	0.228	0.211	0.040	0.187	0.280	0.169
Sanquine Ameliore	0.076	0.198	0.184	0.153	0.024			0.024
Simpson Elite	0.156	0.100	0.116	0.124	0.040	0.324	0.375	0.246
Tom Thumb	0.084	0.150	0.120	0.118	0.033			0.033
Trout's Back	0.254	0.245	0.223	0.241	0.056	0.227	0.252	0.178
Victoria	0.184	0.190	0.220	0.198	0.068	0.080		0.074
Winter Density	0.204	0.200	0.095	0.166	0.052	0.260	0.248	0.187
Yugoslavian Red	0.100		0.133	0.117	0.028			0.028
Overall Mean	0.163	0.172	0.147	0.158	0.050	0.226	0.187	0.139
P Value	0.0000	0.0000	0.0000		0.000	0.0226	0.0133	

Table 3. Mean trimmed head weight (kg) for lettuce varieties grown at WSU Vancouver from August 2003 through June 2004; in order of largest to smallest average yield; in hoop house, in the field, and overall.

Rank	Hoop House Variety	Hoop House Avg	Field Variety	Field Avg	Overall Variety	Overall Average
1	Trout's Back	0.241	Forellenschluss	0.274	Bronze Arrowhead	0.211
2	Romaine Dark Green	0.211	Bronze Arrowhead	0.251	Trout's Back	0.210
3	Victoria	0.198	Simpson Elite	0.246	Forellenschluss	0.202
4	Austrian Greenleaf	0.197	New Red Fire	0.208	New Red Fire	0.200
5	Oaky Red Splash	0.193	Blushed Butter Oak	0.194	Austrian Greenleaf	0.192
6	New Red Fire	0.192	Winter Density	0.187	Romaine Dark Green	0.190
7	Cardinale	0.192	Austrian Greenleaf	0.186	Simpson Elite	0.185
8	Cracoviensis	0.184	Trout's Back	0.178	Oaky Red Splash	0.185
9	Brown Golding	0.172	Oaky Red Splash	0.177	Cardinale	0.184
10	Bronze Arrowhead	0.170	Cardinale	0.176	Blushed Butter Oak	0.181
11	Blushed Butter Oak	0.168	Romaine Dark Green	0.169	Winter Density	0.177
12	Reine Des' Glaces	0.167	Little Leprechaun	0.149	Brown Golding	0.145
13	Winter Density	0.166	Bijou	0.146	Reine Des' Glaces	0.145
14	Oakleaf Redder Ruffled	0.164	De Morges Braun	0.129	Brunia	0.144
15	Brunia	0.161	Brunia	0.126	De Morges Braun	0.137
16	Sanquine Ameliore	0.153	Reine Des' Glaces	0.122	Victoria	0.136
17	De Morges Braun	0.145	Brown Golding	0.119	Oakleaf Redder Ruffled	0.121
18	Kweik	0.143	Roger	0.095	Little Leprechaun	0.121
19	Forellenschluss	0.131	Outredgeous	0.087	Cracoviensis	0.110
20	Outredgeous	0.125	Oakleaf Redder Ruffled	0.079	Outredgeous	0.106
21	Simpson Elite	0.124	Victoria	0.074	Bijou	0.106
22	Tom Thumb	0.118	Cracoviensis	0.036	Roger	0.105
23	Yugoslavian Red	0.117	Tom Thumb	0.033	Sanquine Ameliore	0.088
24	Roger	0.115	Yugoslavian Red	0.028	Kweik	0.084
25	Little Leprechaun	0.092	Kweik	0.025	Tom Thumb	0.076
26	Bijou	0.066	Sanquine Ameliore	0.024	Yugoslavian Red	0.072
	Mean	0.158	**Mean**	0.139	**Mean**	0.149

Table 4. Mean head circumference (cm) for lettuce varieties grown in three successive plantings in the hoop house and field at WSU Vancouver from August 2003 through June 2004.

	Hoop House				Field			
Variety	**Harvest 1**	**Harvest 2**	**Harvest 3**	**Avg**	**Harvest 1**	**Harvest 2**	**Harvest 3**	**Avg**
Austrian Greenleaf	37.9	41.2	35.5	38.2	30.4	44.3	29.7	34.8
Bijou	24.8	31.8	27.2	27.9	17.2	35.7	37.5	30.1
Blushed Butter Oak	36.0	30.0	46.7	37.6	18.4		45.0	31.7
Bronze Arrowhead	34.8	32.2	34.8	33.9	22.6	38.2	39.0	33.3
Brown Golding	26.2	33.3	37.0	32.2	11.8	21.6	27.4	20.3
Brunia	36.3	37.0	33.8	35.7	19.5	34.3	25.5	26.4
Cardinale	39.4	43.2	39.8	40.8	23.5	43.3	29.7	32.2
Cracoviensis	33.3	39.3	32.0	34.9	21.9			21.9
De Morges Braun	33.1	41.2	28.7	34.3	8.8	30.3	36.6	25.2
Forellenschluss		29.7	27.8	28.7		34.3	33.2	33.7
Kweik	42.0	35.0	39.8	38.9	11.9			11.9
Little Leprechaun		23.6	30.6	27.1		29.5	27.5	28.5
New Red Fire	38.4	45.6	36.5	40.2	31.5	43.8	39.4	38.2
Oakleaf Redder Ruffled	35.6	30.8	35.3	33.9	18.1	24.5	20.0	20.9
Oaky Red Splash	34.1	30.8	36.4	33.8	20.7	32.5	32.0	28.4
Outredgeous	27.8	29.2	30.8	29.3	15.8	20.0	28.0	21.3
Reine Des' Glaces	33.1	33.5	33.3	33.3	23.1	34.5	47.8	35.1
Roger		37.8	32.0	34.9		32.0	25.0	28.5
Romaine Dark Green	36.4	34.5	37.0	36.0	23.3	34.0	41.8	33.0
Sanquine Ameliore	24.2	35.5	32.2	30.6	13.9			13.9
Simpson Elite	36.0	31.0	25.6	30.9	22.4	38.0	58.8	39.7
Tom Thumb	30.8	35.5	33.7	33.3	16.3			16.3
Trout's Back	37.0	39.0	34.5	36.8	26.4	33.7	37.2	32.4
Victoria	48.0	38.0	45.2	43.7	31.0	20.5		25.8
Winter Density	34.1	36.0	30.8	33.6	16.2	39.0	35.6	30.3
Yugoslavian Red	33.3		42.7	38.0	17.9			17.9
Overall Mean	34.5	35.0	34.6	34.7	20.1	33.2	34.4	29.2
P Value	0.0008	0.0002	0.0000		0.0111	0.0003	0.0000	

Table 5. Mean head length (cm) for lettuce varieties grown in three successive plantings in the hoop house and field at WSU Vancouver from August 2003 through June 2004.

	Hoop House				Field			
Variety	**Harvest 1**	**Harvest 2**	**Harvest 3**	**Avg**	**Harvest 1**	**Harvest 2**	**Harvest 3**	**Avg**
Austrian Greenleaf	26.1	21.3	21.8	23.1	15.2	29.7	18.7	21.2
Bijou	20.2	20.3	15.6	18.7	14.2	29.3	26.2	23.2
Blushed Butter Oak	23.8	18.2	20.8	20.9	15.7		23.0	19.4
Bronze Arrowhead	33.4	28.8	27.0	29.7	21.6	38.0	32.0	30.5
Brown Golding	24.2	25.7	25.2	25.0	16.5	29.8	27.8	24.7
Brunia	27.6	31.3	24.7	27.8	16.9	30.3	20.0	22.4
Cardinale	23.6	26.2	20.6	23.5	18.2	23.7	20.3	20.7
Cracoviensis	37.3	33.7	31.0	34.0	17.4			17.4
De Morges Braun	24.2	25.3	25.0	24.8	7.6	28.0	23.6	19.7
Forellenschluss		23.2	26.2	24.7		28.0	28.0	28.0
Kweik	15.2	16.7	17.6	16.5	6.0			6.0
Little Leprechaun		22.0	25.6	23.8		31.8	25.8	28.8
New Red Fire	21.4	23.0	29.5	24.6	16.2	28.5	22.6	22.4
Oakleaf Redder Ruffled	28.4	24.5	26.2	26.4	18.2	25.3	21.5	21.7
Oaky Red Splash	34.4	27.3	35.0	32.2	19.6	30.5	31.5	27.2
Outredgeous	25.6	28.4	27.0	27.0	15.6	30.3	25.5	23.8
Reine Des' Glaces	20.0	21.5	18.8	20.1	20.4	18.0	20.3	19.6
Roger		18.2	15.5	16.8		22.0	17.0	19.5
Romaine Dark Green	30.3	20.0	26.8	25.7	12.8	23.3	26.0	20.7
Sanquine Ameliore	25.0	29.5	27.2	27.2	14.6			14.6
Simpson Elite	24.6	20.6	26.0	23.7	15.2	25.8	26.5	22.5
Tom Thumb	11.1	12.8	14.8	12.9	4.7			4.7
Trout's Back	28.2	24.5	28.3	27.0	14.0	26.0	23.8	21.3
Victoria	16.0	20.0	19.7	18.6	14.8	14.0		14.4
Winter Density	22.3	19.5	15.8	19.2	13.0	23.0	24.0	20.0
Yugoslavian Red	14.5		19.8	17.2	9.4			9.4
Overall Mean	24.2	23.3	23.5	23.5	14.7	27.1	24.3	20.5
P Value	0.0000	0.0000	0.0000		0.0070	0.0000	0.0010	

Table 6. Mean flavor rating of lettuce varieties from first (November – December) and third (June) harvests.

Variety	**Harvest 1 (December)**	**Harvest 3 (June)**	**Overall Average**	**Flavor Rating**
Oakleaf Redder Ruffled	4		4.00	Bitter = 1
Yugoslavian Red	3.8	4	3.90	Slightly bitter = 2
Sanquine Ameliore	3.8		3.80	Good = 3
Winter Density	4.4	3	3.70	Very Good = 4
Tom Thumb	3.55		3.55	Excellent = 5
Brown Golding	4	3	3.50	
Romaine Dark Green	3.7	3	3.35	
Cracoviensis	3.3		3.30	
De Morges Braun	3.3		3.30	
Reine Des' Glaces	3.5	3	3.25	
Victoria	3.5	3	3.25	
Bronze Arrowhead	3	3	3.00	
Forellenschluss		3	3.00	
Little Leprechaun		3	3.00	
Blushed Butter Oak	3.8	2	2.90	
Bijou	2.75	3	2.88	
Outredgeous	2.75	3	2.88	
Austrian Greenleaf	2.6	3	2.80	
Oaky Red Splash	3.6	2	2.80	
New Red Fire	3	2	2.50	
Kweik	3.6	1	2.30	
Brunia	2.55	2	2.28	
Cardinale	3.4	1	2.20	
Trout's Back	3.4	1	2.20	
Simpson Elite	3.3	1	2.15	
Roger		2	2.00	
Overall Mean	3.42	2.43	2.92	
P Value				

Figure 1. Temperatures during first planting in the hoop house, field, and under paper mulch from October 21 to December 15, 2003.

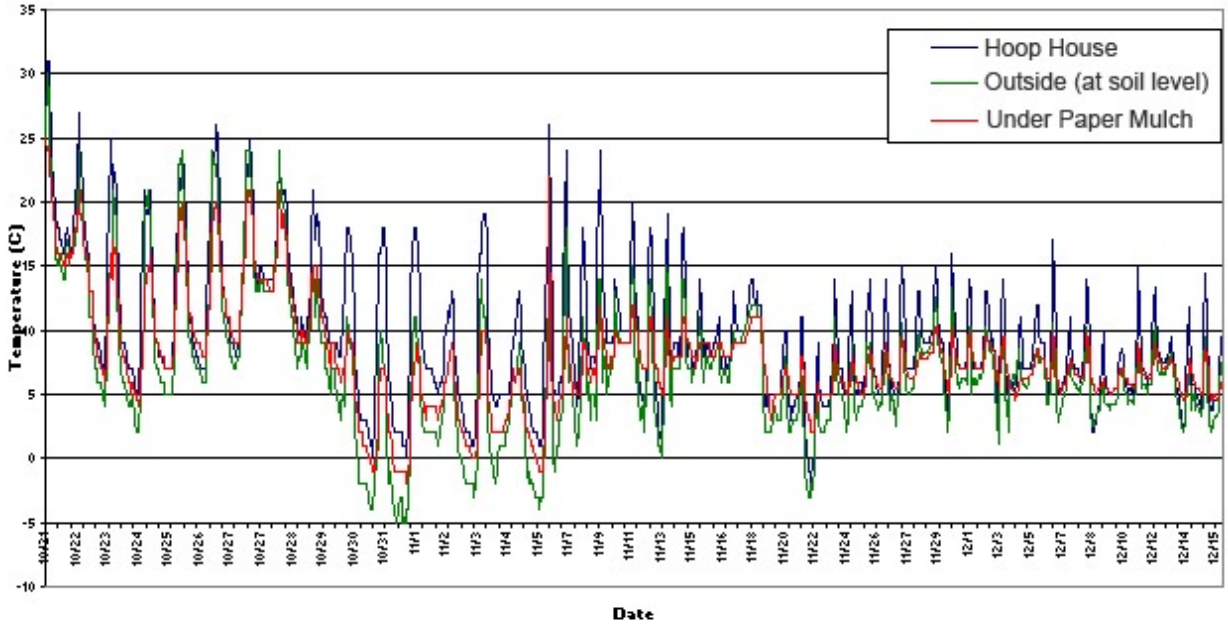

Figure 2. Temperatures during second and third plantings in the hoop house, field, and under mulch from May 3 to June 7, 2004.