

Evaluating Extended Season Lettuce Production in West Virginia

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Lettuce (*Lactuca sativa* L.) is a high-value crop for many retail and wholesale markets. Lettuce is a cool-season crop with an optimal temperature for growth of 60-65°F, yet it may be possible to grow a lettuce crop year-round in the Mid-Atlantic region using a combination of suitable varieties and season extension technology.

Lettuce is the second most widely grown crop in high tunnels in the United States behind tomatoes. Bibb lettuce (or butterhead lettuce) has loose, open heads with soft leaves. Bibb lettuce is an excellent choice for expanded local production because it does not ship well over long distances. The objective of this comprehensive lettuce evaluation was to examine heat (and cold) tolerance of diverse bibb and select romaine lettuces within West Virginia during 2012 using low and high tunnels for extended season production.

Materials and Methods

Lettuce seed of 30 cultivars were acquired from several cooperating seed companies (Table 1), and seeded in 128-cell plug trays filled with Promix BX media starting on April 3, 2012. Plugs were hand-transplanted into rows on black plastic mulch within a high tunnel on May 5. The high tunnel was a Rimol Nor'Easter single poly structure (30 ft wide x 96 ft long) located in central West Virginia (37°N lat.). Each lettuce plug was spaced 6 inches between plants and 6 inches between rows with three rows per bed.

Drip irrigation was used to supply water and fertilizer throughout the growing season. Standard cultural practices for head lettuce production were followed. Varieties were planted into 36-inch long plots and randomized within each row with three replications per variety. Mature heads were hand-harvested from the center row of each bed on June 4. Each head was weighed with intact roots (soil washed) and head diameter recorded. To evaluate heat tolerance, a second planting was made in July-August with harvest in early September. Black plastic mulch was replaced with white plastic and the plots were established in open-field plots rather than a high tunnel. Bolting and tip burn incidence were noted with each variety.

Shade cloth (≈50%) was used for midsummer lettuce production of select varieties. A shade cloth fabric was draped over low tunnel hoops (4 ft wide x 4 ft tall) and five lettuce varieties were planted as above on white plastic mulch with drip irrigation (Figure 1). The storage of washed and unwashed bibb and romaine lettuce was also evaluated in September. A third planting to evaluate cold tolerance was conducted in mid-October and harvested in January 2013.

Results and Discussion

Table 1. List of lettuce cultivars evaluated within high and low tunnels in West Virginia.

Cultivar	Days to Maturity ^z	Seed Source	Description
Quattro Stagioni	55	Seeds of Italy	Green head; red tips
Regina di Maggio	55	Seeds of Italy	Green w/ red blush
Parella Rossa	55	Seeds of Italy	Baby lettuce
Batavia Biondo	52	Seeds of Italy	Light green with red tinge
Maravilla de Verano	55	Seeds of Italy	Green/w/red tips
Regna delle Ghiacciole	60	Seeds of Italy	Crisphead type
Rosa di Trento	55	Seeds of Italy	Green with red tips
Rouge Grenobloise	60	Seeds of Italy	Crisphead type
Passion Brune	55	Seeds of Italy	Heirloom French buttercrunch
Ubriacona	60	Seeds of Italy	Green w/red blush
Dancine	43	Johnny's Seeds	Baby bibb
Adriana	48	Johnny's Seeds	Green buttercrunch
Nancy	52	Johnny's Seeds	Boston bibb type
Rex	50	Johnny's Seeds	Hydroponic type
Australe	49	Johnny's Seeds	Red buttercrunch suitable for mni-heads
Skyphos	47	Johnny's Seed; Siegers Seeds	Red buttercrunch
Red Cross	48	Johnny's Seeds	Red buttercrunch with heat tolerance
Buttercrunch	46	Johnny's Seeds/Fedco Seeds	Green bibb
Big Boston	50	Baker Creek Seeds	Green bibb
Brune D'hiver	50	Baker Creek Seeds	Green/reddish leaves
Blonde Du Cazard	50	Baker Creek Seeds	Large buttercrunch
Little Gem	50	Baker Creek Seeds	Baby romaine
Sierra	50	Harris Seeds; Rupp	Batavian; heat tolerant
Nevada	48	Harris Seeds; Siegers Seeds; Rupp Seeds	Batavian; heat tolerant
Sangria	55	Harris Seeds	Red buttercrunch
Amaze	60	Harris Seeds	Green w/red blush
Margarita	50	Rupp Seeds	Green buttercrunch
Helvius	58	Johnny's Seeds	Romaine
Coastal Star	58	Johnny's Seeds; Siegers Seeds; Rupp Seeds	Green romaine with heat tolerance

^zFrom direct seeding under optimal conditions.



Figure 1. Shade cloth and white polyethylene plastic mulch were used to grow lettuce in midsummer.

The following lettuce cultivars performed very well in both planting dates: *Australe*, *Buttercrunch*, *Coastal Star*, *Dancine*, *Helvius*, *Nancy*, *Nevada*, *Regina delle Ghiacciole*, *Rex*, *Rouge Grenoblois*, and *Sierra*. *Australe* is an excellent red buttercrunch lettuce with very good flavor and texture (Table 2). *Buttercrunch* is a consistent bibb variety with excellent quality even in high-temperature growing conditions. *Dancine*, *Nancy*, and *Rex* were extremely uniform with excellent heat tolerance and quality. Both *Coastal Star* and *Helvius* performed very well in both planting dates, *Helvius* seemed to have slightly higher quality. *Nevada* and *Sierra* are Batavian lettuces with excellent heat tolerance. *Regina delle Ghiacciole* is a crisp head type that had excellent quality during the midsummer. *Rouge Grenoblois* had very high quality during both planting dates. *Parella Rosa*, *Passion Brune*, *Brune D’Hiver*, *Regina di Maggio*, and *Quatro Staggioni* were not heat tolerant lettuce cultivars and bolted rapidly during the midsummer heat. The shade cloth treatment did not improve marketable yield and quality of select cultivars compared with nonshade treatments during midsummer production (Figure 2).

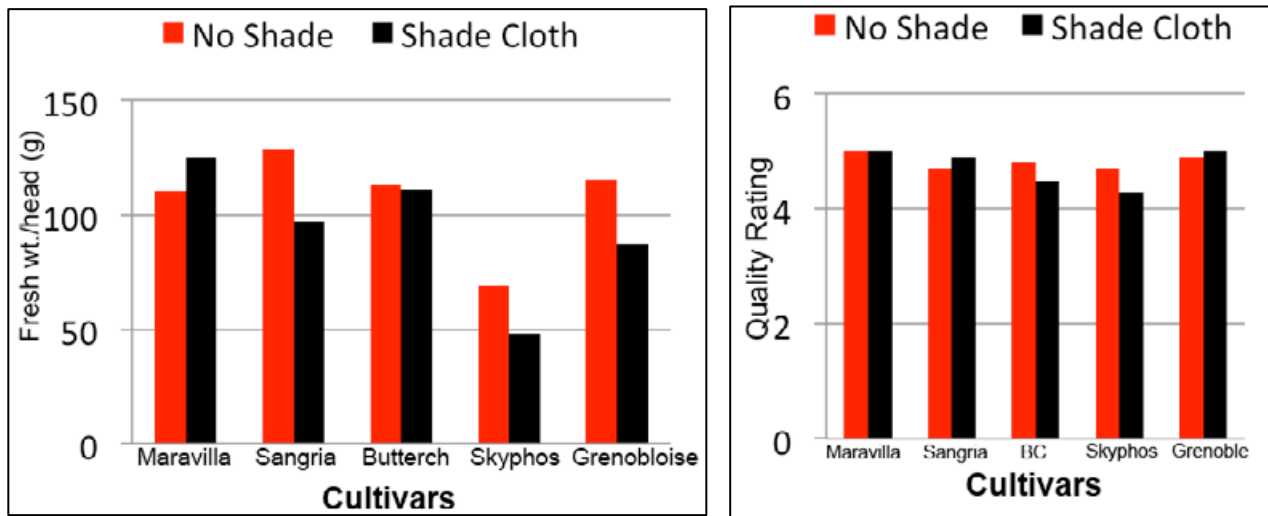


Figure 2. Effect of shade cloth in low tunnels on yield and quality of select lettuce cultivars.

Table 2. Summary of marketable yields, head size, and bolting of lettuce cultivars.

Cultivar	Harvest I		Harvest II		Bolting (%)
	Head wt. (g)	Head dia. (in.)	Head wt. (g)	Head dia. (in.)	
Amaze	91	8.1	84	6.9	0
Arianna	105	8.1	-	-	0
Australe	148	8.5	117	7.3	0
Batavia Biondo	108	8.9	139	8.7	0
Barbardi	-	-	142	7.6	0
Brune D'Hiver	208	11.5	-	-	25
Buttercrunch	156	8.8	123	7.3	0
Big Boston	-	-	171	8.2	0
Coastal Star	249	9.0	141	7.3	0
Dancine	105	6.8	114	6.0	0
Helvius	195	8.4	162	7.4	0
Margarita	138	7.3	-	-	0
Maravilla	127	7.1	120	7.5	0
Nancy	131	8.5	133	7.6	0
Nevada	135	7.2	130	7.3	0
Parella Rosa	-	-	-	-	100
Passion Brune	-	-	-	-	75
Quatro Stagioni	110	9.1	76	7.0	25
Red Cross	109	10.7	-	-	0
Regina di Maggio	-	-	95	6.8	88
Regina delle Ghiacchi	-	-	156	7.9	0
Rex	178	8.6	129	6.5	0
Rouge Grenobloise	140	9.9	125	7.7	0
Rosa di Trento	123	9.9	121	7.8	0
Sangria	-	-	139	7.7	0
Sierra	136	9.9	144	7.3	0
Skyphos	102	8.2	79	7.0	0
Ubriacona	124	12.0	126	9.0	0
<i>Standard Error</i>	<i>5.9</i>	<i>0.2</i>	<i>4.2</i>	<i>0.1</i>	

Table 3. Quality rating for lettuce cultivars grown in midsummer.

Cultivar	Quality Rating ^z	
	Flavor/Texture	Overall Quality
Amaze	4.8	5.0
Australe	4.5	4.8
Batavia Biondo	4.0	4.0
Barbardi	4.5	4.6
Buttercrunch	4.8	4.8
Big Boston	5.0	4.9
Coastal Star	4.3	4.8
Dancine	5.0	5.0
Helvius	4.4	4.7
Margarita	5.0	5.0
Maravilla	5.0	4.9
Nancy	5.0	5.0
Nevada	5.0	5.0
Quatro Stagioni	3.5	4.2
Regina di Maggio	-	4.2
Regina delle Ghiacchi	4.9	4.8
Rex	5.0	5.0
Rouge Grenobloise	4.5	4.9
Sangria	4.2	4.7
Sierra	4.8	4.9
Skyphos	4.5	4.7
Ubriacona	4.2	4.3

^zRating scale: 1-5 with 1=poor flavor or appearance and 5=excellent flavor and appearance

Postharvest Storage

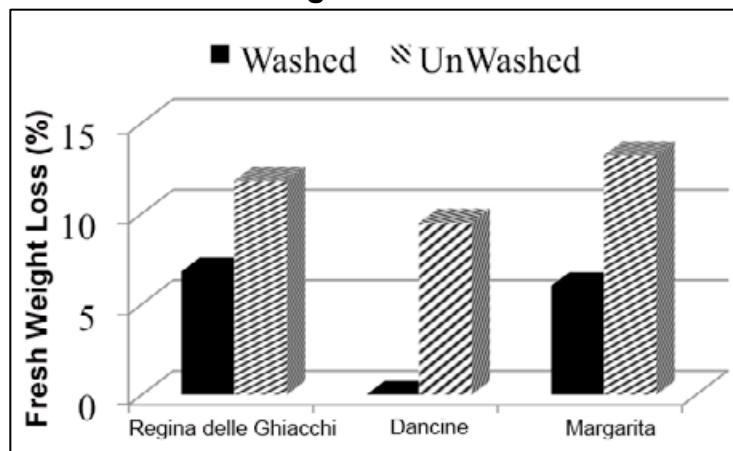


Figure 3. Fresh weight loss of washed and unwashed buttercrunch lettuce after 15 days of storage at 36°F.

Table 4. High tunnel butterhead lettuce enterprise budget per 1,000 ft² (≈1980 heads).

Production Expense	Unit	Quantity	Price (\$)	Labor (rate/h)	Type	Hours	Total Costs (\$)
Variable Costs							
Pre-planting							
Soil test	Entire high tunnel		12.00	10.00	M	0.5	17.00
Tillage			5.00	10.00	M	0.5	10.00
Raised bed formation			10.00	M	3.0	30.00	
Fertilizer and lime		1.3 lbs. N	7.80	10.00	M	0.5	12.80
Plastic mulch		189 linear ft.	7.56	10.00	M	1.5	22.56
Irrigation drip tape		189 linear ft.	4.70	10.00	M	0.5	9.70
Plant Costs							
Planting trays	128 Plug trays	1 case	89.00				89.00
Transplant labor	1,980 plugs	15 trays		10.00	M	17.0	170.00
Seed (pelleted)	1,000 seeds	5,000	1.95				3.90
Rooting media	3.8 ft ³	1 bale	19.00				21.00
Starter fertilizer	20-20-20	1 lb.	2.50				2.50
Production Costs							
Insect/Slug control		6 sprays		10.00	M	3.0	90.90
Fungicide	Oxidate	18 ozs.	9.28	10.00	M	3.0	39.28
Irrigation/ Fertigation	15.5-0-0	6 lbs.	10.00				10.00
(Quick Hoops)	pipe	38 pipe	2.50	10.00	M	2.0	(114.50)
Row covers	roll	1.0	67.00				67.00
(Shade cloth)	roll	1,890 ft ²	0.25/ft ²				(472.50)
Anchor pins	box	500 pins/box	35.00				12.00
Fuel and oil	gallons.	10.0	3.50				35.00
Temp. mgt ^z .	hrs.	1.2 h/week		10.00		7.5	75.00
Transplanting	hrs.			10.00		8.0	80.00
Harvesting Costs							
Cutting/washing	hrs.	1 h/bed		10.00		2.2	22.00
Postharvest Costs							
Boxes/Lugs	lugs	12	14.00				168.00
Total Costs							987.64
Total Revenue^y							2,673.00
							3,564.00
Net Revenue							1,685.36
							2,576.36

^zVenting labor varies with growing season.^yAssumes 90% marketable yield.

Conclusions

Many butterhead and romaine lettuce cultivars can be grown throughout the year in the Mid-Atlantic region. While most romaine cultivars are heat tolerant, there are several butterhead or bibb varieties that perform well in both high and low temperatures. The summer of 2012 had record heat and was an excellent time to evaluate heat tolerance. Shade cloth, however, did not improve marketable fresh weight or quality over unshaded treatments.

Growing the lettuce on white plastic mulch in hot weather, which keeps the growing point of the lettuce plant relatively cool, may be more effective than using shade cloth. The shade cloth was suspended on low tunnel hoops and provided a barrier to insects but could perhaps increase air temperature around the plant because the black cloth absorbs heat. Perhaps suspending the shade cloth over a high tunnel or on a taller structure could be more effective. However, this research project shows the use of shade cloth may not be needed in West Virginia. The majority of lettuce cultivars evaluated had excellent quality with or without shade cloth. Varieties that possessed little or no heat tolerance quickly bolted in high temperatures.

Butterhead lettuce that was washed in chlorinated water and stored at 36°F had excellent quality for more than two weeks. Growing head lettuce on plastic mulch reduces soil splashed on the leaves. However, the lettuce should be washed prior to placing in storage.

Lettuce is essentially a 60-80 day crop depending on the season of the year. Thus it is possible to have as many as four lettuce crops per year in West Virginia. If growers do not have a market for large quantities of lettuce at a given time, a single bed or row can be seeded every other week to provide a continuous, uninterrupted supply. Estimates of profitability have shown lettuce can produce a net return of \$1,600-2,700 per 1000 ft² within a high tunnel (Table 4). A commercial high tunnel with approximately 2,800 ft² could produce as many as 5,400 single heads of buttercrunch or romaine lettuce per crop cycle.