Fall Field and High Tunnel Lettuce Production

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Introduction

High tunnels are a tool used by Iowa growers to extend their spring and fall growing seasons. During fall production, crops are known to be of better quality and yield higher when in a high tunnel vs. in field. Based on needs assessment and discussions with Iowa specialty crop growers, high tunnel producers are seeking ways to diversify their production and understand the unique crop management skills needed when growing new crops in a high tunnel.

Demand for locally grown lettuce is increasing as consumers, restaurants, and grocery stores seek lettuce that is of high quality and locally grown. With this higher demand, growers in Iowa are seeking research-based information on how and what types of lettuce to grow in high tunnels for increased quality and profitability.

This study was designed to address many of the questions growers have with respect to lettuce cultivar selection and effect of growing conditions (high tunnels vs. in field). Field research was conducted in fall 2020 to compare various cultivars of romaines and summer crisps. Two individual studies, one in the high tunnel and the other in open field, were established. Transplanting for both studies took place on the same day.

Materials and Methods

Eight cultivars of lettuce were seeded at the Iowa State Department of Horticulture greenhouses August 5, 2020. Four of the cultivars were Summer Crisps and the other four were Romaine. Summer Crisp cultivars included Cherokee (Johnny's Selected Seeds), Lovelock (High Mowing Organic Seeds), Magenta (Johnny's Selected Seeds), and Muir (Johnny's Selected Seeds). Romaine cultivars included Aerostar (High Mowing Organic Seeds), Coastal Star (Johnny's Selected Seeds), Sparx (Johnny's Selected Seeds), and Thurinus (Johnny's Selected Seeds).

The high tunnel and open field experiments were established at the Iowa State University Horticulture Research Station, Ames, Iowa. The high tunnel was 96 ft long and 30 ft wide, had a single 6 mil polyethylene cover, and was installed with automated roll-up sidewalls set to roll-up when temperatures reached 78°F.

Both the high tunnel and open field experiments were identical in size and experimental design. Both experiments comprised of a randomized complete block design. Treatments included eight cultivars of lettuce. Raised beds were constructed using black plastic mulch. Beds were spaced 4.5 ft center-to-center. Lettuce was transplanted September 1, 2020. Each treatment was 7 ft long and comprised of two rows of lettuce with 9 in. within and between rows. Each treatment was replicated five times. There were two guard rows of lettuce planted for both experiments. Air and soil temperature and light intensity sensors (Hobo, Onset Computer Corporation, Bourne, MA) were installed in both the high tunnel and open field.

Both experiments were drip irrigated weekly. Based on soil test results, the field experiment was fertigated twice with 300 ppm N using Nutriculture (20-20-20). The high tunnel experiment was fertigated twice with 300 ppm N using urea (46-0-0). On September 19, insect damage was noticed in the high tunnel, and a tank mix of Pyganic and Dipel was sprayed. On September 21, the field experiment was sprayed for insects with a tank mix of Pyganic and Dipel.

The lettuce in the high tunnel trial was ready to harvest October 16, 2020, while the field trial had to be harvested October 26, 2020, due to an impending cold snap with nighttime low of 15°F. Lettuce was graded into marketable and non-marketable category based on head quality. Each category was counted for number of heads and weighed. From the marketable heads, four heads were randomly picked to measure head diameter.

Results and Discussion

Lettuce in the open field trial was exposed to suboptimal temperature ranges and fluctuations (Table 1). Cooler temperatures, wind, rain, and other weather conditions detrimentally affected open field lettuce and reduced yield and quality. Given the smaller size, these heads were left in the field longer to mature, which put them at risk for exposure to frost damage.

Lettuce in the high tunnel matured faster with the higher temperatures and protection from the outside environment (Table 2). However, given the protection from the outside elements and robust growth, there were more insect related issues in the high tunnel. Growers should consider increasing the frequency of scouting for insects in the high tunnel, especially during the fall growing season. Irrigating regularly is necessary in high tunnels with the lack of rain events present.

Overall, the lettuce in the high tunnel yielded higher than the lettuce in the field setting with larger heads and heavier weights (Table 3 and 4). Of the four romaine cultivars, Sparx and Costal Star yielded the largest marketable weights in both the high tunnel and field trials. Thurinus and Aerostar had significantly less marketable weight in the field trial of the four romaines. In the high tunnel, Thurinus again had a significantly less marketable weight than other romaines. Of the four summer crisp cultivars, there was no significant difference in marketable heads or marketable weight both in the high tunnel or in the field trial.

One interesting observation was with respect to coloration. Lettuce in the open field experiment was exposed to more light than in the high tunnel. This led many of the cultivars to exhibit a darker purple color than their counterparts grown inside the high tunnel (Figures 1 and 2). This study will be replicated in fall 2021. A spring component of the project will be added in 2021.

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Table 1. Air and soil temperatures and light intensity in open field lettuce plots at the ISU Horticulture Research Station, Ames, Iowa.

	Air temperature (°F)			Soil temperature (°F)[z]			Light (lux)
	Min	Max	Mean	Min	Max	Mean	Mean
September	48.3	89.1	64.9	59.5	70.9	64.7	14870
October	34.8	75.9	51.8	50.1	57.4	53.7	12784

[z]Soil sensor placed 4 in. below the soil surface.

Table 2. Air and soil temperatures and light intensity in high tunnel lettuce plots at the ISU Horticulture Research Station, Ames, Iowa.

	Air temperature (°F)			Soil temperature (°F)[z]			Light (lux)
	Min	Max	Mean	Min	Max	Mean	Mean
September	50.1	89.5	66.2	64.6	72.8	68.4	9807
October	40.0	86.6	60.1	59.0	64.7	61.8	9279

[z]Soil sensor placed 4 in. below the soil surface.

Table 3. Average yield and quality of open field lettuce October 26, 2020 at the ISU Horticulture Research Station, Ames, Iowa. Yield data reported from 7-ft long bed with two rows of lettuce.

Cultivar	Marketable number	Marketable weight (kg)	Frost damaged heads (no.)	Frost damaged heads (kg)	Average head diameter (cm)
Aerostar[y]	7 c	1.9 cd	2 b	0.38	14.2 bc[x]
Cherokee[z]	9 a	2.4 bc	3 b	0.58	17.1 ab
Costal Star[y]	8 ab	2.8 ab	4 ab	1.08	18.1 a
Lovelock[z]	8 ab	2.5 bc	2 b	0.62	18.4 a
Magenta[z]	9 a	2.9 ab	2 b	0.48	18.5 a
Muir[z]	9 a	2.8 ab	2 b	0.78	17.8 a
Sparx[y]	8 ab	3.0 a	7 a	1.08	16.9 ab
Thurinus[y]	7 c	1.3 d	7 a	1.44	13.2 c

[z]Romaine lettuce cultivar.
[y]Summer crisp cultivar.
[x]Means within a column with the same letters are not statistically different ($P < 0.05$).

Table 4. Average yield and quality of high tunnel lettuce October 16, 2020, at the ISU Horticulture Research Station, Ames, Iowa. Yield data reported from 7-ft long bed with two rows of lettuce.

Cultivar	Marketable number	Marketable weight (kg)	Insect damaged (no.)	Insect damaged (kg)	Small Heads (no.)	Small Heads (kg)	Average head diameter (cm)
Aerostar[y]	11 a	7.2 ab	0 b	0.14	-	-	15.6 abc[x]
Cherokee[z]	10 ab	5.1 cd	-	-	-	-	14.3 bc
Costal Star[y]	11 a	8.1 a	-	-	0	0.14	16.3 a
Lovelock[z]	9 ab	5.6 bcd	1 b	0.38	1	0.36	16.1 ab
Magenta[z]	10 ab	6.4 abc	1 b	0.52	0	0.12	14.4 bc
Muir[z]	8 b	5.2 cd	2 a	0.46	0	0.22	14.4 bc
Sparx[y]	10 ab	7.7 a	-	-	-	-	16.2 ab
Thurinus[y]	10 ab	4.0 d	-	-	1	0.14	14.2 c

[z]Romaine lettuce cultivar.
[y]Summer crisp cultivar.
[x]Means within a column with the same letters are not statistically different ($P < 0.05$).

Figure 1 (Above) and Figure 2 (Below). The following are images of plots October 2, 2020. Above is the open field and below is the high tunnel plot. The images are following cultivars from left to right: Costal Star, Aerostar, Sparx, Thurinus, Lovelock, Magenta, Cherokee, and Muir. Notice the smaller size and the darker purples in the open field plot compared with the high tunnel.