



Looking for a Seasonal CEA Crop? Consider Strawberries

Greenhouse strawberries have the potential to become a profitable seasonal crop during those times of year when the quality and availability of field-grown crops is inconsistent.

By David Kuack

The interest in greenhouse strawberries has been increasing over the last few years. Part of this has to do with the demand for year-round production of the crop. The variability in quality and availability of field-produced strawberries due to disease outbreaks and weather-related issues has increased interest in controlled environment production. This year's early-season strawberry harvests in California and Florida were delayed by cool temperatures and/or rainy weather.

Another reason for the appeal of greenhouse strawberries is the ability to supply a consistent locally-produced crop in most parts of the country during the time of year when field production is not possible.

"Strawberries are perfectly capable of growing year round in a controlled environment," says Jonathan Allred, Ph.D. student at Cornell University in Ithaca, New York. "But in terms of being financially competitive, controlled-environment growers would be doing off-season production, which would be a late fall to early spring production season. Growing over the winter and being able to produce locally is when the crops are going to be most in demand.

"In general, greenhouse strawberry production is difficult financially even under the best growing conditions. Like any other value-added crop, greenhouse strawberry growers are going to have to establish the right market. Most greenhouse growers cannot expect to be competing in terms of volume and sales with field-produced product. They won't be able to get the prices they need to be profitable. Greenhouse growers have to add some sort of value-added aspect whether that is locally-grown, fresher or higher sugar content than field-grown strawberries."



Three plants each of 'Albion' and 'Cabrillo' strawberry plants were grown in 11-liter buckets filled with a peat:perlite:coir substrate mix and watered using drip irrigation.

Photos courtesy of Jonathan Allred, Cornell University.

Allred says strawberry producers want to be able to produce the highest quality strawberries every single day of the year to supply consumers. This is achievable with greenhouse production.

"Driscoll's is one of the largest berry producers interested in doing greenhouse strawberry production," he says. "I expect most of the large-scale field producers are interested in greenhouse strawberry production and have considered it as a potential option."

IDENTIFYING CULTIVARS FOR CEA PRODUCTION

Increased production of controlled-environment strawberries has been ongoing for many years outside the U.S., including the Netherlands, Japan and Canada.

"There has been an increasing interest in growing greenhouse strawberries in the U.S.," Allred said. "However, there really

isn't much practical application of CEA strawberry production in the U.S."

He says one of the major reasons is the limited availability of cultivars for CEA growers. The breeding of strawberries has been primarily for field production.

"The greenhouse strawberry market is very small when compared to field production. I expect there are some growers producing greenhouse strawberries who are using cultivars that have been bred in Japan and the Netherlands. Other growers are using field-bred cultivars and adapting those to the greenhouse environment. There are breeding efforts occurring, but I am unaware of any U.S.-bred cultivars for greenhouse production that have been released."

One of the most affordable ways for CEA growers to start producing greenhouse strawberries is to use off-patent, field-bred cultivars from the University of California-Davis or University of Florida breeding programs.

As part of the Greenhouse Lighting and Systems Engineering (www.glase.org) consortium, Allred has been studying which field-bred cultivars are best suited for CEA production.

"I started my research with seven cultivars and very quickly narrowed it down to two everbearing cultivars that worked best for CEA production," he says. "'Albion' and 'Cabrillo' are from the UC-Davis breeding program."

GREENHOUSE PRODUCTION TRIALS

Allred has been performing greenhouse trials with 'Cabrillo' and 'Albion' for about a year. The strawberry plants are being grown in 11-liter buckets filled with a peat:perlite:coir substrate mix. Each bucket contains three plants, which are spaced at one plant per square foot. Plants are watered using drip irrigation and fed with a custom-blended fertilizer, which is a modified Yamazaki formula.

"We trialed production for a five-month period from Jan. 1 to May 31," he elaborates. "There were three different light treatments. Ambient light was the control. The daily light integral (DLI) was as low as 1-2 moles per square meter per day.



Strawberry plants grown under ambient light levels never developed as many crowns as plants that received supplemental light treatments. The vegetative growth of the ambient light plants was also much slower.



The sweetness of the strawberries (Brix value) was highest for both 'Albion' (9.4°Bx) and 'Cabrillo' (7.3°Bx) plants grown under high pressure sodium (HPS) lamps.

"Supplemental light was provided by either LED or high pressure sodium (HPS) lamps. We achieved 98% light uniformity over the crop canopy. The DLI was set at 15 moles per square meter per day, which is on the low end for strawberries. We weren't looking at the effect on total yields. We were looking at the differences between the light treatments. Greenhouse strawberry growers would want to increase the light intensity. For most strawberry

cultivars the recommended DLI is 20-25 moles. More light almost always means higher yields for most crops. This is something that needs further study for strawberries."

IMPACT OF LIGHT

Throughout the five-month trial, the plants were maintained as much as possible at three crowns per plant. Within that requirement, under the ambient light treatment, there was



Strawberry plants grown under LED lights produced more berries so the yields were larger and fruit size was larger.

almost always one to two crowns per plant. The plants under ambient light never developed as many crowns as the supplemental light treatments. The vegetative growth on the ambient light plants was also much slower.

Under ambient light the plants had very little energy so the total strawberry yield was much smaller. The ambient light plants produced fewer berries and each berry was larger. LEDs produced more berries so the yields were larger and had a larger berry size.

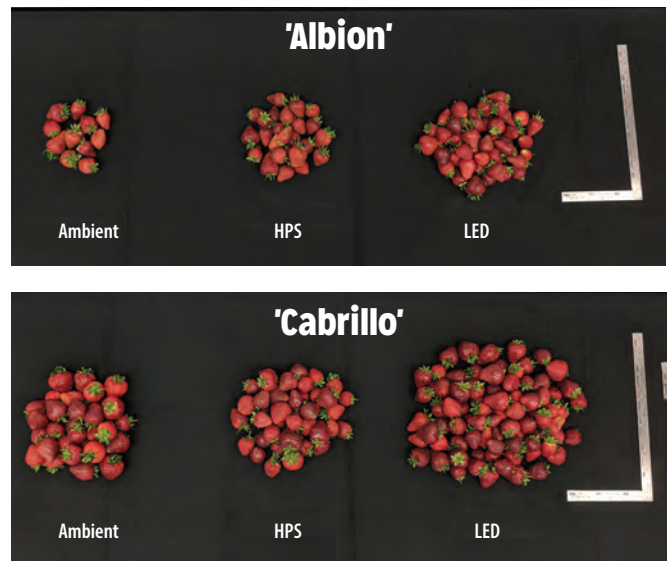
In all cases for the five-month trial, the light treatments outperformed the ambient light treatment for total yield. Under ambient light, the yield for 'Albion' was 1.77 kilograms per square meter. Under HPS lights, the yield was 2.72 kilograms per square meter. 'Albion' had its highest yield under LEDs at 3.68 kilograms per square meter, which was 100% over ambient light.

'Cabrillo' under ambient conditions had a yield of 3.03 kilograms per square meter. 'Cabrillo' had a 72% higher yield than 'Albion' under ambient light. Under HPS, the yield for 'Cabrillo' was 4.9 kilograms per square meter. Under LEDs, the yield for 'Cabrillo' was 5.67 kilograms.

Under ambient and LED light, the average berry size for 'Albion' was 16 grams per berry. Under HPS light, 'Albion' berry size was 14 grams per berry.

'Cabrillo' followed the same berry size trend as 'Albion'. Under ambient and LED light, the berry size for 'Cabrillo' was 18 grams. Under HPS light the berry size was 15 grams.

Under HPS lights, both cultivars produced the smallest berries, but plants had more berry clusters. Allred said the radiant heat provided by HPS lamps wasn't necessarily beneficial because the berries were smaller and yields were lower than LEDs. He couldn't say whether the differences in yield and berry size were due to the temperature difference or if the light quality may have played a role.



For the five month trial done at Cornell University, HPS and LED light treatments outperformed the ambient light treatment for total strawberry yield of 'Albion' and Cabrillo'.

The sweetness of the fruit (Brix value, °Bx) was also measured for the strawberries produced under the three different light treatments. Under ambient light, 'Albion' had the lowest Brix value at 7.4 degrees. Under LEDs, 'Albion' had a Brix of 8.5 degrees. 'Albion' strawberries grown under HPS had the highest Brix at 9.4 degrees.

'Cabrillo' had slightly lower sugar content than 'Albion'. For 'Cabrillo', grown with ambient light the Brix value was 5.9 degrees. Under LEDs, the Brix value was 6.7 degrees. As with 'Albion', 'Cabrillo' grown with HPS lamps had the highest Brix at 7.3 degrees.

FUTURE STRAWBERRY RESEARCH

Allred plans to run an identical trial with 'Albion' and 'Cabrillo' at the same time of year. Other experiments will be conducted using a range of different DLIs, including 15, 20 and 25 moles per square meter per day.

"We are also going to be doing some other experiments with light and carbon dioxide, looking at the interaction between DLI and carbon dioxide," he says. "One of the things that can be done with greenhouse lettuce is a higher level of carbon dioxide can be used to achieve the same yields as higher light levels. For example, 1,000-ppm carbon dioxide can offset the need for additional light by a couple moles of light. We want to look at the impact of higher carbon dioxide levels on strawberries. It may be possible to use higher carbon dioxide levels to substitute for higher light levels in respect to fruit yields."

For more information: Contact Jonathan Allred at jaa337@cornell.edu, or visit www.cornellcea.com, www.greenhouse.cornell.edu or www.glase.org. ♦

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