Roberto Lopez, an OptimIA project researcher and Michigan State University horticulture professor, is studying how environmental parameters can impact plant growth, quality, yield and morphology of controlled environment crops. Photo courtesy of Roberto Lopez, Mich. St. Univ.

How Can You Manipulate The Environment To Improve Leafy Greens Production?

April 3, 2023
By David Kuack, UrbanAgNews.Com

OptimIA researchers are studying how the environment can be manipulated to improve crop quality, increase yields and change the plant morphology of leafy greens.

You know how important maintaining the proper environment plays in the production of controlled environment crops. Is it possible to change the environmental parameters to improve crop quality and yield?

Researchers with the OptimIA project are looking at how the environmental parameters such as light, temperature, relative humidity and carbon dioxide concentration can impact plant growth, quality, yield and morphology of leafy greens.

"There is a not a lot of production information available for most leafy greens other than lettuce," said OptimIA researcher and Michigan State University horticulture professor Roberto Lopez. "Lettuce is a significant crop for the controlled environment industry. Kale and arugula are up-and-coming crops that are being sold more as stand-alone, prepackaged leafy greens. Microgreens are also a relatively new crop and not much research has been done on them beyond the influence of light quality and intensity.

"Kale and arugula are similar to lettuce, they don't grow too large and have a similar crop production time to lettuce. Microgreens are a short-term crop that only take a few weeks at most."

Michigan State graduate student Devin Brewer is studying how the color of lettuce and microgreens can be enhanced by altering the light quality and reducing the air temperature. Photo courtesy of Devin Brewer, Mich. St. Univ.

Improving crop quality

Lopez and graduate student Devin Brewer are particularly interested in looking at leaf color in regards to improving crop visual quality and potentially nutrition.

"Consumers, when it comes to red leaf lettuce, prefer dark red leaves because they like the color and texture," Lopez said. "One of our goals with OptimIA is to really push leafy greens crops to produce them as quickly and profitably as possible. By pushing the plants there is a lot of biomass produced quickly. However, one of the down sides is that the foliage can lack the desired color, especially red leaf lettuce and brassica microgreens."

Brewer is studying how the color of lettuce and microgreens can be enhanced by altering the light quality and reducing the air temperature. He is looking at different light qualities, primarily a combination of red and blue light or blue light alone. He is also looking at reducing the temperature a few days prior to the crop being harvested.

"Devin found that reducing the temperature in combination with a light ratio (percent) of 75 blue:25 red light produced intense leaf coloration," Lopez said. "However, in the case of indoor farms, it is much easier to heat than to cool. Most of these farms use LED lights. Even though there is a misconception that LEDs don't generate heat, the fixtures can produce quite bit of heat."

Depending on the time of year, lowering the air temperature would be more feasible for greenhouse lettuce production. During cooler times of the year, there is not going to be the heat load in greenhouses that could occur in indoor farms. Because lowering the temperature could potentially be a challenge for indoor farms, Lopez said he is looking at other ways of reducing the temperature including lowering the irrigation water temperature.

Another benefit of the end-of-production lighting or cooling is the impact it has on some plant nutrients, vitamins and carotenoids.

"Not only is the color being affected, but in some instances the parameters related to nutrition are increasing," Lopez said. "We are looking at this with lettuce and this summer will be studying the impact light and

temperature can have on microgreens. We are quantifying the changes in the amounts of anthocyanins. We will not be measuring these changes with kale or arugula."

The red butterhead lettuce variety 'Barlach RZ' was placed under the end-of-production cool temperature treatments the final eight days before harvest. From left to right: 20°C (68°F) 14°C (57.2°F) and 8°C (46.4°F). ***Photo courtesy of Devin Brewer, Mich. St. Univ.***

Two characteristics of leafy greens Lopez won't be studying in the short-term are texture and taste.

"Leaf texture is an important factor to consider when studying the impact of light and temperature," he said. "When lettuce is grown warm, it tends to be softer, not as crisp as lettuce that is grown at cooler temperatures.

"Unfortunately, with the OptimIA project we don't have the time to determine if environmental parameters can affect taste. In a separate USDA Specialty Crop Research Initiative project called CEA HERB focused on culinary herbs, we will have a consumer taste panel looking at flavor profiles as well as studying the impact on nutrients within the plants."

Increasing crop yields

Another aspect of Lopez's research is focused on how temperature impacts the yields of lettuce, kale, arugula and microgreens.

"These four crops are being grown under various temperatures so that we can estimate what the base, the optimum and maximum temperature are for each crop," he said. "This will enable us to determine the temperatures that are going to produce the maximum yields as well as the best quality."

Lopez said growers may not always want to grow a crop at the optimum temperature because the light intensity might have to increase to a level that the crops won't be profitable to produce.

"Lettuce, kale and arugula have been grown as field crops," he said. "Studies to determine the base, optimum and maximum temperatures have not been consistent. Lettuce for example, has a much higher base temperature as well as optimum temperature than most growers thought. Considered to be a cooler season crop, lettuce can tolerate temperatures into the upper 70s. Yields can be pushed by growing them warm. Obviously, there is a point where too much heat is going to lead to lower quality crops and potentially bolting."

Changing plant shape to meet market demand

Lopez said changing the shape of the plants will be important depending on how a crop is marketed.

"In the case of lettuce, if a head is too tall it may not fit into the clamshell packaging it is typically sold in," he said. "We are only focusing on lettuce in regards to changing morphology. The responses that we see in lettuce to environmental parameters should be similar in the other crops we are studying. We estimate similar responses with arugula and kale.

"We are looking at various ways to produce more compact leaves or elongated leaves with the use or far-red or blue light. This will allow growers to manipulate the plants based on consumer demand."

Looking ahead

Lopez said what has been learned with the crops from the OptimIA project will help in the studies that will be done with culinary herbs.

"Culinary herbs are much more diverse than the crops we are studying in the OptimIA project," he said. "The environmental requirements for herbs vary considerably. Some do very well under high temperatures. Others require cooler temperatures. Photoperiod can induce some into flower. What we have learned from the OptimIA project will give us some good starting points so that we aren't guessing as to where we need to begin with the various herbs we plan to study."

For more: Roberto Lopez, Michigan State University, Department of Horticulture; rglopez@msu.edu; https://www.canr.msu.edu/people/dr_roberto_lopez?profileDisplayContent=contactInfo.
Devin Brewer, Michigan State University, Department of Horticulture, brewerd9@msu.edu.