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FEATURES

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Combatting Lettuce Tipburn With a Biostimulant

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Tipburn is the necrosis and curling of inner, newer leaf edges at the lettuce crown (Figure 1). It worsens as lettuce continues to mature. If not addressed in time, it results in a largely unmarketable crop. Tipburn is a headache to many hydroponic growers specializing in head lettuce production. Even cultivars advertised as “tolerant to tipburn” or found to have minimal tipburn in research trials can inevitably develop tipburn under conducive environmental conditions. To combat tipburn, we must understand its cause and effect.

Figure 1. Symptoms of tipburn in lettuce Rex grown hydroponically in a greenhouse.

A deeper understanding of tipburn

Tipburn is caused by calcium deficiency. Because calcium is an immobile element, it cannot move from older leaves to newer leaves. As a result, when calcium is deficient in the plant, newer leaves near the meristem show symptoms first, while older leaves at the bottom are unaffected. Counterintuitively, adding more calcium in the hydroponic nutrient solution is not guaranteed to control tipburn. Tipburn can still occur despite sufficient calcium in the solution.

In most instances, tipburn results from an imbalance of calcium demand exceeding calcium supply at the shoot tip due to environmental conditions. Calcium is taken up from the root to the shoot via the xylem through mass flow, a process of water movement driven by transpiration. Both high humidity and stagnant air movement inhibit transpiration and thus calcium uptake and supply to the shoot tip, causing tipburn to occur. In addition, high light and/or high temperature increase the plant growth rate and thus calcium demand, which can exacerbate tipburn.

Current strategies vs. a novel biostimulant

Current strategies combat tipburn by alleviating these factors, but not without limitations:

■ Foliar spray of calcium chloride delivers calcium to the shoot tip, which lacks calcium. However, it may not

get into inner, newer leaves of tightly enclosed head types of lettuce. Wetting plants may be undesirable for disease management.

■ Vertical airflow fans installed above the plant blow air downward to disperse humid air away from the shoot tip and thin the leaf boundary layer to increase transpiration. However, they're bulky to install, consume electricity and block light in greenhouses.

■ Precise humidity control optimizes transpiration. However, it's technically difficult and costly in controlled environments.

■ Decreasing light and/or temperature slows down plant growth, decreases calcium demand, and thus delays tipburn, while harvesting early avoids tipburn. However, both come with a yield penalty.

As an alternative, my team has identified a novel biostimulant to be highly effective at combatting lettuce tipburn with little to no yield reduction when it's added to the hydroponic nutrient solution. This chemical-based, calcium-mobilizing biostimulant is a commercial product developed by Croda, Inc. It has calcium, zinc and proprietary calcium mobility technology to facilitate calcium movement within the plant. It does so by activating ion transport channels on cell membranes and allowing calcium to be transported from cell to cell, in addition to the typical transport path between cells as determined by mass flow and transpiration.

Greenhouse hydroponic studies

In a series of replicated greenhouse experiments on hydroponic lettuce throughout the year, the biostimulant markedly reduced tipburn incidence and severity with little to no influence on shoot fresh weight (yield).

In summer (late July to early September), we grew green leaf lettuce Rex in deep-water-culture hydroponic trays in a greenhouse at an average air temperature of 77F (25C), an average relative humidity of 75% and an average daily light integral of 22 mol·m−2·d−1. Plant roots were submerged in the same nutrient solution without (0 ppm) and with the addition of the biostimulant at two concentrations [22 (lower) and 220 (higher) ppm].

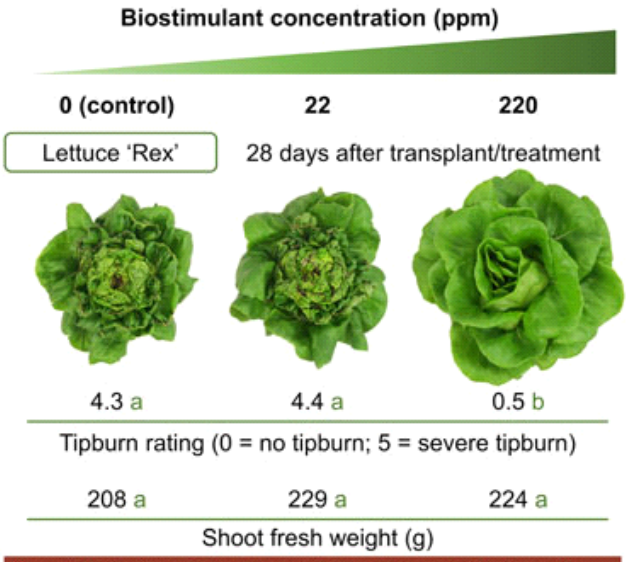

Figure 2. Adding the biostimulant to a nutrient solution markedly reduced the tipburn rating without affecting shoot fresh weight in greenhouse hydroponic lettuce Rex in summer. Numbers within each parameter followed by different letters are statistically different.

At 28 days after transplant/treatment, plants that had no or lower biostimulant treatment developed severe tipburn, even though calcium concentration in the nutrient solution was within the sufficiency range (Figure 2). In contrast, plants from the higher biostimulant treatment had an 88% lower tipburn rating and 85% fewer leaves with tipburn, while having similar shoot fresh weight when compared to plants without the biostimulant.

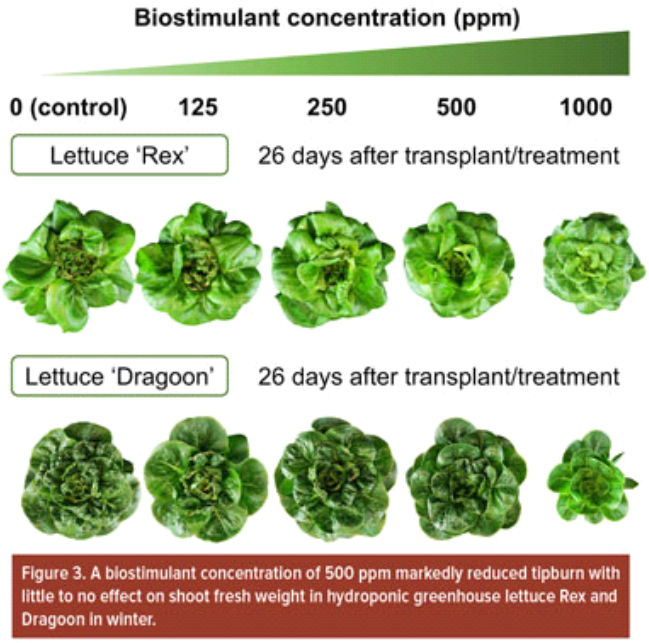

Figure 3. A biostimulant concentration of 500 ppm markedly reduced tipburn with little to no effect on shoot fresh weight in hydroponic greenhouse lettuce Rex and Dragoon in winter.

In winter (late December to early February), we grew green leaf lettuce Rex and Dragoon in deep-water-culture hydroponic trays in a greenhouse at an average air temperature of 77F (25C), an average relative humidity of 33% and an average daily light integral of 17 mol·m−2·d−1. Plants were grown in the same nutrient solution without (0 ppm) and with the addition of the biostimulant at four concentrations (125, 250, 500 and 1,000 ppm).

The highest biostimulant concentration stunted plant growth and was not recommended (Figure 3). At 28 or 35 days after transplant/treatment, increasing the biostimulant concentration from 0 to 500 ppm gradually decreased the tipburn rating by up to 71% in lettuce Rex and up to 85% in lettuce Dragoon. At 35 days after transplant/treatment, the biostimulant at 500 ppm did not affect shoot fresh weight of lettuce Rex and slightly decreased shoot fresh weight of lettuce Dragoon by 12% when compared to plants without the biostimulant.

Takeaways

The results across the experiments were consistent, demonstrating the high efficacy of this biostimulant at controlling lettuce tipburn with little to no negative effect on yield. Lettuce without the biostimulant had severe tipburn even in dry winter when light levels were sufficiently high under supplemental lighting. We used

greenhouse exhaust fans and horizontal airflow fans in summer, but not in winter. The increased airflow likely promoted transpiration to a certain extent, so a lower biostimulant concentration was needed to achieve comparable tipburn control in summer than in winter.

This calcium-mobilizing biostimulant is a highly effective solution to combat lettuce tipburn and bypasses the limitations of current strategies. My lab is continuing to work with Croda, Inc. to maximize its application potential in both greenhouse and indoor vertical farming environments. Growers who are interested in this biostimulant are welcome to contact me (qwmeng@udel.edu) and Dr. Susan Sun at Croda, Inc. (Susan.Sun@croda.com) for more information.

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