LEDStorm™

Advanced LED Technology • Customer-Driven Solutions

LEDStorm™ Grow Spectrum Light (with EMS Technology)

"A New Natural Approach to Lighting"

Light Comparison Testing

Spokane, WA

April 12-15th 2016

This was a test to show that the **LED**Storm PL11, 75w (Grow Spectrum Light w/EMS Technology), with its special array, can be used in a growth room to promote plant growth - similar to, or better than, conventional lighting (Gavita Pro 1000 DE, 1000w).

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Experimental Materials and Conditions

- We chose to use vegetative plants, C3 (GG4), in matching 5 gal soil medium. Plants were watered the same.

- One variety where both plants were of similar size, age, and condition. Both plants were grown, previously, under a HID light source, Gavita Pro 1000 DE (850w)

- 2 treatments: 1. **control** – conventional, HID Light (Gavita Pro 1000 DE, 1000w), and 2. **LED-** Light (LEDStorm PL11, 75w)

- Proximity to the lights: control-36", LED 18" from tallest point of each plant, and kept in separate rooms (8'x6') to avoid light bleed from either source.
  The positions of each light allow for their respective optimal performance.

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Experimental Materials and Conditions (cont)

Control: *(Gavita Pro 1000 DE) 1000w*

LED: ***LED****Storm* ***PL11, 75w***

(Grow Spectrum Light w/ EMS Technology) w/EMS Technology

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Procedure (Measurements)

After 24 hours of exposure:

A plant leaf from the top whorl, mid whorl, and bottom whorl of leaves from the control and LED plant were sampled. The leaves, and the leaves petioles (small stem directly attached to the leaf), were analyzed by a portable X ray fluorescent spectrometry (PXRF) using a Bruker Tracer SD III for both Macro and Trace elements. The Tracer demonstrates immediate results in real time. The spectra were compared, and are shown in the following slides. Ca and Zn (particularly Zn) are critical elements in plants for the synthesis of chlorophyll, promoting photosynthesis.

- To analyze sugar content, the same leaves were extracted and the dissolved solids measured by Refractometer (Brix).

- C3 or cool season plants accumulate sugars in their leaves while they are photosynthesizing and then dump them to the roots to keep actively photosynthesizing.

NOTE: This perhaps makes conditions more advantageous to have a light source with less heat. Let temperatures be regulated entirely by climate control.

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Hypothesis

By measuring the difference between the elements in the petiole (small stem directly attached to the leaf) and leaf of each plant we can effectively demonstrate how the EMS energy created by the LEDStorm light promotes better distribution of essential elements through the entire plant as compared to traditional HID lighting. Plants with high differentials are limited and will slow down the movement of food and water through the leaf. If the leaf is actively growing it will be moving food and water into the leaf and their will be very little in the petiole and most of the essential elements will be in the leaf. This is vital to the overall health and growth rate of the plant.

Results

Refractometer (Brix Readings)

Date	Treatment	Leaf Whorl	Brix Reading
April 14th 2016	Control	Top, Mid, Bottom	t: 6.1 m: 8.1 b: 6.0
	LED	Top, Mid, Bottom	t: 5.9 m: 6.6 b: 5.0
April 15th 2016	Control	Top, Mid, Bottom	t: 8.2 m: 5.3 b: 8.2
	LED	Top, Mid, Bottom	t: 6.6 m: 7.6 b: 6.4

Refractormeter (Brix) is a measure of the amount of dissolved solids in a solution and is often associated with the amount of sucrose, or sugar, in the leaf. The Brix clearly indicated that the plant under the LEDStorm light responds quite differently, and the LEDStorm exposed plant continued to increase more rapidly as it adjusted to the unique array of light energy. In conjunction with the following results of the Spectrometry reading from the Tracer, the leaves had greater density in the LEDStorm plant than the control which would account for the difference in the Brix readings. However, it also indicated that the dissolved solids and sugars were more evenly distributed through the whole plant under the LEDStrom light as compared to the control plant. In addition, there was far less differential between the petioles and the leaves in the LEDStorm plant as compared to the control.

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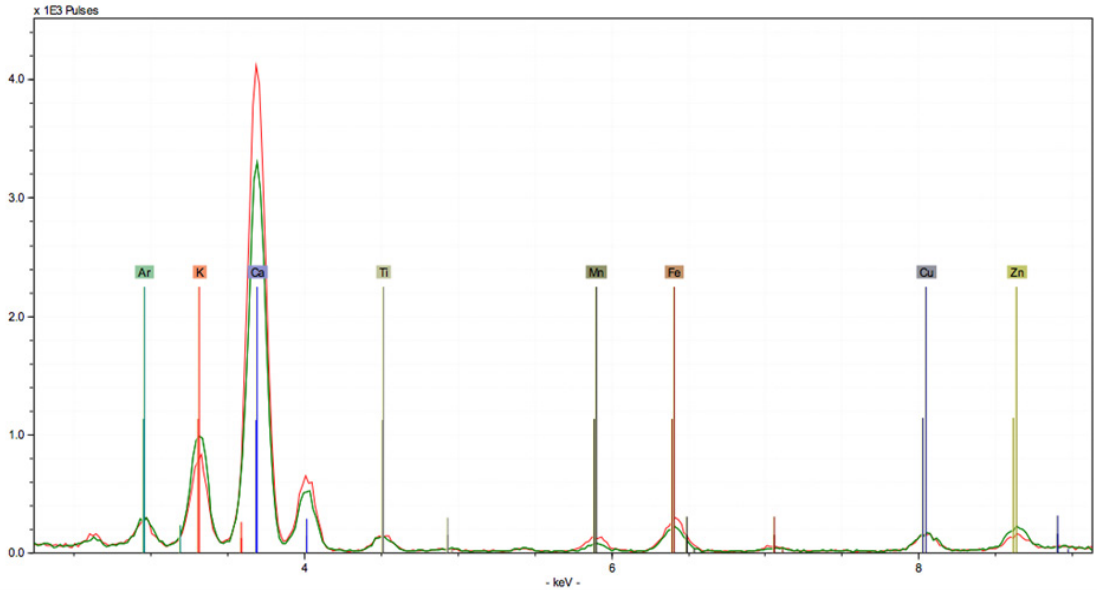
Results

(Spectrometry- Bruker Tracer SD III)

April 15th



Bottom Leaf

Green represents LED and **Red** control- April 15

The bottom control leaves were yellowing or beginning to decline, and it was very likely that the plant in the control environment was dehydrated and showing signs of water stress, which is why we see an increase in manganese (Mn) and iron (Fe) in the bottom leaves of the control plants – these elements cannot be moved easily and accumulate. The LED leaves seemed to be healthy and moving elements.

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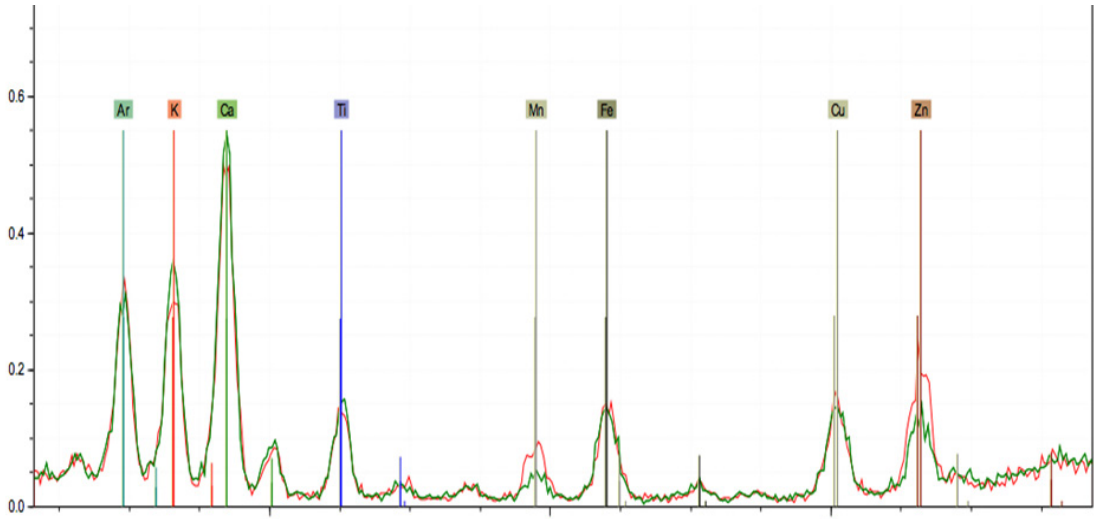
Results

(Spectrometry- Bruker Tracer SD III)

April 15th



Bottom Leaf Petiole

Green represents LED and **Red** control- April 15

The analysis of the bottom leaf petioles showed that the control leaves were definitely senescing and the LED bottom petioles were still moving K and Ca- or actively growing- suggesting that the LED light was penetrating the canopy.

LEDStorm, LLC, 15 Union St, Lawrence MA 01840, (305) 331-0458, E-MAIL: scottlgordon@ledstorm.com

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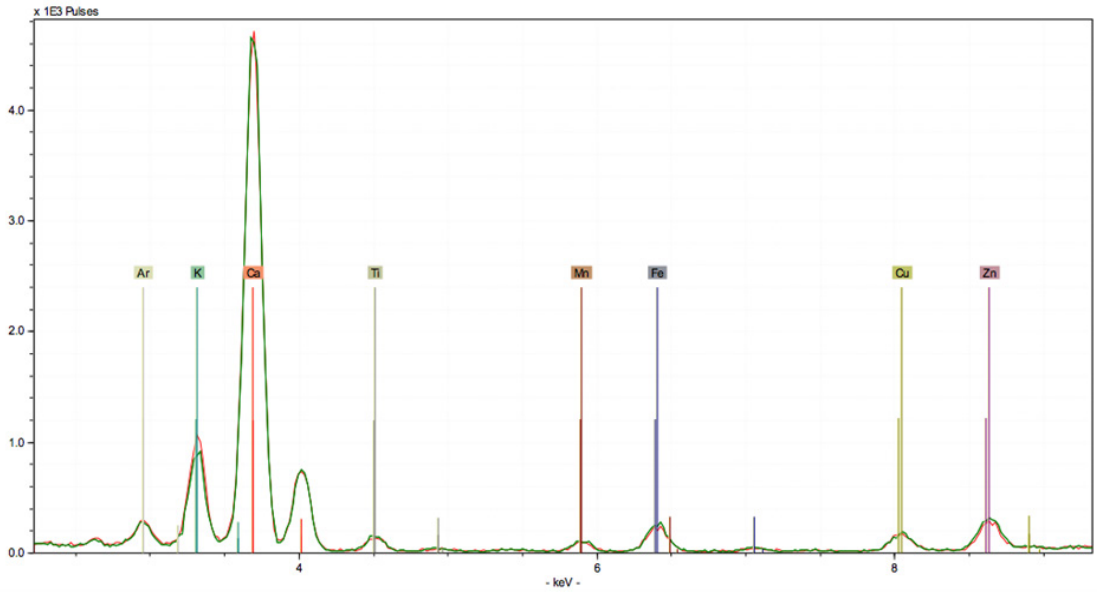
(Spectrometry- Bruker Tracer SD III)

April 15th



Middle Leaf

Green represents LED and **Red** control- April 15

The mid plant whorl of leaves are considered the most actively photosynthetic. As the plant grows, the next upper whorl of leaves will take over, and the lower leaves will eventually start to feed the reproductive growth. The plant can generate more power if all the leaves have access to photosynthetic energy. There is no difference between treatments for the middle leaves.

This is the total elemental content for the control leaf that had the highest Brix. Clearly, elementally, there is no difference despite the Brix readings. The LEDStorm leaves were denser than the control – despite being watered the same, which also affects the Brix. This accounts for the slight differences of the Brix readings. This slide shows that elementally the middle whorl leaves from the control and LEDStorm plants were the same.

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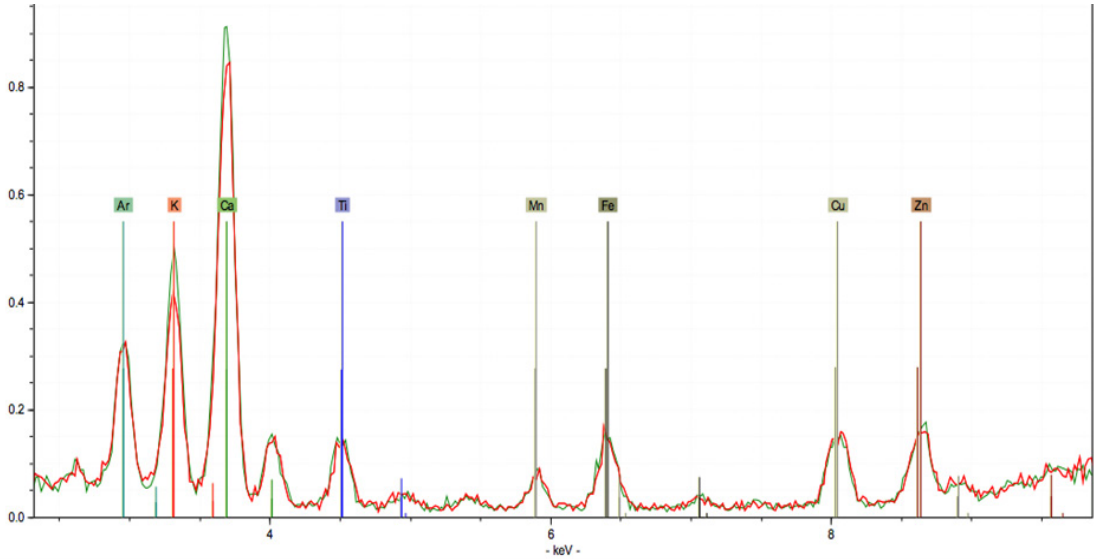
April 15th



Middle Leaf Petiole

Green represents LED and **Red** control- April 15

Middle leaf petiole - this slide shows that the middle leaf whorl petioles were very similar in content but that the LED plant was moving more K and Ca to and/or from leaves. This suggests more active growth for the LED plant.

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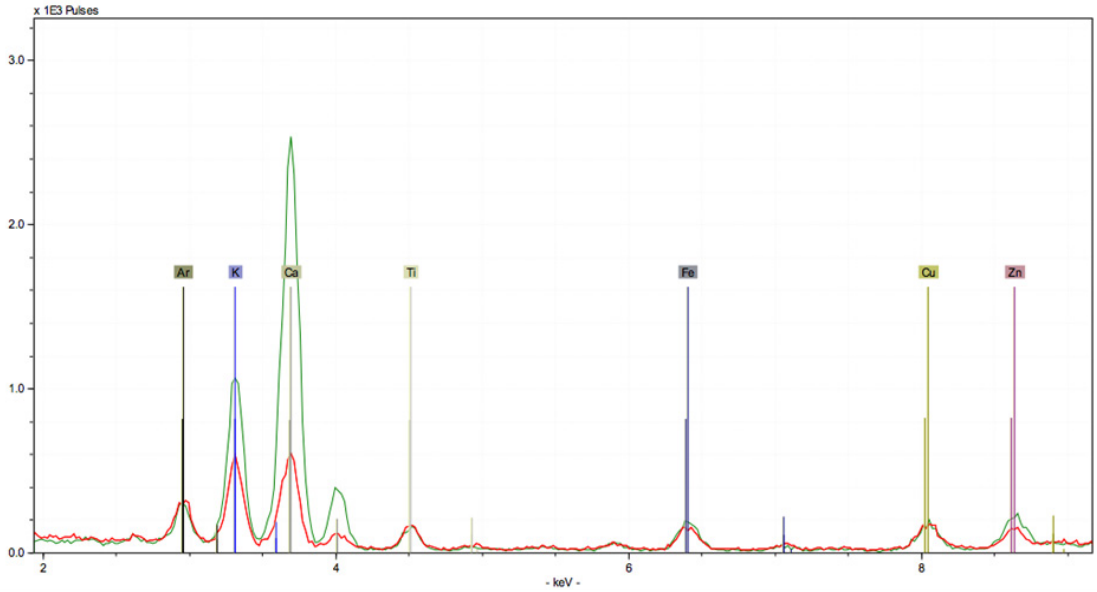
April 15th



Top Leaf

Green represents LED and **Red** control- April 15

Comparing the PXRF spectrum between the LED and control leaves, shows how much more potassium (K), calcium (Ca) and zinc is in the LED leaf compared with the control.

This comparison of spectra clearly shows that the LED top leaves were more mature (more K, Ca, and Zn) than the control leaves. Zn is a required element for making chlorophyll, as is K and Ca – this means that the LEDStorm treated plant also had more chlorophyll in the leaves. The top leaves of the LEDStorm plants are more mature compared with the control plants, and therefore contributing to the overall energy of the plant.

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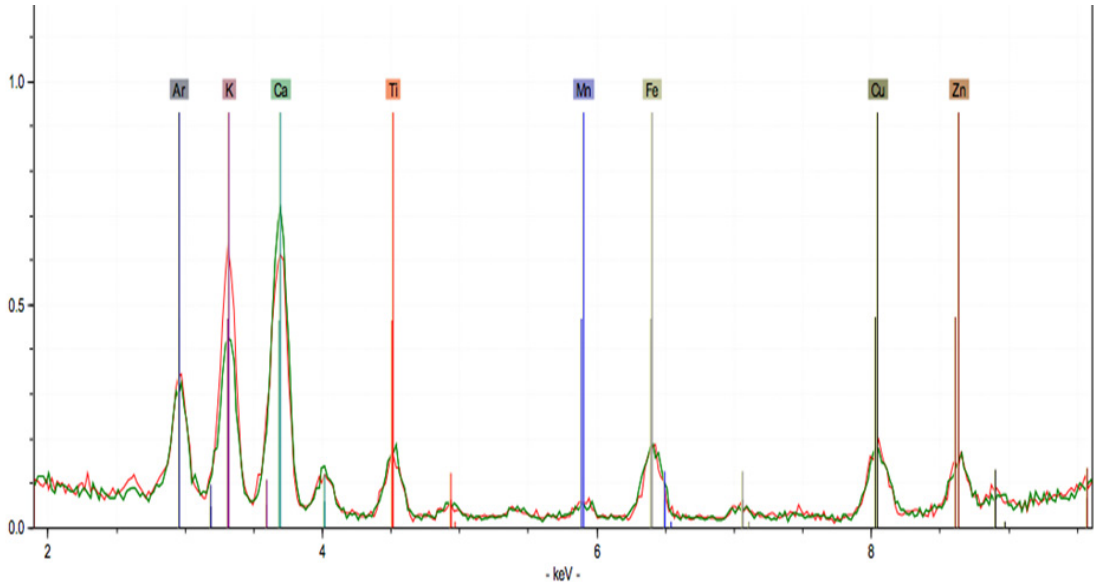
Results

(Spectrometry- Bruker Tracer SD III)

April 15th



Top Leaf Petiole

Green represents LED and **Red** control - April 15

This slide compares the amount of key elements in the petiole (stem immediately attached to the leaf) showing that the control leaf is moving more potassium (K) whereas the LED leaf is moving calcium (Ca). Ca as an element regulates water uptake, and growth in length.

The top fully expanded leaf petioles- were similar between both plants- the differences are related to the level of maturity. When we compare (first slide), the amount of these elements in the leaf compared with the petioles for each treatment, we see that the top leaves of the LED plant are more actively growing- given the amount of K and Ca that is in motion between the leaf and petiole compared with the control plant.

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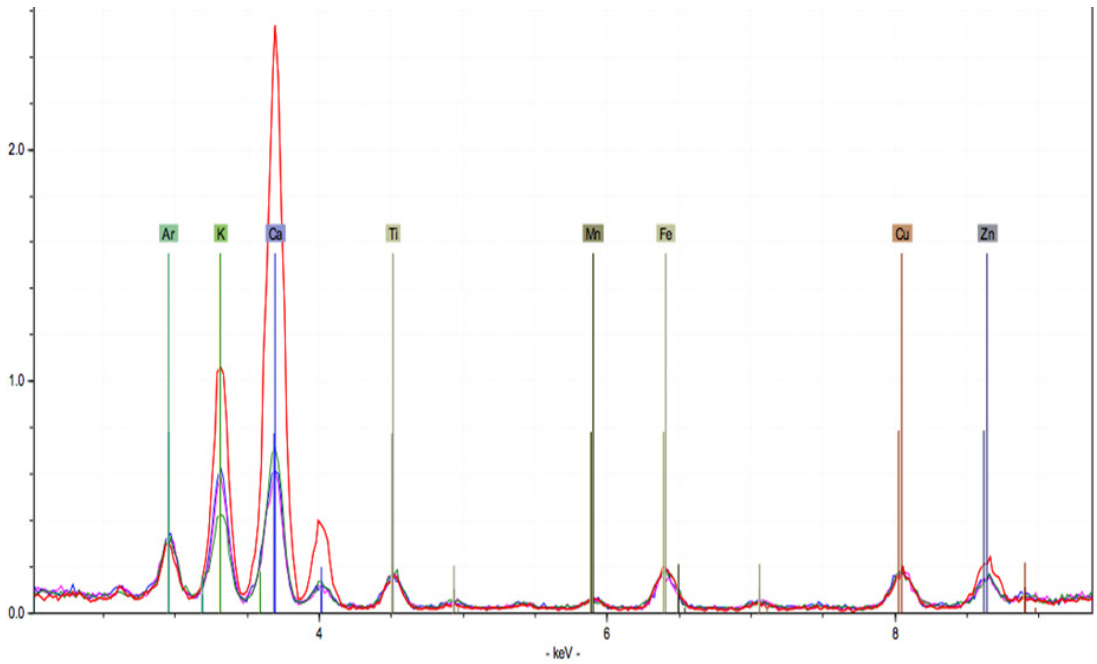
Results

(Spectrometry- Bruker Tracer SD III)

April 15th



LED and control top leaves and petioles

Green represents LED and **Red** control- April 15

This slide shows the PXRF spectra from the LED and Control leaf and petiole in an over lay. The elements shown are Argon (Ar), potassium (K), calcium (Ca), titanium (Ti), manganese (Mn), iron (Fe), copper (Cu) and zinc (Zn). LED top leaf (red), petiole (green); Control top leaf (pink), petiole (blue). The spectrum for the LED top leaf also shows that the leaf was more dense- These results clearly display significantly less differential in the LEDStorm plant as compared to the control. The graph clearly shows the LEDStorm leaves have more K, Ca, and Zn compared to the petioles, whereas the control plants have similar amounts of elements in both leaves and petioles. This demonstrated that the upper leaves of the LEDStorm plants were functioning (moving solutes) compared with the control leaves. The large difference in total elemental content between the petiole and leaf from the LED compared with the control leaves also confirms increased maturity.

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Discussion

This was a preliminary test to show that the LED lights (LEDStorm PL11, 75w), with its special array can be used in a growth room to promote plant growth – similar or better than the conventional lighting (Gavita Pro 1000 DE, 1000w).

The LEDStorm PL11 exposed plant responded with increased growth and maturity compared with the control. The LEDStorm plant also had far less of a differential, than the control plant, between the petioles and the leaves throughout the entire plant.

It is recommended to expand testing with more replicates and plants in both reproductive and vegetative states.

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Conclusion

- Based on this preliminary test- the **LED**Storm lighting (PL11, 75w) increased the rate of plant growth compared with conventional HID lighting (Gavita Pro 1000 DE, 1000w).
- The opportunity for manipulating spectra to affect plant secondary metabolism is also possible with the **LED**Storm PL11 lighting system.
- This experiment suggests that **LED**Storm lighting can be used in growth rooms instead of conventional lighting.
- **LED**Storm lighting also appeared to increase the rate of maturity in vegetative phase.
- Plants exposed to the EMS (Electromagnetic Spectrum) wavelengths produced from the **LED**Storm fixture appear to grow faster, more efficiently, and are exposed to less temperature extremes which is also more conducive to the growth pattern for a cool season C3 plant species.
- Increased growth rates
- More photosynthetic capacity
- Less drought stress