Side by Side Spectral test Sativa (South African Rose) using standard cultivation processes and AirROS by SAGE Industrial Corp

Emerald Metrics Spectral Test

SAGE Industrial Corp,
AirROS GroShield Series

Chris Rushing

AirROS BY SAGE INDUSTRIAL

Table of Contents

Overview

Testing crop inputs is difficult to measure as results are typically obtained at the end of the growth cycle and only measured in yield. When a cultivator visually sees a problem (damage caused by input, process, disease, etc.) the crop always takes a loss in labor cost to resuscitate the damaged areas, product loss where it can't be corrected, or a combination of both. In the event a positive effect takes place, the grower must again rely on visual assessment to determine what occurred. Even when harvest weight assessments or lab assessments indicate an increase, the results are highly scrutinized as the cultivator is not able to pinpoint what action caused the effect. Emerald Metrics provides unique spectral imaging designed specifically to visualize how the plants are interacting with changes (environmental, SOP, nutrient, additives, etc.). Images taken at a constant interval provide visual confirmation in a selected spectral index and in RGB. This imagery will be used to track the growth cycle, monitor growth stress and determine if Powdery Mildew (PM) is able to grow and spread in the observed room. Emerald Metrics, AirROS, and KBB Farms are collaborating to test the AirROS unit on a cannabis Sativa strain "South African Rose" during the flowering phase of the cycle, using the Emerald Metrics CannaIntelligence system.

NOTE: Emerald Metrics is an independent company that documented and codified data for an independent outcome. Emerald Metrics does not own or otherwise have financial interest in Sage Industrial Corp, its parent company, or any subsidiaries.

History

KGB Farms and Emerald Metrics conducted an initial visual and olfactory trial utilizing the AirROS product in the initial installation prior to the test. Both organizations observed the Air ROS unit eliminated cannabis odor to a level that employees remarked *" it is strange to work in a cannabis facility that does not smell like cannabis"* Both companies asked employees to scent test the room and all confirmed that the scent was eliminated, not covered. "It completely eliminated all odor of cannabis".

Sage Industrial Corp

SAGE Industrial Corporation is a Clovis, CA. (Fresno) based company that manufactures Surface & Air Purification Equipment. MADE in the USA! For over 15 years they have applied technology to Destroy, Purify, & Defend perishables including Fresh Fruit & Vegetables, Nuts, Wine, Flowers, Meats, Poultry, Seafood, and **Cannabis** and have over 7,000 units installed worldwide.

AirROS by SAGE purifiers create and utilize **ROS** (Reactive Oxygen Species). ROS is a group of oxygen byproducts that are highly reactive and have strong antimicrobial properties which organically (without using consumable chemicals whatsoever...**100% ORGANIC**) will indiscriminately destroy, purify & defend against bacteria, molds (BOTRYTIS, POWDERY MILDEW, ASPERGILLUS, etc.) viruses, and other pathogens, and Eliminate/Neutralize ODOR and VOC's.
The purifiers are compact, ultra-low energy efficient and will effectively treat/sanitize facilities of all sizes ranging from small indoor grow/processing rooms to large multi-acre greenhouses. The systems quickly and effectively sanitize both **SURFACES and AIR** in Greenhouses, Mothering, Cloning, Veg, Flower, Drying and Trim/Processing rooms. All indoor areas of grow and processing.

Emerald Metrics

Emerald Metrics utilizes unique spectral imagery to identify pests, pesticide, disease, nutrient issues, etc., beyond what the eye can see. We see what the plant is doing and how it is reacting in real time. We provide that actionable intelligence so the producer can maximize the operation. We help producers increase yield, reduce input cost, increase quality, and decrease risk. Spectral imaging is not new, the body of work including the use of satellites to detect crop health dating back to the 1970's. The U.S. government including NOAA, DOD, NASA, USDA and large and small farms and crop production companies use satellite and aircraft based spectral imagery today as a cornerstone of precision agriculture systems. While this technology has improved significantly over the course of

time, Emerald Metrics and its partners worked to reduce the size and cost of the systems to something that is affordable and scalable.

Spectral imagery produces results based on how light interacts with a target substance and how it can be seen through machine vision in sections of the spectrum not visible to the naked eye. Humans see in a very narrow section of the electromagnetic spectrum; however, machine vision allows us to see in other parts of the spectrum where these interactions of light show damage, health issues, chemical substances, metals, disease, etc. The software identifies specific anomalies and displays them in a colorized form we can see and make decisions on. Emerald Metrics systems have embedded AI that allows for the recognition of these anomalies combined with targeted spectral code to provide accurate and immediate results.

KGB Farms

KGB Farms was established as a medical grower in 2015 in Portland Oregon and was transitioned to a Tier II indoor hydroponic operation. KGB Farms is a unique craft producer that utilizes unique strains and high-technology systems to increase yield and quality for customers. KGB Farms took the position early that quality craft cannabis has a strong place in the larger market space but in order to be successful, the industry would need to drive technology development that brings return to both the cultivator and the customer. In addition to its consumer production, KGB tests and implements technology, processes, and products that demonstrate a clear value to cultivators and ultimately the customer.

Tryon Creek Software

Tryon Creek Software, LLC is a professional development services company based in Portland, OR. It serves clients worldwide including across the USA, Great Britain, India, and Malaysia. The company provides US-based software development services including consulting, design, engineering, project management, and quality assurance for Enterprise. The company was founded on the principles of Integrity, Creativity, and Quality. It differentiates itself based upon its professional approach to software development activities as well as its high standards for the products that it collaborates on with its external clients. Its engineers each have over a decade of experience. Tryon clients include Adidas, Cigna, Blue Cross/Blue Shield, CHS, McAfee, Comcast, Time Warner Cable, Spectrum Co., and many others

Test Preparation

Prior to test, the South African Rose strain will be prepared in the prescribed manner used by KGB Farms to ensure standard, equal growth. When transitioned to room 2b, Emerald Metrics will begin imaging to create a baseline prior to flower phase. When “flipped” to flower phase, the test will start, and imagery will be taken on a standard timeline.

The test is designed to collect standard data and spectral imagery for comparative analysis. The Cannaintelligence system calendars are set with tags and alerts for the entire test cycle.

Standard Functional Information:

Item	**Schedule**
Lights - Metal Halide Phantom	12 hours on, 12 hours off (3pm-3am)
Nutrients -	*KGB Proprietary*
Temp – 77	Daily Review
Humidity -39	Daily Review
Reservoir – Table Flood & Drain	Changed Weekly
Ph - 5.6-5.7	Daily Review
Medium -Hydroton Clay Pellets	Standard

Emerald Metrics Imager Specifications:

Specifications
-Firmware Version: 1.69
-Bootstrap: 1.31.0.140
-Relative Exposure: 310 (variable through cycle)
-Image Type: RGB/NDVI/Veg Segregation
-Calibration: RobsRoomFinal CPF/Robs Base ICP
-Min .18 Max 1
-High Resolution

The Schedule for all imagers is set to high resolution imagery with an image taken every hour. One Imager is mounted and positioned on the "Light Rail" system that travels the length of the room at a rate of 4ft per min. Two imagers are set to image the length of the room to monitor trend. Images collected over the course of time will be compared and select images will be placed into the document. Although Imagery is taken daily, this report will compare imagery on a periodic basis, or upon discovery of a significant issue/finding for brevity. The Callaintelligence system maintains a full image bank of daily collection for comparison.

NOTE 1: Imagers may be booted every Sunday to ensure long term processing. This may change the individual time, but it will remain hourly image cycle.

NOTE 2: Out of cycle images may be taken for test, clarification, additional view etc.

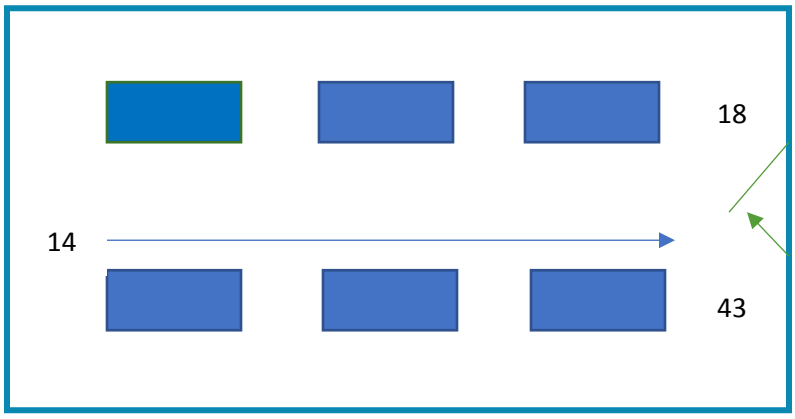
Emerald Metrics will collect multi-spectral imagery through the Canaintelligence system to and provide image data to determine how the plants react to the product and whether Powdery Mildew (PM) is prevalent.

NOTE 1: As the initial unit was physically installed and calibrated, the room for test was permitted to grow without controls for PM. This was done to ensure that the room could grow PM if controls were not in place. Typically, Standard Operating Procedures (SOP) preclude growth.

Initial Observations: Initial visual observations of the plants by employees of KGB Farms and Validated by independent members of Emerald Metrics, as well as pre-test spectral imagery indicated:

1. Each table sets contained healthy South African Rose Sativa Plants (10 Plants per table, 60 total)
2. Both table sets are currently using the same methods, processes, SOP, lights, environmental controls etc.
3. The room has the AirROS unit active and calibrated

The room and tables are set up in the following configuration with imager 14 integrated into mobile rails conducting side by side imagery using 43 and 18 from the side. (Diagram below).



Method of Operation

Emerald Metrics, KGB Farms, and SAGE Industrial teamed for a test project to determine if using AirROS unit will impact the growth of a selected strain.

-SAGE Industrial Corp: AirROS unit
-KGB Farms provided: Active testing location and plant strain South African Rose Sativa
-Emerald Metrics provided: Cannaintellignce multi-spectral imaging, dashboard, daily review/processing and reports.

Test Size: A Micro Test is selected to demonstrate value at the smallest possible level.

The Operation will consist of:

1. Utilize KGB room 2b with integrated Emerald Metrics imagers 18, 43, and 14 to monitor plants though the flower cycle
2. Utilize Strain South African Rose Sativa
3. Monitor and image pants through the flower cycle to observe for PM
4. Image hourly through the flower cycle
5. Collect daily secondary data sets for trend analysis
6. Corelate imagery and secondary data sets

Test Goals:

1. Conduct olfactory test to determine if the product eliminates odor
2. Image the plants hourly to ensure standardization and comparison
3. Correlate and compare image set daily for the individual imager and between the two imagers
4. Corelate and compare images to secondary data sets (Trendlines grid/pixel analysis)
5. Determine how the plants react to the AirROS product
    a. Determine if odor exists
    b. Determine if PM emerges or is prevalent through the course of the test
    c. Determine if plants are positively or negatively affected by the AirROS unit
6. Observations
7. Conclusion(s)/Recommendations
8. Test/Report Personnel

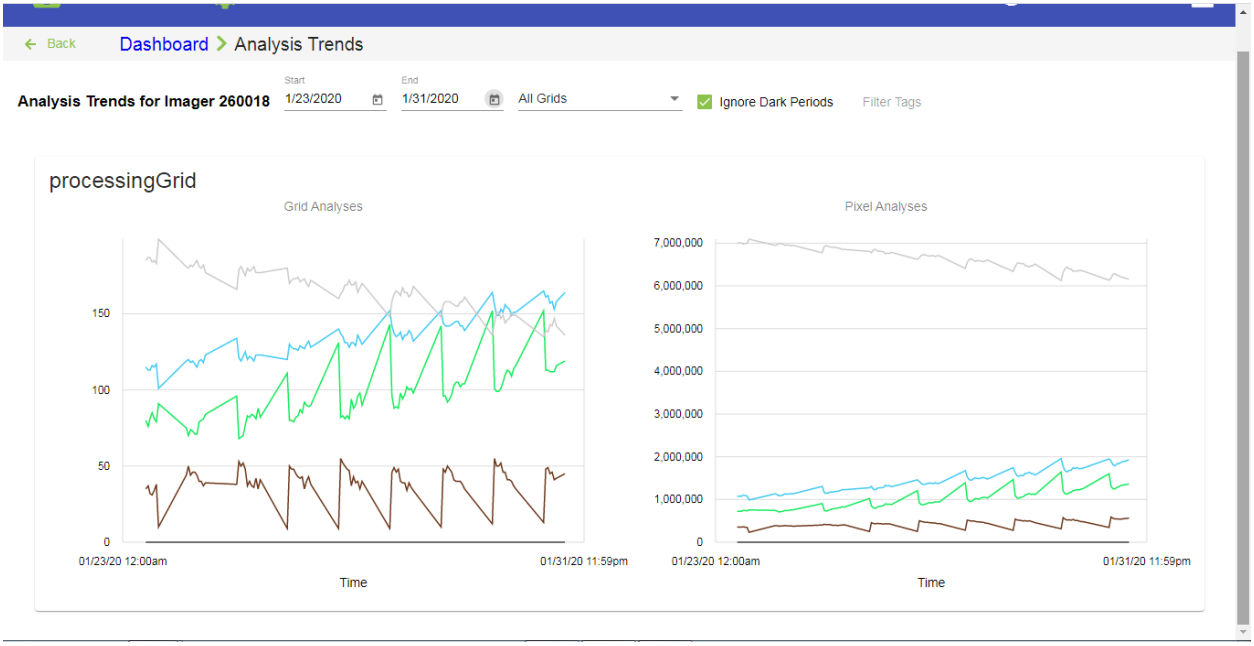
Trendline Analysis:

The Grid analysis and Pixel analysis both show trend analysis for a strong healthy grow cycle.

The Grid Analysis evluates imaged material in a larger format. This is generally used when imaging a plant or series of plants. The grid analysis shows strong growth in both imagers, but the Field of View (FOC) differs for each which shows a slightly different profile.

The Pixel Analysis evaluates every pixel. Both imagers show the expected strong growth in pixel analysis and are expected to track nearly evenly.

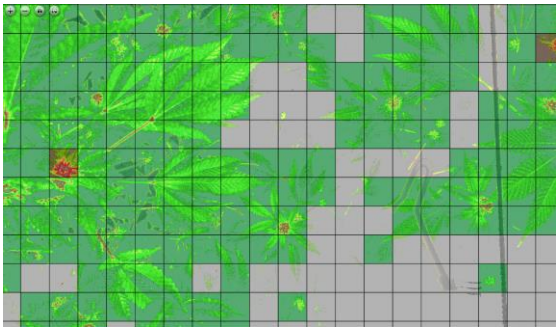
The Brown trend line at the bottom of the analysis shows the stressed/bad plant material. Often when initially planting the stressed or bad material is somewhat high and trends down. In this case the line did exactly as expected with the AirROS unit and both grid and pixel tracked down through the grow to very low levels. The Gray trend line starts very high and rapidly trends down, this line indicates no plant material. As the room is planted, only a small section of the grow will indicate as plant material. As the plants grow and take more space, the line trends down. Blue indicates total plant material which typically starts low and trends up. Green indicates healthy growing plant material and should track with the total plant material. This grow demonstrates a strong disease free operation.



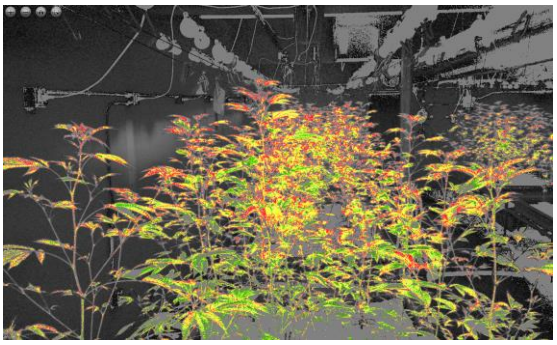
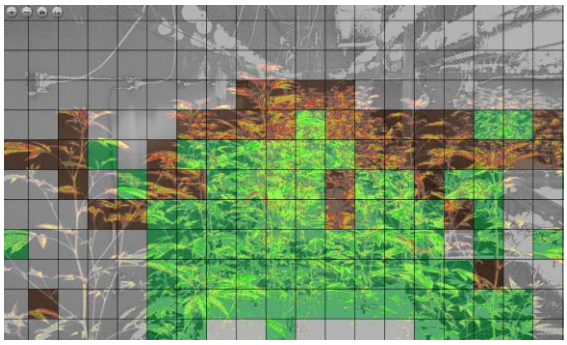
Week 1

The Initial Grid and Pixel analysis display is as expected with high level of no plant material and what is considered high levels of stress due to transplant in the grow room. Through the course of the week the no plant material trends down as the plant and healthy plant material trends up. The stress/bad plant material begins to trend down.

1-23-2020




Initial imagery shows plants are growing well.

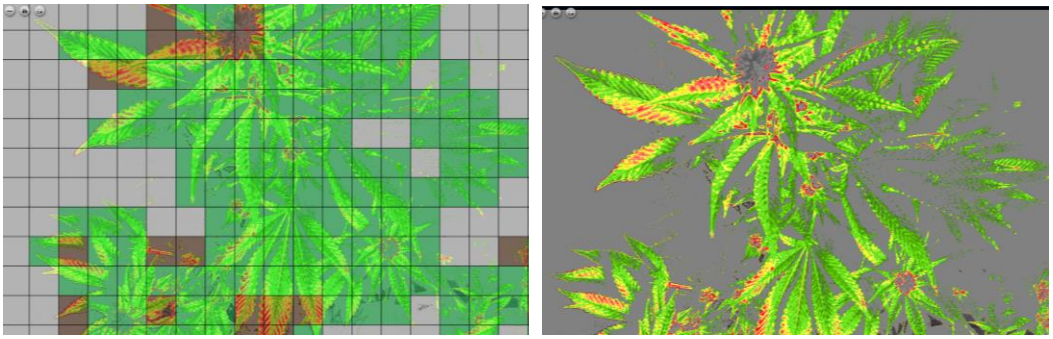



Initial imagery shows the plants are stressed from transplant, but are not infected with PM.

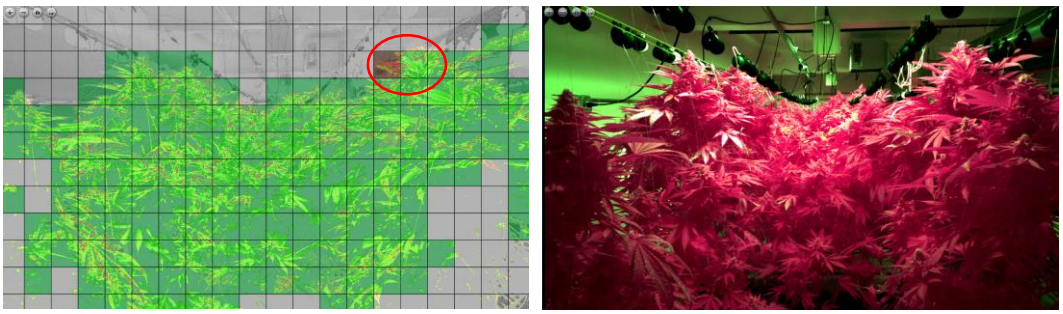
Week 4

Into week 4 the trend indicates the stressed/bad material has been eliminated and strong, healthy material is increasing.

2-13-2020



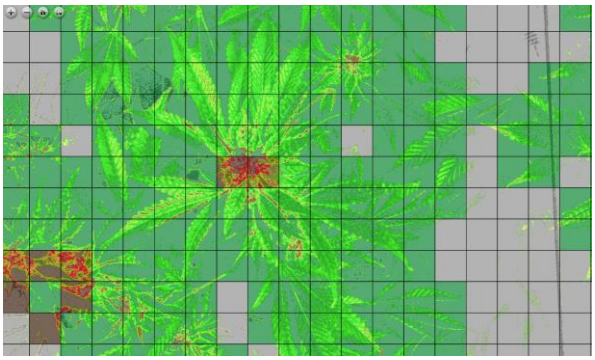
Imager 14 showing close up of plant material. No PM detected.



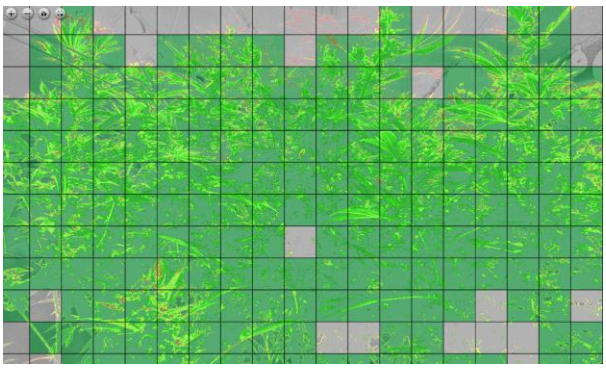
Imager 18 showing spectral and filtered RGB image. The AirROS unit eliminated disease in the room leaving only a small section with heat damage noticeable in the spectral image.

Week 6

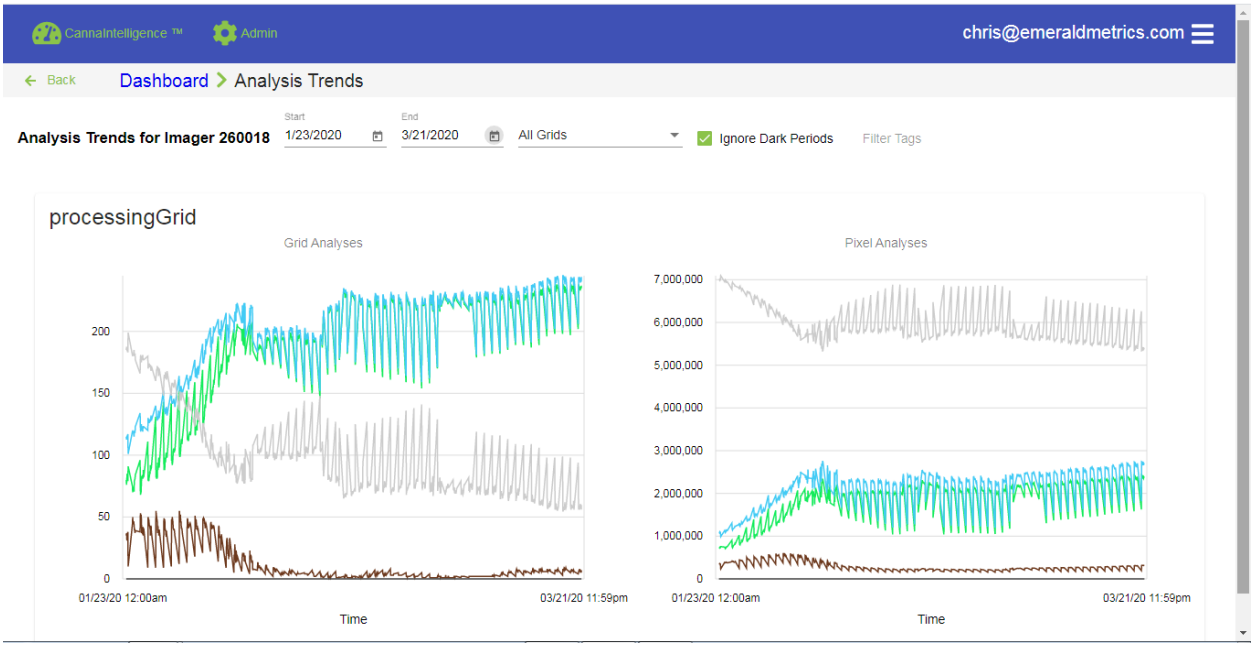
2-29-2020



Imager 14 showing close up of plant material. No PM detected.

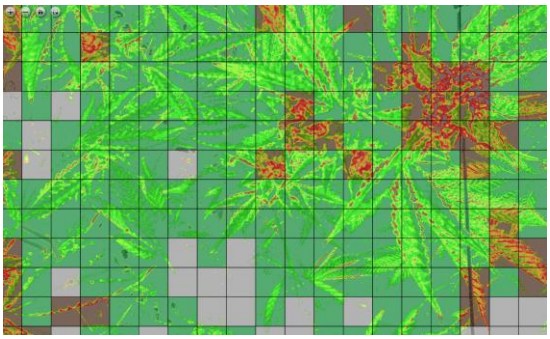


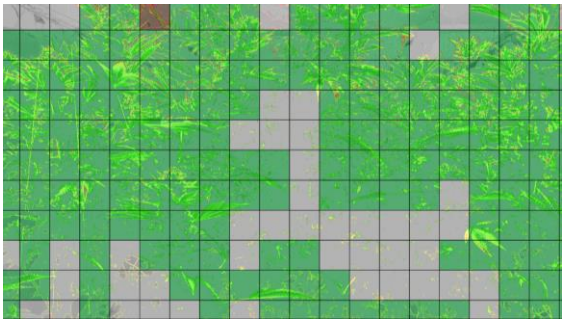
Imager 18 showing spectral and filtered RGB image. The AirROS unit eliminated disease in the room. This image shows no disease or damage which is unusual for a standard operation.

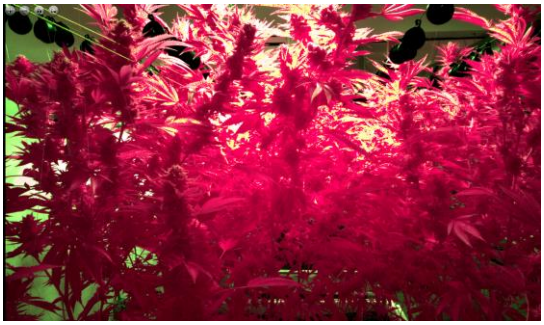


Week 9

3-21-2020







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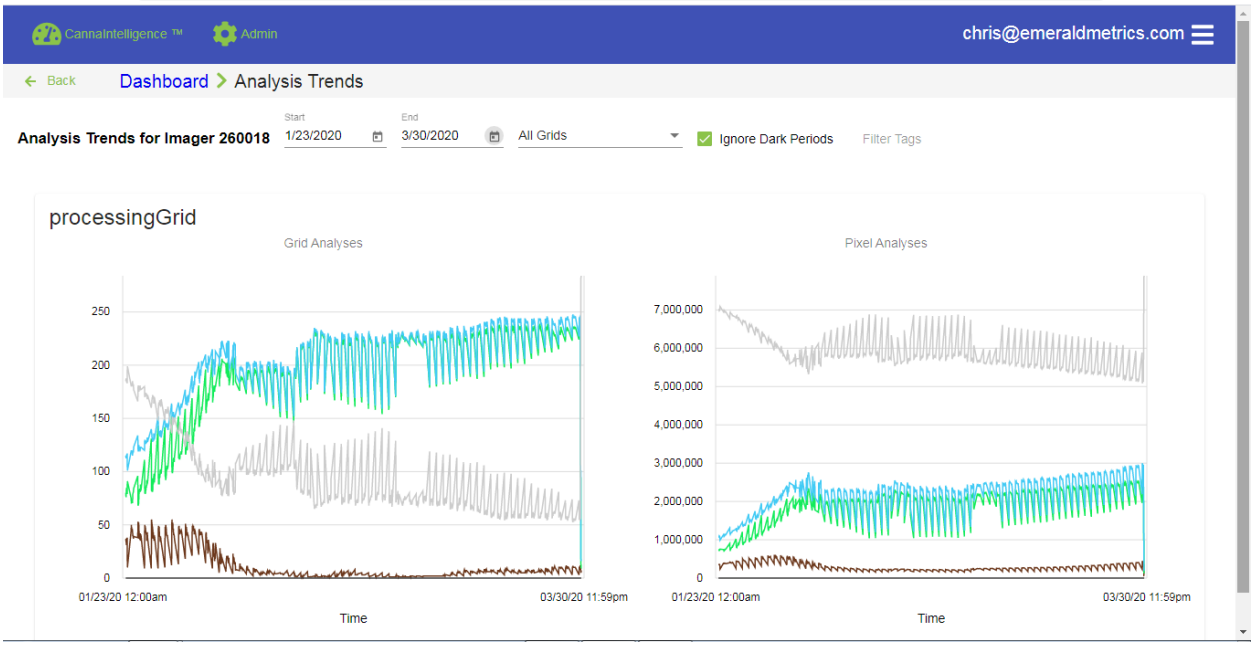
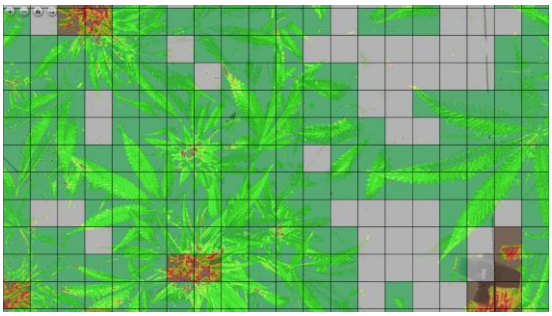
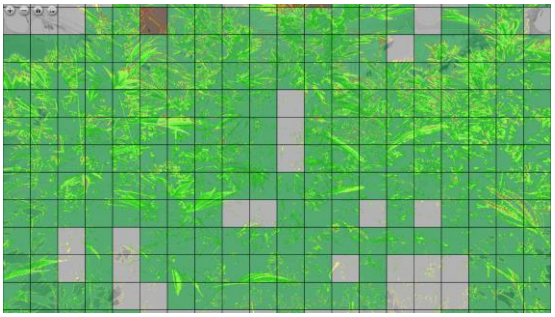


Week 11

3-30-2020





Imager 18 showing spectral and filtered RGB image. The AirROS unit eliminated disease in the room. This image shows no disease or damage which is unusual for a standard operation.

Results

Test Goals:

1. **Demonstrate the room used will cultivate Powdery mildew prior to official test**
   (A) Completed: Imaging of plants pre-test was conducted in order to determine a baseline of reading and calibration for accuracy. System was calibrated for standard NDVI, filtered RGB, Green NDVI and vegetative segregation. This included removing back end safeguards and protocols for PM
2. **Image the plants hourly to ensure standardization and comparison**
   (A) Completed: Plants were imaged on an hourly basis through the course of the cycle.
3. **Correlate and compare image set daily for the individual imager and between the three imagers**
   (A) Completed: Images were reviewed daily and corelated for comparison.
4. **Corelate and compare images to secondary data sets**
   (A) Completed: Multiple image sets using several spectral end member libraries were used to determine overall health, search for PM and monitor growth.
5. **Determine how the plants react to AirROS**
   a. Determine if health of plants increase (Potential Positive Effect)
      (1.) Completed **Positive Effect.** In all cases, the health of the plants manifested positive and provided increased value. Direct observation of the plants for disease showed no visible PM. The test room remained disease free during the grow so no correlation could be made between product use and independent plant strength against disease. It is known in agriculture that plants that grow weakly from issues in genetics, general health stress, etc., become more suspectable to disease pressure.
   b. Determine if volume of plants decrease (Potential Negative Effect)
      (1.) Completed **No Negative Effect**. There was no decrease in plant volume. To the contrary, the product showed immediate and long-term benefit to the plants during the grow operation. This was demonstrated through the lack of PM without secondary controls (**NOTE:** *Emerald Metrics does not recommend replacing strong SOP, IPM or disease mitigation strategy by any single product)*
   c. Determine if health of plants decrease (Potential Negative Effect)
      (1.) Completed **No Negative Effect**. There was no negative effect on the plants observed. To the contrary, the product showed immediate and long-term benefit to the plants during the grow operation.
   d. Determine if there is no comparable effect (Potential Neutral Effect)
      (1.) Completed: **No Neutral Effect.** As indicated in the previous sections, the use of the AirROS product positively impacted the plants in all sections.

6. **Observations**: The AirROS product performed as advertised eliminating PM through the course of the grow cycle. Spectral imagery provided unique and real time information supporting the strong, healthy growth. Upon execution of the test and within the first week, the plants rapidly trended healthy, much faster than we typically see without the unit. Additionally, by the 4th week the plant showed healthy to a level we have not seen in the past. This level was maintained throughout the cycle which is also incredibly difficult to do.

7. **NOTE: Upon initial installation of the AirROS system, the Parts Per Million (PPM) must be adjusted for the size of the room and the volume of plants growing within the space. The test room used in KGB farms is a strong production room with a large number of plants in a confined space. This had the effect of reducing the efficacy in the initial activation (prior to test) The SAGE Industrial technicians immediately responded to adjust the PPM to the unique specifications of the room. Once adjusted the unit operated and without issue.**

8. Conclusion(s)/Recommendations

The AirROS product performed well and provided good return on investment as described in the preceding sections.

- Are the purported effects of AirROS definitively connected to the product or are they linked to other factors (strain, environment, SOP, etc.)?
  - Answer: Yes, the room was tested prior in order to release conditions and determine if PM would propagate without controls. This eliminates the opportunity to claim the room, SOP, or external items could skew the test. Conditions were identical except for the introduction of the AirROS unit and the release of operational PM controls. The spectral imaging monitored the actual plant reaction to the product. This eliminates questions as to the efficacy of the product vs external influences that can cast doubt on the product itself. The effects were attributed directly to AirROS

- Did the AirROS unit perform as advertised?
  - Answer: Yes. The AirROS test required more set-up than would normally be required for a standard unit. The unit needed to be adjusted to the unique conditions within the KGB Farms room in order to operate correctly. As this adjustment was being made the question arose, '*How do we know PM is an issue in this room if we don't have PM in the room."* As this could potentially skew the result (positive or negative), KGB Farms took the extraordinary step to release standard controls on the room prior to activating the AirROS unit to determine if PM would take hold. Although it is understood that this would and did create a PM infection in the test room, the collective group felt the demonstration was vital to eliminating any question as to the room specification prior to test. Once complete, the room was cleaned, planted and activated for the test. The AirROS unit was activated and no PM was record during the course of the test.

  NOTE: KGB Farms is recognized for their willingness to provide the location for test and the willingness to risk profitability to provide a complete and accurate test.

- Can the AirROS decrease in the odor of cannabis?
  - Answer: Yes, the AirROS system eliminated the odor of cannabis in the room it operated in. While olfactory testing can be deemed subjective, all staff members were asked to evaluate the following:
    - Did the AirROS unit eliminate the cannabis odor?
    - Did the AirROS unit cover the odor?
    - Did the AirROS unit function to a level where a "passerby" would notice the odor of cannabis

    It was unanimously determined by staff that the AirROS unit eliminates the odor of cannabis completely in the space it operates. Additionally, the odor was not simply covered up by a secondary smell or cover, it was converted through the AirROS technology. It was determined that a "passerby" would not recognize a cannabis operation using AirROS units by smell. This is important when locations have ordinances that require odor mitigation or guidance requiring minimal public detection.

- Can the AirROS product increase general plant health?

- Answer: In terms of health as quantified by elimination of disease, yes. This test was conducted on a micro scale in a single room. It is well understood that general plant health is directly affected by disease pressure, but what is less well known is disease pressure reduces the ability for plants to defend against secondary disease and pest. Eliminating PM and other diseases directly affects the health of the plants. The Emerald Metrics trending graphs indicate rapid growth of healthy plant material and rapid reduction in stressed or unhealthy material. In future tests it would be valuable to determine comparative effect of equal operations and strains with respect to yield, THC percentage, waste comparison, etc.

- Does the AirROS product provide a good return on investment at scale?
  - Answer: Yes, as demonstrated the AirROS unit eliminated PM and odor from the active location. When compared to the cost of treating infected material, reduction in profitability, failure to maintain compliance with codes and regulations, the minimal cost of the AirROS unit was more that acceptable.

Why is this Test Important:

Testing systems that support growth is difficult to measure as results are typically obtained at the end of the growth cycle and only measured in yield. By the time a cultivator visually sees problems (disease) the crop takes a loss. In the event a positive effect takes place, the grower must again rely on visual assessment to determine what occurred and to what level. Emerald Metrics provides unique spectral imaging designed specifically to visualize how the plants are interacting with changes (environmental, SOP, nutrient, additives, etc.). Emerald Metrics sees the results real time.

This test was designed to answer some basic questions concerning the product and whether the product itself eliminates odor and Powdery Mildew (PM). While the product does indeed eliminate PM and odor, the AirROS product serves a more important role in the industry. As adoption and acceptance in the cannabis market becomes a reality, the product(s) are likely to become commodities with depressed pricing and profitability. Successful businesses will plan now for profitability and scale while regional pricing and emerging markets permit. There will always be a market for smaller, craft cannabis operations, however, as these markets solidify, businesses that have invested in technology and products that streamline cost and increase yields, reduce risk, and reduce input cost will survive.

9. Test/Report Personnel

Chris Rushing: Chris Rushing drafted the initial report.

Chris spent a career with the U.S. Air Force with experience in unmanned systems technology, intelligence, and presidential service. Upon exiting, he created and sold the first and highly profitable unmanned systems services company, and as President managed over 200 deployed personnel and multiple multi-million dollar government and commercial contracts. Most recently Chris managed a commercial agriculture intelligence operation including air, ground, design, and software functions for a Fortune 100 agriculture company. This contract required management of 30 direct staff culminating in 88% staff growth and 400% revenue growth. Chris has held a Top Secret. NATO Secret, and Yankee White Clearances and has 20+ years' experience in technology, unmanned systems and intelligence systems. Additionally, Chris has aided in the design and testing of sensors for DARPA, Northrop Grumman, and the Department of Defense and is a U.S. patent holder for spectral anomaly detection.

Brendan Joyce: Coordinated all Cannaintelligence software operations, collection, and correlations for the test.

Brendan ran his own consulting company until 1993 following which he held management positions at Symantec and Critical Path Software. Following the acquisition of Critical Path in 2010 by eBay, Brendan founded Tryon Creek Software. He has led dozens of successful projects including mission critical applications for Adidas, Apple, HP, Intel, Comcast, Spectrum Co. and NIKE, and health care software for Welch Allyn, Blue Cross/Blue Shield and Cigna. Brendan was instrumental in the success of the mainstream agriculture project prior to joining Emerald Metrics.

Rob McCorkle: Coordinated and provided the growing location, plants, staff and labor to complete the test. Rob set up the testing protocols and collected all data.

Rob spent 20+ years in Law Enforcement and is a retired Lieutenant/Commander from a large law enforcement entity on the West Coast where he gained extensive experience in legal and legislative process related to the passage and enforcement of various state and federal regulations. This experience includes testifying in front of various legislative bodies and writing/formulating laws, regulations and policies in a variety of areas including controlled substances. Rob holds a BS in Criminology and a MS in C.J. Administration and currently provides consultative services to various private entities and municipalities who are navigating the myriad of issues surrounding the growing opportunities in the cannabis industry. In addition, Rob is a Managing Member of a Tier II, 10,000 sq. ft. indoor hydroponic cannabis operation in Oregon.