



Cannabis Greenhouses

creating conditions which

with the DryGair Solution



Case Study



Intro

The innovative DryGair solution targets one of the biggest issues in greenhouse climate control: **humidity**. Plant transpiration occurring within the greenhouse produces moisture in the air. If not regulated properly, humidity condenses on plant surfaces, greenhouse structures, and equipment, and creates the necessary conditions for the development of **detrimental cannabis diseases including botrytis, powdery mildew, and hemp canker (white mold)** which damage quality and significantly reduce yields.

The DryGair solution offers an innovative way of managing humidity that is effective, energy efficient, and economical.

Ventilation: Not Always Possible

Traditionally, humidity is controlled in greenhouses by ventilation. Openings like windows or ventilating fans lead humid air from the greenhouse out to the open air. The humidity is lowered, but the introduction of outside air often leads to temperature loss as well, and this is problematic especially at night as the outside air is often cooler. The grower must invest energy to reheat the greenhouse back to optimum levels. In cannabis production, ventilating is not always possible. Cannabis production is based on a light regime, extending day length with artificial lighting or shortening day length while using black screens. Certain regional environmental regulations require the grower to apply black screens in order to prevent issues such as light pollution. Once black screens are in use, the option for ventilating the growing facility is no longer possible, and humidity increases without any possibility to treat it.

How does DryGair work?

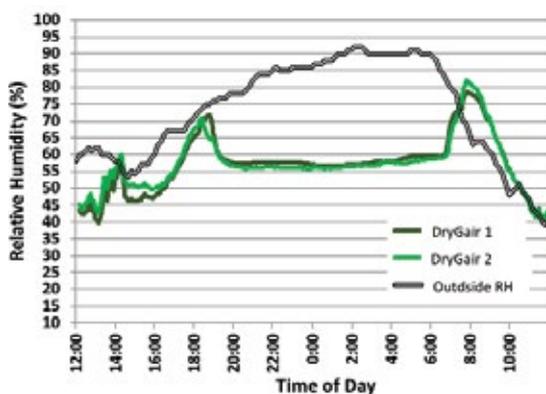
DryGair's concept offers an alternative to ventilation: it works in a closed greenhouse, isolated from the outside air, and reduces the humidity from within. The patented technology takes the humid indoor air, extracts humidity at a rate of $12 \text{ G}_{\text{water}}/\text{hr}$ ($45 \text{ L}_{\text{water}}/\text{hr}$)*, and recirculates the dehumidified air uniformly throughout the greenhouse, minimizing moist microclimates that can lead to disease development. DryGair's target operation times are during lights-off periods or activated black screen times, when a closed greenhouse benefits from dehumidification and retention of heat collected indoors during the day. The plants transpire and humidity rises in the greenhouse, and DryGair operates to control humidity levels in order to guarantee dry plant surfaces. During the day (lights-on period), the plants evapotranspire 10 times more than at night, leading to very high amounts of water vapor in the growing facility. At these times, the most economical option is to ventilate the greenhouse.

Experiments

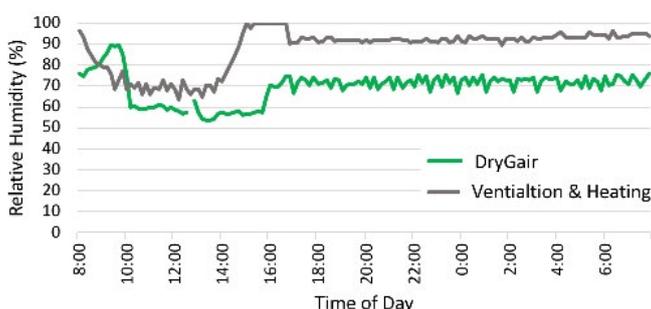
The following data was gathered from data sensors measuring temperature, relative humidity, and water outputs in trials conducted in medical cannabis greenhouses.

Relative Humidity

1/ DryGair was operated within a cannabis greenhouse during nighttime hours and relative humidity levels were recorded by 2 sensors located at different distances from the unit and at different heights in the greenhouse. 2/ Nighttime relative humidity levels were measured in a greenhouse using DryGair and a control greenhouse utilizing a ventilation system.



Within these greenhouses, the DryGair unit maintained a steady humidity level of 57% during operation hours, compared to fluctuating high outdoor humidity levels throughout the operation time. *The alternative, ventilation, is reliant on outdoor air and so is subject to fluctuation and can often be ineffective when outdoor humidity levels are high. Additionally, during times when the black screens are closed, ventilation is also not possible meaning there is no measure available for humidity control. The grower gets less than optimal conditions which can lead to humidity disease outbreaks indoors.*

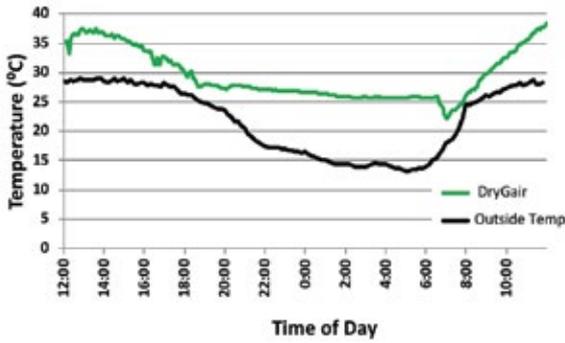


In the greenhouse with DryGair, relative humidity levels of under 70% were maintained during operating hours whereas the greenhouse utilizing the traditional ventilation and heating technique had relative humidity levels around 93%.

*at designed conditions of 65°F (18°C), 80% Relative Humidity.

Temperature

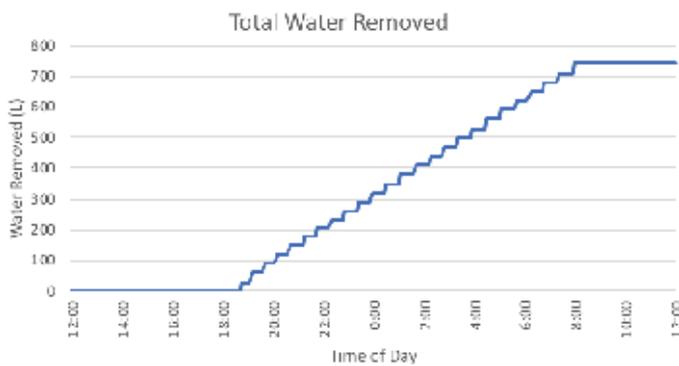
Temperature was measured outdoors and within a closed greenhouse using DryGair (without additional heating).



During the nighttime, outdoor temperatures dropped to ~13°C. In contrast, temperatures within the greenhouse remained ~26.5°C consistently during DryGair’s operation, due to DryGair’s conversion of electric energy to heat energy and the isolation of the greenhouse from outside conditions. *The DryGair concept reuses all of the energy invested in the operation of the unit and the energy released from the water condensed in the process. This energy can increase the temperature inside the greenhouse by 1-8°C, depending on the greenhouse structure and needs.*

Humidity Extraction

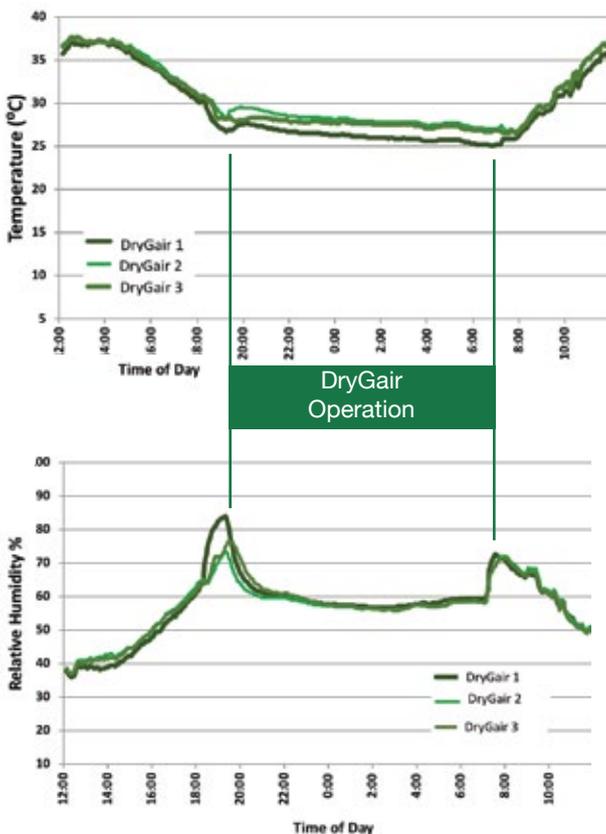
Water output volumes extracted by a DryGair unit were measured during nighttime operating hours.



During operation, DryGair extracted a total of 740 L of water from the greenhouse air. This is a dehumidification rate of ~54 L/hr. **DryGair has the highest dehumidification rate on the market, with the capacity to extract 12 G_{water}/hr (45 L_{water}/hr)*.**

Homogenous Climate Conditions

Temperature and humidity sensors were placed at different heights and different distances from the DryGair unit within the greenhouse.



Despite the different placements in the greenhouse and throughout the height of the cannabis plants, uniform levels of temperature (~27°C) and humidity (~57%RH) were found within the greenhouse.

Uniform growing conditions produce a uniform crop, critical for the high standards required by the medical cannabis industry. DryGair is able to provide uniformity of indoor temperature, leaf temperature, and relative humidity helping to produce high quality, uniform growth of the cannabis plants. Additionally, the uniform conditions DryGair produces are optimal for the prevention of the formation of microclimates in the greenhouse where condensation forms on plant surfaces that lead to disease. Cannabis flowers have a dense structure which makes them especially prone to surface moisture. Disease on the flower makes it unmarketable and can have a heavy economic price for the grower, and so the maintenance of uniform optimal conditions is critical.

*at designed conditions of 65°F (18°C), 80% Relative Humidity.

ADVANTAGES

Effective Dehumidification

DryGair is designed to extract 12 Gwater/hr (45 Lwater/hr)*. This is the highest output available on the market!

Prevents Diseases

Humidity diseases such as botrytis, powdery mildew, and hemp canker lead to losses in yield quality and quantity. Prevention is key in managing cannabis diseases and by creating conditions which prevent the development of disease, DryGair offers a solution to the problem before it can even develop.

Fewer Pesticides

Less diseases means less pesticides needed to protect cannabis crops. The reduction of pesticide use is critical for meeting health and safety standards, savings on resources, and the contribution to a greener environment.

Energy Savings & CO2 Emission Reduction

Cannabis is one of the crops with the highest carbon footprint due to the high energy consumption needed to maintain growing conditions necessary for the cultivation of this highly sensitive crop. Indoor cannabis growing accounts for 1% of all of the total electricity consumption in the United States (New Frontier Financial Group, 2016). Many growers use heating or HVAC systems to control climate and energy costs are a massive part of the total growing costs. Governments often subsidize energy-saving technologies in order to promote a greener environment and reduce CO2 emissions. DryGair allows the grower to save energy and enjoy a significant financial advantage.

Easy Integration

DryGair's integration is simple and easy to use. The unit is an automated plug and play solution that reduces the need for complicated infrastructure. The unit does not require any adaptation in the existing greenhouse, only minor rearranging of a few plants to make space.

Higher Quality and Quantity Yields

DryGair's humidity reduction capacity means less diseases in the growing facility which automatically translates to higher quality and quantity of yield. The uniformity created by DryGair leads to a more uniform product, which is especially important in cannabis production. Growers reported an increase of 30.40% in yields in greenhouses utilizing the DryGair solution.

Fast ROI

Increased yields (30-40%) translate into greater profits for the grower. The reduction in heating expenses (average savings of 50%) and humidity diseases lead to a return on investment of 1-3 years. This measurement is conservative and does not include additional advantages such as decrease in pesticide use, CO2 loss, decrease in working hours, etc.

Conclusion

DryGair was able to maintain the desired humidity level in the greenhouses while creating homogenous climate conditions in all areas of the greenhouse. DryGair's proven results make it an important growing tool, having many advantages compared to alternative methods due to the high amount of water it removes from the air, the air circulation it creates in the growing space, and the efficiency of its operation. It is easily integrated and operated into the growing facility, and provides the cannabis growing operation with a preventative solution for humidity diseases that is effective, economical, and green. DryGair allows the grower to be competitive by preventing yield loss, maintaining high quality produce, and reducing costs.

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