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Climate Controllers: Calibration for Indoor Gardening Success

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In indoor gardening, the ultimate goal is always quality harvests with maximum yields; invested time and money must be profitable! A conscientious gardener will take care of measuring his harvests to determine the profit of his garden after each crop.

How? For example, simply counting and classifying the fruits and flowers according to their size or to weigh the leaves or the harvested fruits. What's important is to find a suitable method to quantify the different parts of the plant in which we are interested. As one production varies from another, it is important to take note of the parameters used for each of them. This way, we better understand the crop's evolution and it becomes possible to identify the ideal "recipe" to gain maximum benefit. In order to find that famous "recipe" and to repeat it again, it is necessary to work with precise instruments!

Calibration

In your indoor garden, the thermometer shows 75°F, the hygrometer reads 58 per cent and the CO2 (carbon dioxide) controller, 1048 ppm (parts per million). So, you think your plants are comfortable and existing in the best conditions. But now, leaves are curling and some mildew has developed. Your harvest prospect looks disappointing, in other words, less quantity and less quality. What's happening? Since the beginning of the crop, you took good care of following every step of your usual recipe, which every time produced good results. It could be that the measuring devices for the temperature, humidity and CO2 concentration give false readings. What's the problem? Could it be the calibration?

The calibration of measuring devices has the goal to obtain an exact value of what we wish to measure. The calibration's action is to adjust a measuring instrument against a standard measurement of which the precision is certain. In indoor gardening, an appropriate calibration of your climate controllers is essential because false readings bring inadequate actions which in return cause unwanted situations that affect the productivity. With such a chain reaction, it becomes difficult to identify the true source of the problem.

Figure one: Mercury thermometer, psychometer and CO2 sensor calibration kit at 1000 ± 20ppm.

When to calibrate

Just as the majority of sensors are factory calibrated, it is recommended to verify the exactitude of the calibration at installation time and every crop start, particularly for CO2 sensors, which are considerably more fragile and subject to an important reading variation. A simple shock, in transportation or at the installation, is enough to make the sensor reading slip away from the true value. From our experience, we recommend calibrating NDIR CO2 sensors before each crop or every three months to offer your plants the best possible growing conditions. Some CO2 controllers even display a reminder message to calibrate it at regular intervals.

How to calibrate

Calibration methods vary according to the controller and sensor's type. But for all calibration, the basic principle to remember is to use a reliable reference. We can think about a mercury thermometer for the temperature, a psychrometer for relative humidity or a calibration kit for CO2 sensors (figure 1). Without a reliable reference value, we risk falsifying the reading even more from what it was originally. Among calibration methods, some are more effective while others are to be completely avoided.

Off Set

When a controller or sensor can't be calibrated, which is often the case for temperature and relative humidity sensors, it is possible to validate its precision by comparing its reading to a reliable measuring device. Simply note the difference on a piece of paper and place it near the controller to remember adding or subtracting a given value to the displayed reading. Then, adjusting the controller's set point to apply the corrected value will be needed. For example, in the case of a controller displaying two degrees more than the real value, it will be necessary to add two degrees to the set point to obtain the desired temperature.

However, this method might become tedious and can be subject to errors. Fortunately, there are some electronic controllers that allow correction of their reading by adding or subtracting automatically a value to the controller's reading (off set). This way, the controller displays a corrected reading and applies it to its programming!

The calibration limits

Although practical, the calibration with another reference has its limits. Remember that scientific uncertainty analysis adds up errors from the measuring instruments. In other words, the calibration is affected by both controllers' imprecision deviations. Let's take for example a CO2 controller. With a precision of ± 75 ppm for the sensor to be calibrated and a similar ± 75 ppm reference controller, we would obtain on the newly calibrated controller readings within ± 150 ppm from the actual CO2 concentration; there's the importance of having a reference as precise as possible. In the particular case of a CO2 sensor, the method by comparison also presents other inconveniences. In fact, we have to assure that the CO2 concentration is as stable as possible during the whole calibration process, which is not an easy task in a non isolated environment. The simple fact of breathing (between 30,000 to 40,000 ppm) near the controller significantly influences the sensor! So which method should be adopted for this type of sensitive sensor that requires regular calibration?

Calibration kit for CO2 sensors

The ideal calibration method is to expose the sensor or the controller to a gas mix with a known and certified CO2 concentration. Some sensors have a built-in calibration circuit in which we vaporize a known concentration gas mix. Most of the horticultural controllers used in indoor gardening do not have such a circuit. We can then place the controller in a sealed bag to protect it against human breathing, remove the air from the bag and replace it with a known CO2 concentration mix (figure two). Then, just follow the user's manual calibration instructions. Like every precision measurement device, we have to remember that a CO2 sensor will be inaccurate at its measurement scale limits, for example around 0 and 5000 ppm. To obtain a calibration as precise as possible, the ideal way is to calibrate the controller with a gas mix that has a concentration close to the one desired in the garden (around 1000 ppm).

Some retailers and manufacturers offer, at an affordable price, a calibration service using this precise and reliable method. According to the calibration number to make and frequency, it might be worthwhile for the gardener to get a calibration kit.

Why not calibrate CO2 sensors outdoors?

For many years, CO2 controller manufacturers have recommended the outdoor calibration method, for want of anything better. This method suggests an average outdoor CO2 concentration from 350 to 400 ppm, which is never truly right at any location depending on the area's different CO2 emitting sources. For example, vehicles reject approximately 20 per cent of their exhaust in CO2. Imagine the CO2 quantity rejected during rush hour in the cities, and this is without taking in consideration the CO2 rejected from factories. We can also think about those wood, fuel oil and gas heating systems. Depending on the time of the day, the outdoor real CO2 concentration in the air is between 350 and many thousands ppm. We also have to consider that in cold weather, the difference between the outdoor temperature and the garden's temperature will falsify the calibration as the electronic circuit operates in different conditions. So it is better to avoid this method.

With all aspects we just covered, you are now well informed on the need for precise climate factor readings in indoor gardening and the importance of calibration to get them right. And once your controller is well calibrated, it is still necessary to know your plants' needs in order to properly program it for maximum yields.