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Precise and Stable: CO2 Concentration in the Garden

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Some believe that talking to plants helps them grow better. This theory is based on the power of waves and positive thoughts, but there is certainly an explanation that is more mundane to this phenomenon. When one knows that a human exhales at a CO2 concentration between 30,000 and 40,000 ppm, it is easy to assume that gossiping with the plants provides them with a high quantity of CO2 essential to photosynthesis. Of course, this is only a theory, but it clearly exposes the importance of CO2 for the optimal growth of the plants. Fortunately, there are ways to provide the needed CO2 to plants that are more precise and practical! The following article will allow you to better understand the causes of the variable CO2 concentration in the garden as well as the different ways to control it.

The influence of human activity

As the exterior air generally influences the garden's atmosphere, it is important to understand the exterior CO2 concentration variations. Many factors affect the composition of the air, but one in particular has a noticeable impact: human activity. According to the measurements of an air sampling global network (NOAA/ESRL's Global Monitoring Division), the average international CO2 concentration in November 2009 was near 390 parts per million (ppm). Such a low level is often observed in limited human activity zones, but rarely in the city where industries, vehicles and numerous other CO2 sources (often combined to the effects of smog) will increase the concentration to variable levels.

The diagram below shows the CO2 concentration variation in an urban region over a 48 hour period. We observe that the concentration varies on a range of approximately 150 ppm in the same day, so about 400 ppm to 550 ppm. The maximal concentration is reached between 8:00 and 10:00 in the morning, probably due to rush hour. Then, it tumbles down in the afternoon, perhaps caused by the surrounding vegetation. It is difficult to identify the exact causes of CO2 level variations but certainly, it is real and it has to be taken in consideration in the garden!

CO2 concentration variations in the garden

In the microclimate created within the sheltered garden, numerous causes explain the variation of CO2 concentration, such as the plant's photosynthesis and respiration processes, but also the exchange with exterior air. Each of these causes must be taken into consideration and be well understood to conserve an ideal CO2 concentration.

Photosynthesis and Respiration

The vegetal growth depends on photosynthesis, a process that happens in the presence of light and during which the plant absorbs CO2 to transform it in cells and tissues. To reach the maximal photosynthesis level, most of the plants need a CO2 concentration between 700 and 1000 ppm. It is important to know that in the absence of CO2 enrichment or ventilation, fast grown plants may easily consume all the available CO2 in the garden, and this, within a few hours only (depending on the plant's density). For example, a CO2 concentration between 400 and 1000 ppm can easily go down to 340 ppm within an hour or two in the presence of light, and even down to 150 ppm if the luminosity is important. With such results, it is obvious that the garden needs CO2 enrichment, for example, with combustion CO2 generators or again, with regulated CO2 bottles. For lack of CO2 enrichment, the air in the garden should minimally be exchanged with exterior air, although this method does not generally allow an optimal concentration for growth.

In dark periods, the CO2 concentration naturally increases in the garden. Why?

Because in the absence of light, photosynthesis stops; the plant does not consume CO2 anymore, but continues with the respiration process, meaning the plant consumes the oxygen and rejects the CO2. It is then unnecessary to enrich the air with CO2 during the dark period. At the end of a period without light, the CO2 concentration may reach between 400 to 1000 ppm, depending on a plant's density, environmental conditions and how airtight the garden is.

Exchange with exterior air

It is important to consider the exchanges with exterior air. If one chooses not to enrich the garden with CO2, the ventilation has to be sufficient to provide the plant with a maximum of CO2. If one chooses to enrich the garden with CO2, it is important to minimize the exchanges with outside air; in this particular case, leaks of air and ventilation will contribute to the drop of CO2 concentration in the garden. Minimal ventilation is still recommended. Even if it makes the CO2 level slightly drop in the garden, it allows the plants to benefit from oxygen and also ensures the gardener's safety. CO2 concentration over 1200 ppm can degrade lucidity and lead to various discomforts; exceeding 6000 ppm, the gardener may even pass out.

CO2 management

In a garden enriched with CO2, a controller is an essential tool to maintain an optimal CO2 concentration for the plants. Unfortunately, some choose to use a timer to periodically activate the enrichment equipment. Although it is less expensive than a

Interesting features to consider when purchasing a CO2 controller

<p>Light Sensor</p> <p>Since adding CO₂ is useless in dark periods, even harmful, it might be interesting to opt for a controller equipped with a light sensor that can be set to enrich in the presence of light only. No more need to synchronize the enrichment with the lamps or with the sunrise and sunset.</p>
<p>Automatic Differential</p> <p>The differential represents the CO₂ concentration variation around the set point. We can also say that it is the different range between the value at which the controller deactivates the enrichment equipment and the one where the controller activates the equipment. In the case of an automatic differential (optimized), the controller automatically modifies the differential's value in order to narrow the range around the desired set point. This feature allows the grower to obtain a more stable and precise concentration.</p>
<p>Combined Controller</p> <p>It is common to want to enrich a cultural environment with CO₂ that is partially vented. In order to avoid wasting CO₂, it is better to avoid enriching while the venting equipment is running. Some controllers, called combined controllers, allow you to intelligently manage more than one piece of equipment at once, for example by avoiding opposite actions, such as the enrichment and ventilation, to be simultaneously activated.</p>

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controller, a timer is an inaccurate method that does not allow the desired CO2 concentration in the garden to be reached and maintained. The adjustment of the timer is usually an estimate calculated according to the volume size of the garden and type of enrichment equipment. But this estimate cannot include all other factors that influence the CO2 concentration, such as the plant's consumption, air leaks or the ventilation. This way, unknown and approximated CO2 concentrations are obtained, which are rarely the ones plants' need. In the case of too high concentrations, the excess of CO2 is wasted and can even be harmful to the plants and persons working in the garden. Sad conclusion: the sums invested to enrich will probably not bring the expected results in return.

The controller is much better than the timer. With a built-in infrared sensor, which permanently measures the CO2 with high precision, the controller activates and stops the enrichment equipment to maintain the concentration as close as possible to the value selected by the user. CO2 is added only when the concentration goes below the set point and the controller stops the equipment when the concentration exceeds the set point. This way, we obtain an ideal concentration, stable, without waste or worries for the plants!

To be really effective, the controller must be installed to a location that represents the cultural environment. For example, it is recommended to avoid placing the controller too close to the ventilation system or the CO2 source. The superior part of the plants is usually the best location to measure the CO2 level since it is at this location that the photosynthetic activity is maximal.

To summarize, the best way to maintain the ideal CO2 concentration in the garden is to use a controller, combined with CO2 enrichment equipment such as a combustion CO2 generator or a regulated CO2 bottle. It is also important to maintain good management of the ventilation, meaning sufficiently venting the garden to provide the plants with the needed oxygen, while minimizing CO2 waste. In addition, enriching the garden with CO2 during dark periods should be avoided since plants only absorb it in the presence of light. For the ones that choose not to enrich with CO2, it is essential to provide frequent ventilation with exterior air to maintain an acceptable CO2 level to the plants. In this case, having frequent chats with the plants will certainly help!

"To reach the maximal photosynthesis level, most plants need a CO2 concentration between 700 and 1,000 ppm."
