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## CO2: The Secret Ingredient for a Better Harvest

by Isabelle Lemay, agr. and Melissa Leveille | 2010-01-01

**In cookery, the best recipes are usually the result of many trials and errors. The most famous recipes often have a little something, a secret ingredient that makes all the difference between an acceptable dish and a divine dish! This concept translates to gardening as well. All gardeners are looking for the perfect recipe to grow their plants with high quality in record time. The ones that succeed most often have the “little something” that makes all the difference...carbon dioxide (CO2)!**

### A real treat for the plants

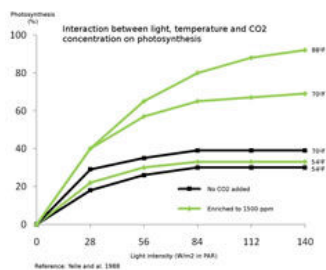
CO2 is an essential element in the photosynthesis process, which is directly responsible for the growth of vegetal species. Without taking water in consideration, the plant is principally composed of carbon (C) and oxygen (O), which mainly come from CO2. During photosynthesis, the CO2 in the air is sort of “captured” by the plant through the light. So, when the CO2 concentration in the air is increased, the photosynthesis process and the growth increase as well. To make it simple, plants feed themselves with CO2 and use it to fabricate tissues. The more plants eat, the bigger they get!

It is important to ensure a rich CO2 concentration at the plant’s canopy, since it’s from the stomas that the absorption happens. During photosynthesis, the plant consumes CO2 and makes the concentration drop around itself. A simple way to counter this effect is to use a recirculation fan to mix the ambient air and to ensure a higher and consistent CO2 concentration around the plant.

### The importance of proper dosing

In nature, the average CO2 proportion in the air comes close to 400 ppm (parts per million), and can largely vary depending on natural or human made CO2 production. The air in the garden should be close to this concentration; below this limit, the photosynthesis and the growth considerably slow down and might even stop around 200 ppm or less. This situation might happen in an isolated indoor garden with no CO2 added. The plant will then consume the ambient CO2 until it’s all gone.

The majority of plants will appreciate concentrations between 700 ppm and 1000 ppm during daytime (light period) and around 400 ppm at night time (dark period). Why are these ideal conditions different from day to night? As mentioned earlier, the photosynthesis process occurs only in the presence of light. The CO2 enrichment is then necessary only in the presence of light and therefore is useless, even harmful, in the dark period. In order to provide the plants with the optimal CO2 concentration for their growth, many gardeners turn themselves towards CO2 enrichment. In addition to improving the yields, maintaining the recommended CO2 concentration in the air will also have the advantage of reducing the production time, accelerating flowering,



Interactions between light, temperature and CO2 concentration on photosynthesis.

improving the quality and the quantity of fruits and flowers and may even diminish the incidence of some pathogenic fungus.

Not enough CO2 is harmful, but too much is just as bad. Equal or superior concentrations to 1500 ppm are generally less effective and less profitable and can even have a negative effect on some crops. One of the most serious impacts is an overflow of CO2, which reduces the plant’s stomas opening, resulting into a reduction of the CO2 absorption and a limitation of transpiration. The transpiration is a key process for vegetal species because the water and nutrients’ absorption depends on it. Far from serving the plant’s interest, an excess in CO2 slows down the growth and, in some cases, can even cause leaves necrosis and curling or again provokes flower malformations. Tomatoes and cucumbers are particularly sensitive to high CO2 concentrations.

When choosing to enrich the garden with CO2, adjusting the garden’s temperature will be necessary. In fact, the optimal temperature for the plant’s growth increases by a few degrees (as much as 8°F) when the air is enriched with CO2. Consider that the plant’s metabolism works faster when it benefits from a CO2 supplement; CO2 allows plants to produce better, but to do so, they need to consume more. Every need, like water and nutrients for example, will be increased. To fully take advantage of CO2 enrichment, we have to pay attention and take care of our plants to provide them with everything they need.

### A good balance

A successful recipe is determined by a good mix between all the ingredients. Similarly, even if we provide plants with the ideal CO2 concentration, this will not guarantee success if we do not manage the other factors properly. Before getting into CO2 enrichment, it’s important to master the plant’s basic needs in order to submit them to conditions that are favorable to the yield. If

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these conditions are not accomplished, they will be an obstacle for the growth, and the CO<sub>2</sub> enrichment will have no significant impact and will be wasted. They are many conditions, but usually one in particular will harm more than others; we call it the "limiting factor," since it's the one that limits growth.

## The limiting factor

To better understand the effect of the limiting factor, we can compare a plant's yield to the maximal quantity of water that a barrel can hold. A barrel is usually composed of many boards of equal length, but let's suppose that the barrel would be built with boards of different lengths. The water level contained could not exceed the shortest board. The same way, a plant's yield would not go further than the limiting factor who limits the growth, even if the other factors are optimal. These factors are the CO<sub>2</sub>, light, temperature, humidity, water, nutrients or substrate.

The diagram illustrates the interactions between the light, the temperature and the CO<sub>2</sub> concentration and perfectly shows the effects of a limiting factor on the photosynthesis process. For example, we observe that at 54°F, the rate of the photosynthesis does not increase despite the CO<sub>2</sub> enrichment and the augmentation of light intensity. In this situation, it's the temperature limiting the plant's growth. However, note that if we augment the temperature to 70°F, the addition of CO<sub>2</sub> significantly raises the photosynthesis level. Again, the temperature is the limiting factor, since with an increase to 88°F the photosynthesis process goes up 30 per cent. So it is only when all the plant's needs are fulfilled with light, temperature and CO<sub>2</sub>, among others, that a maximum level of photosynthesis is reached.

To summarize, remember that plants require well balanced conditions as close as possible to their needs to get the full potential of CO<sub>2</sub> enrichment. This way plants reach an exceptional growing level! But how can you ensure and maintain an ideal CO<sub>2</sub> concentration in the garden, day and night? Among other things, technology helps in the form of a CO<sub>2</sub> controller with a properly calibrated sensor.

