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## **Facts about CO<sub>2</sub> Enrichment**

CO<sub>2</sub> or carbon dioxide is an odorless, colorless, gas found in small amounts in the air. It is actively absorbed by plants during photosynthesis and is an essential element to plant growth. Your plants will use all the available carbon dioxide in an enclosed room in approximately 3 hours! When CO<sub>2</sub> levels fall, plant photosynthesis and growth slows to a crawl. By increasing the amount of carbon dioxide available to your plants, you can increase their growth rate 2 to 3 times (providing that light, water, and nutrients are not limiting). CO<sub>2</sub> enrichment has little to no effect on plants being grown under fluorescent lights. The tubes do not supply enough light for the plants to process the extra available carbon dioxide. On the other hand, if you are using HID lights (MH or HPS) they supply ample light to process the CO<sub>2</sub> enriched air. In a garden room using HID lights, carbon dioxide enriched air, adequate water and nutrients, unbelievable results can be achieved.

Plant demands increase when grown in a CO<sub>2</sub> enriched environment. They will consume nutrients, water, and space about twice as fast as normal. A higher temperature range (75-85 F) will help stimulate a more rapid chemical process within the super plants. With proper CO<sub>2</sub> management the plants will grow so rapidly that flowering must be triggered much sooner. As a general rule of thumb, when using CO<sub>2</sub> enrichment, your plant growth cycle could be shortened by one to four weeks.

To be most effective, the carbon dioxide level must be kept near 1000-1500 ppm everywhere in the garden room. To accomplish even distribution of CO<sub>2</sub> the room must be completely enclosed. Cracks in and around the garden room larger than one-eighth-inch should be sealed to prevent CO<sub>2</sub> from escaping. A room that is not sealed can use as much as 50% more carbon dioxide. A sealed room will be easier to control, but vent fans must also be installed to remove the stale air that will be replaced with carbon dioxide. It is also important that fresh oxygen be brought into the garden room as plants need fresh oxygen as much as they need carbon dioxide. Vent fans with flaps or a baffle will help contain the carbon dioxide and prevent backdrafts.

CO<sub>2</sub> is heavier than air, so it should be released above your plants so that it can "rain" down upon them. Carbon dioxide should be released under your light. The heat from a HID lamp could carry the CO<sub>2</sub> up to the ceiling and away from your plants.

## Producing CO<sub>2</sub>

There are many ways to increase the carbon dioxide content of your grow room. Two of the most common ways are by using fermentation or dry ice. Both of these methods are acceptable ways of generating CO<sub>2</sub> but it is difficult to measure how much is being produced.

**Fermentation:** To brew some carbon dioxide with the fermentation method it is best to use a one gallon milk jug or other gallon container. In the container you need to mix one cup of sugar and three packets brewer's yeast with three quarts of warm water. This concoction smells horrible, but will produce an initial burst of CO<sub>2</sub>. Fermentation is one of the least expensive ways to produce carbon dioxide; it works best when used in a small growth chamber. This concoction should be changed one to four times daily. Half the solution is poured out, then one and one half quarts of water and another cup of sugar is added. If the yeast does not continue to grow during the fermentation process, add another packet of yeast. As long as the yeast continues to grow, the mix can be used indefinitely.

**Dry Ice:** Dry ice is frozen CO<sub>2</sub>. The carbon dioxide is released when it comes in contact with the atmosphere. As it sublimates, dry ice turns from a solid to a gas. It is easy to approximate the amount of CO<sub>2</sub> being released. One pound of dry ice is equal to a pound of carbon dioxide. By determining the thawing time of a pound of dry ice you can estimate how much CO<sub>2</sub> is being released into the garden atmosphere. To prolong the thawing process some gardeners put the dry ice into insulated coolers and poke a couple of holes in the lid and sides to release the carbon dioxide. The size and number of holes will allow you to regulate the time it takes for a block of dry ice to melt. Despite the fact that this is an economical method of production, dry ice is difficult to store. The melting can be slowed through insulation, but it cannot be stopped.

**Emitter Systems:** Compressed or bottled CO<sub>2</sub> is safe, versatile, and easy to control. These enrichment systems consist of a combination regulator/flow meter, solenoid valve, short-range timer, and a tank of compressed CO<sub>2</sub> gas. The carbon dioxide gas passes out of the tank and into the regulator/flow meter where the pressure is reduced. The regulator can be adjusted and should be set to deliver CO<sub>2</sub> at a rate between 10-15 CFM. The solenoid valve is controlled electrically operated and is used to stop and start the flow of gas from the regulator/flow meter. The solenoid should be plugged into a short range timer. Be sure to get a short range timer because the carbon dioxide dispersment is usually only a few minutes long and occurs several times a day. Widely available lamp timers offer a minimum on/off time of half an hour. By altering the flow rate and the duration of injection, a gardener can control the exact amount of CO<sub>2</sub> dispersed into the garden room. To determine how long the valve should remain open, first determine the number of cubic feet of gas required. To do this, first find the cubic volume of your grow room (LxW xH) and divide this by the desired ppm (1,000ppm = 0.0010). This will give you the cubic feet of gas required to achieve a CO<sub>2</sub> concentration of 1,300 ppm (including 300ppm ambient CO<sub>2</sub>). Divide the cubic feet of gas required by the flow rate you set on your CO<sub>2</sub> regulator (i.e., 10 or 15). This will give you the on time for the short-range timer. For example an 8' x 8' x 8' room is 512 cubic feet. 512 times 0.0010 is 5.12 or 5 minutes on time for your timer. You can dose your room every three hours for 5 minutes, or to maintain a more steady level of CO<sub>2</sub> you can split the 5 minutes into smaller increments dispersed more frequently. Gardeners have found two successful methods for distributing the CO<sub>2</sub> from the tank to the garden room: the tube and the fan method. To provide uniform distribution some gardeners suspend lightweight tubing from the ceiling. The tubing has been punctured in key areas directly above the plants. Because CO<sub>2</sub> is heavier and cooler than air, it falls to the plants below. Overhead fans also successfully distribute CO<sub>2</sub>. The carbon dioxide is released directly below the fan into its air flow. This evenly mixes the CO<sub>2</sub> throughout the air and keeps it recirculating across the foliage area.

When using compressed CO<sub>2</sub> you should vent the room about 10 minutes before the carbon dioxide is injected. The fan should be off while CO<sub>2</sub> is being dispersed and for at least one hour afterward.