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Greenhouse CO_2 Supplement

CO_2 supplementation may be worth investigating for a grower that is growing cut flowers, however if the grower is producing vegetables, CO_2 supplementation usually does not increase production enough to offset the added cost of CO_2 supplementation.

Advantages And Disadvantages

The beneficial effects of CO_2 supplementation does not always translate into increased profits in the greenhouse due to a limited response from the plants. The limited response may be due to other limiting factors such as adequate levels of nutrients, water and/or light. CO_2 supplementation will not increase production and therefore profits if all systems in the greenhouse are not already at optimum. The grower must understand that if there is one limiting factor for production then increasing one factor alone will not always increase overall production. Only if the grower is supplying all the other factors and the only limiting factor in the production regime is CO_2, will CO_2 supplementation increase production.

CO_2 can produce larger plants, larger flowers, higher quality plants, flowers, can decrease the time from planting to resale and flowering in some plant species. This decrease in the time to maturity can save considerable heating costs by allowing the grower to start the plants later and shorten the time the greenhouse is heated. It is also important to understand that CO_2 supplementation must be done at the proper time in the growing season depending on the growth habits of the plants, since older plants will not respond as dramatically as younger plants unless the older plants are replacing old growth with new growth. The greenhouse must also be prepared for CO_2 supplementation. If the greenhouse is not properly sealed, excess infiltration of outside air will diminish the effect of adding CO_2. Also a greenhouse that is too well sealed may inhibit the natural air exchanges needed to remove excess CO_2 from the internal greenhouse atmosphere and create toxic levels of CO_2 in the greenhouse.

Methods Of Supplementation

There are several methods of CO_2 supplementation in a greenhouse environment. Once the decision has been made that CO_2 supplementation will enhance the productivity of the greenhouse, the grower must understand the advantages and disadvantages of each system. There are a number of low tech approaches the greenhouse grower can use to supplement CO_2.

A cheap method of CO_2 supplementation is the venting of the flue gases from a fossil fuel heating system directly into the greenhouse. This method is however, extremely dangerous to plant health as well as human health as the flue gases can contain poisonous gases as well as the sought after CO_2. Gases such as sulfur dioxide, ethylene, nitrogen oxides and ozone can severely damage green plants. These gases are products of incomplete combustion and are created from burners that are not functioning properly, are not properly supplied with outside air containing oxygen, or are present as contaminants in the fuel source.

Another low-tech method of CO_2 supplementation is composting plant material in the greenhouse. The composting process produces CO_2 but it can produce harmful gases as well as create a reservoir for disease pathogens and insects. The CO_2 generated by these methods is also hard to control and unreliable.

CO_2 generators using hydrocarbon fuels are common CO_2 sources in the greenhouse. These generators are specifically designed to produce CO_2 from the combustion of hydrocarbon fuels. However, if the generator is not properly supplied with adequate amounts of oxygen, the burners are out of adjustment or the fuel source contains high levels of sulfur than harmful contaminates will be produced possibly injuring or killing the greenhouse crop. These generators also produce heat during the process of creating CO_2 and can be

used to supplement the heating system during cold periods. The CO_2 generators can also provide too much heat in the greenhouse necessitating venting which will dilute the CO_2 present in the greenhouse and defeat the purpose of the CO_2 generator in the first place. Therefore there are certain advantages and disadvantages to fuel burning CO_2 generators.

The safest method of CO_2 supplementation is the use of compressed CO_2 from cylinders. This CO_2 is pure and free of contaminants and is easily regulated. The possibility of contaminate gas production is eliminated and no supplementary heat is produced. The compressed CO_2 is also more expensive than the previous methods described. Since the cost of CO_2 supplementation must not exceed the benefits, than this method of supplementation must be considered carefully. Pressurized CO_2 may not be available to the grower at a reasonable cost and the grower is then faced with accepting the risks associated with the other methods of CO_2 supplementation. However with a high value crop such as cut flowers the elimination of the risks would far outweigh the extra cost of pressurized CO_2 supplementation.

The crop being grown would be the deciding factor for whether or not to use CO_2 supplementation as a growing tool.

How Does CO_2 Affect Plant Growth?

The ambient level of CO_2 in the atmosphere is approximately 400 PPM. At 100 PPM of CO_2 the rate of photosynthesis would be stopped completely. At 150 PPM the plants begin to respire, and photosynthesis is stopped. At this low level the plant will no longer be able to obtain CO_2 from the atmosphere and photosynthesis is restricted. The plant will eventually use all of the CO_2 present, photosynthesis will stop and the plant will die.

The rate of photosynthesis at 350 PPM will be consistent with growing conditions outside of a controlled environment, given that ambient levels of CO_2 in the atmosphere are approximately 400 PPM.

With no other limiting factors such as heat, light and nutrients the plants will photosynthesize at a rate consistent with ambient conditions (i.e. outside of the greenhouse). There may be a slight increase in photosynthetic efficiency due to the higher than ambient CO_2 level, however this increase will probably be insignificant. The level of 1000 PPM CO_2 is very close to the optimum level of CO_2 required, given no other limiting factor, 1200 PPM, to allow a plant to photosynthesis at the maximum rate.

At this level most plants will respond favorably by increasing photosynthesis, however this is dependent on all the other limiting factors being optimum for the plant. Therefore at 1000 PPM the photosynthetic rate should be almost at maximum for most plants. However unlikely, at 10,000 PPM of CO_2 the photosynthetic rate in the plants will be very low due to the closing of the plant stomata and the exclusion of air into the leaf interior.

This level of CO_2 is sufficient to cause toxic effect on the plants and cause damage and eventually death of the plant. Also at this level of CO_2 it would be very hazardous to workers in the greenhouse, as they too would experience CO_2 poisoning. The photosynthetic rate would likely be zero at 10,000 PPM of CO_2 for the above stated reasons.

When To Supplement With CO_2?

The high level of CO_2 at sunrise in a greenhouse is caused by plants respiring and releasing CO_2 into the atmosphere. The respiration process continues in light but at a reduced rate. The plant must be able to produce enough carbohydrates during the light period with photosynthesis to overcome the loss of carbohydrates by respiration throughout the day and night. Since there is no photosynthesis occurring during the dark period, there is a net production of CO_2 from the respiration process.

These high levels of CO_2 are a direct result of the metabolism of photosynthates by respiration. The increase in the level of CO_2 would only occur in a very well sealed greenhouse, as infiltration of outside atmosphere would tend to dilute the increased concentration of CO_2 in the greenhouse. This being the case, the level of O_2 (oxygen) in the greenhouse would be lower than atmospheric levels due to its consumption in the respiration process.

CO_2 supplementation is most effective during the period of active growth of the plant, during the light period. CO_2 supplementation should begin in the morning for a short period until desired levels are reached, then the generator should be shut down and the levels of CO_2 allowed to return to ambient before nightfall.