USE LESS CO_2 IN DOUBLE POLY HOUSES

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A carbon dioxide (CO_2) concentration of 1000-1500 ppm is generally suggested in greenhouses to improve productivity. To provide this level in a glass house with one air exchange per hour, 1500 ppm is added per hour.

The air exchange rate in double polyethylene glazed houses may be less than once per hour; it may be only once in several hours if the house is very tight. An **injection rate of only 800-1000 ppm per hour** may be more appropriate. How much is this?

A common size for a plastic covered greenhouse is 2500 sq ft (26x96). If an average height of 8 ft is assumed, the volume is 20,000 cu ft. An injection rate of 1000 ppm means that 20 cu ft of CO_2 would be injected per hour. Since CO_2 weighs roughly 2 oz/cu ft, this is (2x20) 40 oz, or 2½ lbs for a 2500 sq ft greenhouse. (Note that this is 1 lb/1000 sq ft.)

A gallon of propane weighs 4.24 lbs. It provides 12.7 *lbs CO_2. This* is enough for 5 hrs at 2.5 lbs/hr, so a CO_2 generator should burn ⅕ gal/hr for a 2500 sq ft double poly greenhouse.

Combustion of ⅕ gal propane will produce about 18,000 BTU (91,000 ÷ 5). This is an advantage on any day when heat is required. This unvented combustion is supposedly 100% efficient and may cost less than providing heat with conventional heating systems using fuel that costs less than propane (since they may be only 60-85% efficient).

A commercially available unit that produces 20,000 BTU/hr at minimum setting is only a smidgin too large for a 2500 sq ft double poly greenhouse. It is acceptable.

A simple gas hot plate produces somewhere around 5000 BTU/hr. Three of these, lit 30-60 minutes before sunrise and turned off an hour before sunset (and during venting) should provide about 850 ppm CO_2/hr. This is probably sufficient for adequate crop response. But some burners are larger or smaller than this. If combustion is not perfect, gaseous by-products may be dangerous. Beware of open flames. On the other hand, as Dr. Sharvelle of Purdue once said, brew your coffee and broil your steaks over the fire; increased profits will pay for them.

Don't worry about the CO_2 distribution. Place the units anywhere that is convenient. Horizontal air flow will give perfect distribution. Even a fan-jet will do a *pretty good job.* Without any fan, the CO_2 will diffuse the length of the house in less than an hour.

Providing 18,000 BTU/hr to 2500 sq ft will raise temperatures during the day, perhaps as much as 7°. This will supplement normal heating requirements. But it may raise the temperature above the optimum for plant growth. Remember that day temperatures are elevated by 10-15° when CO_2 is used. This warms the crops, soil and everything in the greenhouse, storing energy. This stored heat is returned during the night, reducing heating requirements probably enough to pay for the CO_2.

Suppose that the temperature is being maintained at 60° nights. Normally, ventilation would begin at 70° and full vents used at 75°. With CO_2, day temperatures would be allowed to soar to 80-85° before venting. If fan/tube venting is used with perhaps 6-15 air exchanges per hour, the CO_2 might remain on. If full venting is necessary to keep the temperature low enough, the CO_2 is discontinued.

There is some concern over increased humidity due to water produced as a product of combustion. Don't worry about the extra humidity. Dr. Aldrich (CT Greenhouse Newsletter 108:1-6, Nov. 1981) states that a mature crop will transpire about 0.15 lbs water/hr/sq ft during the day. Assuming 2000 sq ft of plants in a 2500 sq ft greenhouse, this is 300 lbs/hr. The burner, while producing 2½ lbs CO_2 from propane, will produce only 1.4 lbs water. This is inconsequential (for natural gas, the figure is about 2 lbs).

At the same time, remember that humidity is a problem and good air movement is essential to reduce disease problems in all tight greenhouses.

If any of our readers have ideas regarding small CO_2 generators appropriate for greenhouse use, we would be pleased to hear from you.

SOME APPROXIMATE EQUIVALENTS

1000 sq ft x 8 ft deep = 8000 cu ft
8000 cu ft x 1000 ppm = 8 cu ft
8 cu ft CO_2 x 2 oz/cu ft = 16 oz = 1 lb
(more accurately, 8.7 cu ft = 1 lb at 60°F)
Therefore, 1000 ppm CO_2/1000 sq ft = 1 lb/1000 sq ft

One gal propane = 4.24 lbs
One pound propane yields 3 lbs CO_2
Therefore, 1 gal = 12.7 lbs CO_2
One gal propane yields 91,000 BTU
91,000 ÷ 12.7 = 7000 BTU/lb CO_2 from propane (7 BTU/sq ft)

8 cu ft natural gas = 8 cu ft CO_2 = 16 oz CO_2
8 cu ft natural gas = 8000 BTU (8 BTU/sq ft)

A single poly greenhouse will require about 100 BTU/sq ft (assuming a 60° difference in indoor/outdoor temperature)
A double poly greenhouse will require about 60 BTU/sq ft (This is 1 BTU/degree temperature difference)
Therefore, a 7 BTU/sq ft input should increase the temperature about 7° (8° for natural gas).