Chapter 16
CO_2 Enrichment

The CO_2 concentration inside a greenhouse can drop significantly below outside level when a dense crop is growing, even if the greenhouse is well-ventilated. The concentration can drop to less than 200 vpm during winter in mild climate regions. As the CO_2 concentration limits the photosynthesis of most vegetable species, the productivity decreases. The optimal CO_2 concentration for growth and yield seems to be 700–900 vpm (De Pascale and Maggio 2005, 2008). The CO_2 concentration should be kept to at least the outside level, but CO_2 enrichment is not a current practice in mild climates up to now.

The production loss due to CO_2 depletion may be higher than the production loss due to a reduced temperature through ventilation (Stanghellini et al. 2008). The enrichment of greenhouse air with CO_2 leads to better plant growth, shorter cropping times, and higher quality. Therefore a combined control of ventilation and CO_2 enrichment with low-cost CO_2 sources may result in improved and economically viable methods for crop growth in greenhouses.

Production losses in greenhouses are influenced by two main factors:

- Sufficient ventilation to avoid CO_2 depletion.
- Maintaining a higher temperature by heating on sunny, chilly days in spite of CO_2 depletion.

It is necessary to assess running and installation costs for CO_2 enrichment or heating to find out the optimal strategy for climate control. The compensation of CO_2 depletion by increased ventilation or even by CO_2 enrichment seems to be cheaper than compensation of production loss by heating. A good management strategy can be to ventilate as much or as little as necessary for temperature and humidity control, and to control CO_2 concentration inside the greenhouse up to outside level when ventilation is being used, and to higher levels when no or little ventilation is required for temperature control (Stanghellini et al. 2008, 2009).

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The CO_2 concentration can be raised as follows (von Zabeltitz 1999):

- Technical carbon dioxide from bottles or tanks.
- Exhaust gases from gas burner for CO_2 enrichment with simultaneous heat production.
- Exhaust gases from directly fired air heater with gas burner.
- Straw between the plant rows, enriched with fertiliser and wetted. CO_2 is released during decomposition, but the amount of CO_2 cannot be controlled.

Exhaust gases from oil and coal heaters must not be used because of the content of sulphur dioxide.

Exhaust gases from gas burners can be led directly into the greenhouse (Fig. 16.1). Gas will be burned, and the CO_2 is blown with the circulating air into the greenhouse. Special control systems are necessary, and care must be taken that no carbon monoxide is formed. It is practical to mix the exhaust gas with fresh air. The water vapour and heat production, as well as the maximum allowed concentration, have to be taken into consideration.

CO_2 from an air heater (Fig. 16.2) can only be produced while it is in operation and when heating is needed, which is normally necessary only at night in mild climate regions. Some of the combustion gases are tapped off and used for CO_2 enrichment.

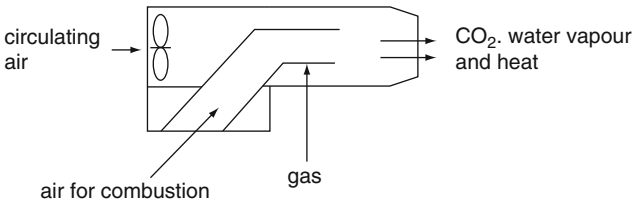

Fig. 16.1 Gas burner for CO_2 enrichment

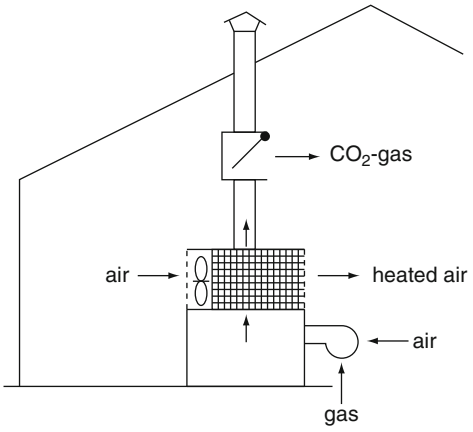

Fig. 16.2 Directly fired gas burner for heating with CO_2 discharge for enrichment