Greenhouse Applications

Improving plant growth and maximising yield

Carbon dioxide (CO_2) is an essential element of photosynthesis required for growth and food production in plants. Photosynthesis is a process by which CO_2 and water are absorbed by plants and then converted in the leaves into sugars, cellulose and starch under the influence of light energy. More photosynthesis means more growth although there are optimal CO_2 levels for all plants, as shown in the table below:

Table 1: Optimum concentrations of CO_2 for a sample of greenhouse plants

Product		kg CO_2 / m^2 / year	Target level (ppm)	Reference
Fruit	Tomatoes	20-25	800-2000	[1]
	Capsicums	10-15	Up to 1000	[1]
	Cucumbers	30-35	800-2000	[1]
	Aubergines	30-35		Linde documentation
	Lettuce		Approx 1000	[1], [2]
	Kohlrabi		Up to 1000	[1]
Flowers	Roses	25-40	750-1000	[1]
	Chrysanthemums	25-30	700-1000	[1]
	Geraniums		600-800	Test report from Osnabrück University of Applied Sciences
	Hydrangeas		800	[1]
Other	Potted plants	10-25	600-900	[1]
	Annuals		50-800	[1]
	Bedding plants		600-800	[1]

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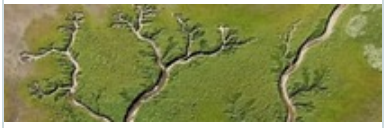

Pepper	800-1000	[1]
Basil	350-500	[3]

[1] Soyez K., Baier D., Fieback K., Koller M., Matthäi M., Reinhold J., Sommerfeldt H. Verfahren zur Kopplung von Kompostierung und Gewächshausproduktion [Procedure for Connecting Composting and Greenhouse Production] Bioplan study, University of Potsdam, 1996 (http://www.gts-oekotech.de/docs/kurzbericht_carboferm.pdf)

[2] CryoGas International, CO_2 — The Good Greenhouse Gas Article, May 2007

[3] Prof. Dr.-Ing. L. Köhler and Dipl. Ing. (FH) F. Lecker Wirkung von CO_2 und NOx auf Gewächshauspflanzen [Effect of CO_2 and NOx on Greenhouse Plants] Report, Inst. for Horticultural Technology at Weihenstephan University of Applied Sciences in Freising 1997

Significant increases in plant growth and yield can be obtained in greenhouse-grown plants by increasing the concentration of CO_2 from 400 ppm to the optimum level for that commodity.

The following rule of thumb for improved plant growth and yield is applied when calculating the increase of CO_2 levels:

- From 250 to 350 ppm: 23% more growth
- From 350 to 450 ppm: 12% more growth
- From 600 to 700 ppm: 4% more growth
- From 1000 to 1100 ppm: 1.5% more growth

There are a number of ways of increasing the levels of CO_2 in a greenhouse. Linde supply options for CO_2 offer a purity above most onsite generation - meaning you are not introducing toxic flue gas - while our application systems ensure consistent application, optimising the addition of CO_2. In a closed environment like a greenhouse, this level could fall to about 120-180 ppm (due to the plants consuming CO_2) with the result that photosynthesis would no longer take place and the plants would stop growing.

A Worked Example

Let us assume that the air in the greenhouse contains a CO_2 level of 400 ppm; that equates to 0.72 g/m3. At an average greenhouse height of 6 m, that amounts to 4.32 g of CO_2 per square metre. Now, to increase production, we want to increase the level of CO_2 to 1000 ppm. This would equal 1.8 g/m3, or 10.8g/m2 with our average greenhouse height of 6 m. We therefore need to add around 6.5 g per square metre.

CO_2 also escapes from the greenhouse, e.g. through ventilation, leaks, and of course also through the plants and crops. This means that an additional 2.3 g of CO_2 needs to be added per square metre per hour. In this example, the total CO_2 to be added would amount to 88 kg per hour for an entire hectare.

References:

[1]Linde internal report: Application Report CO_2 in Greenhouses

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