

CO₂ enrichment - there are more questions than answers

The following is an article written in 1998 and published in the Grower.

Introduction

UK growers are now known as "CO₂ junkies" amongst the Dutch, and how many of us would have foreseen the manner in which the use of CO₂ enrichment for glasshouse crops has taken off a few years back! From winter CO₂ to summer CO₂, and from depletion avoidance to dosing levels of 5 cubes (m³/0.1ha/h) and then on to 10 and 15 cubes, and now 30 with levels of 25 being common. With these kind of steps taken it is perhaps useful to reconsider some of the points about CO₂ enrichment which perhaps we do not have the answers to, although it is very much a case of 'There are more questions than answers!'

Distribution

Growers frequently ask the question where the sensors for the CO₂ system should be located - in the path, in the crop, at growing tip height, at a mid point or does it really matter? A secondary question is whether there is any benefit to having higher level distribution outlets, as has been tried both experimentally and commercially. The nub of the problem is how the CO₂ is distributed. In ambient conditions CO₂ can be assumed to be reasonably uniform - once an enrichment process takes place this can no longer be assumed since gas of a greater concentration and different temperature is being introduced. The basic laws at work are as follows.

- CO₂ as a gas is heavier than air, and will therefore tend to sink.
- The CO₂ within flue gases is warmer than the air in the house and will therefore tend to rise.
- The gas diffusion laws dictate that the CO₂ will try and equalise out, and will therefore move radially from the point source.

All of the above mean that there is no simple answer to distribution. When this is coupled with the uptake by the leaf, *i.e. how the plant sees things*, and air movement due to vents and fans it becomes even more complex. How much of the CO₂ goes out of the vents, and how stratified are the various gas components? Experience dictates that sulphur damage is generally on the lower leaves, but stratification could be a phenomenon we need to consider, especially with closed vents under winter conditions. One interesting illustration of how distribution alters yields came to light in the reported case of one grower who recently installed a CO₂ system into a modern venlo block and a multi-span poly tunnel, after which the house giving the highest cropping changed from being the venlo to the poly tunnel. Obviously there will be other factors involved, but the fundamental differences will be due to different air movement characteristics and a more airtight structure.

Crop response

With regard to the different types of crop response to CO₂ there has been an ongoing debate on the accuracy of small compartment trials compared to large blocks, and whether the methods for scaling up are correct. The fact that the recommendations from research as to maximum economic levels were so different to commercial reality has led to commercial practice rapidly overtaking research activity. This year we have the new phenomenon of some growers querying whether detrimental effects from the very high dosing rates of CO₂ (whether it be the associated heat, NO_x or SO_x is another matter) are greater than the beneficial ones - again we need research linked in with commercial practice to give answers. Commercial experience in Guernsey on freesia crops has been the reverse - that the economic level of enrichment suggested by Dutch research has not

proven to be viable. Again the question is why should this be, and should there be a change in growing technique applied which would transform it in the same way as we have seen with tomatoes, where we have seen increasing summer planting densities become the norm to avoid large fruit

It could be that there are other areas in which growing and management practice needs to be altered in order to maximise the benefits to the grower - the observed response of the poly tunnel crop above being a case in point. It will be interesting to see in due course how the ongoing research work on CO₂ optimisation strategies tackles some of these questions, but there are still many more affecting **all** crops not just the current main users like tomatoes. Physiologically we believe that the potential for even greater output from tomatoes is there, how much more so for other edible crops such as cucumbers where dosing is still at a significantly lower level, and also other ornamentals crops.

Investment

The value of the fuel burnt to produce CO₂ enrichment is likely to exceed £8 million p.a., and although a large proportion of this is effectively 'free' from the heating system it is still a large sum. Questions still remain on the use of summer CO₂ with regard to entry point, sensor position, plant uptake, distribution and levels. Any lack of correct application will either result in a waste of CO₂, or a lack of return on investment due to reduced potential yields. Unfortunately none of our research stations is equipped with natural gas burning CO₂ plant, let alone of the capacity being used by growers, to answer these questions.

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