

Root oxygen use determination of propagated cucumber on rockwool cubes

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Oxygen Use

The critical oxygen levels mentioned in literature vary from 0.1-3.0 mg.L⁻¹. The reason for this wide range is believed to be that roots can function on low oxygen levels as long as the supply rate surpasses the demand of the roots.

The goal for this experiment was to determine the critical root oxygen use nondestructively in situ over a longer period in a climate chamber environment.

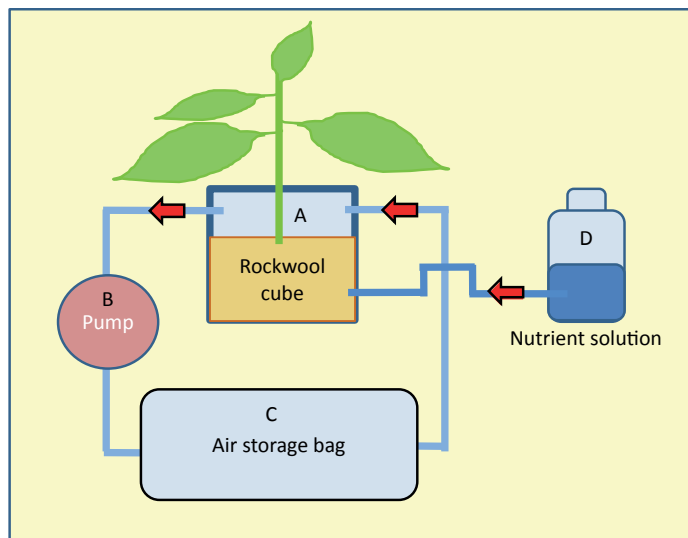


Figure 1. System to control the supply of oxygen and water, showing an airtight box with rockwool and a plant (A), an air pump (B), an air bag (C) and an air free supply of nutrient solution (D).

Method

Airtight boxes of 1.5 mm thick polyvinylchloride (PVC) were constructed (Figure 1). A nontoxic flexible paste allowed plant growth in diameter while maintaining air tightness. A harmonica type peristaltic pump was used to circulate air from the top of the box over an airtight Tedlar bag. The bag contained 3.0 liter of air. The bags were refilled with fresh air when oxygen levels dropped below target levels. At the bottom of each box there was an air free connection to a reservoir with nutrient solution.

In a climate chamber white TL tubes provided 200 micromole.m⁻² of PAR light. The temperature was set at 22 degrees C°. The carbon dioxide level was kept at 400 ppm and the relative humidity was set at 75%.

In treatment H roots were subjected to a relatively high average oxygen level (21%), whereas treatment M stood for medium oxygen levels (7%) and treatment L for low oxygen levels (2%). As reference, without control of the root gas content, plants were either grown with the roots in an open box (ROB) or in cubes without a box (RWB).

Results

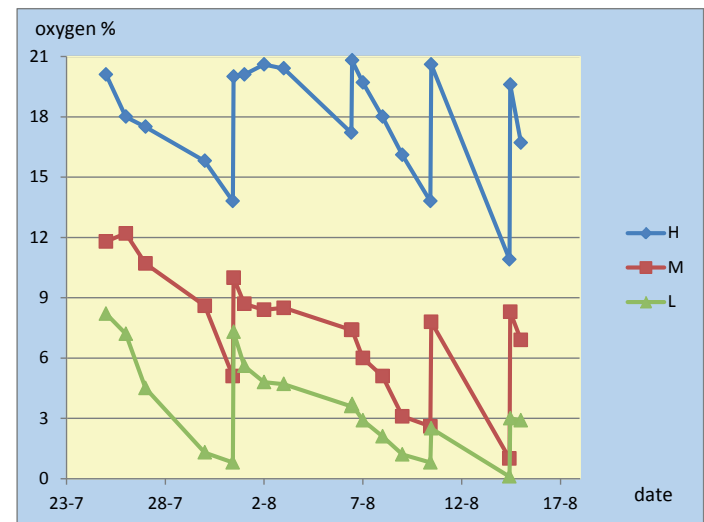


Figure 2. Evolution of the oxygen level in the experiment.

Table 1. Calculation of oxygen consumption* per treatment in mg/h and mg/h/gram of fresh root.

Treatment	Oxygen after %	Oxygen before %	Time h	System volume l	Oxygen use mg/h	Fresh root weight g	Oxygen uptake mg/h.g FW root
H-21	19.6	10.9	96	4.5	5.3	25	0.21
M-7	8.3	1.0	96	4.5	4.4	20	0.22
L-2	3.0	0.1	96	4.5	1.8	16	0.11

* Average of 3 plants for treatment H and M and 4 plants for treatment L.

**NB the root content is determined afterwards.

The oxygen uses of the H, M and L treatments were 0.21, 0.22 and 0.11 mg/h/g of root Fresh Weight. Above ground fresh weight production was respectively 100% , 71% and 62% of the H treatment.

The day time oxygen use rates in this experiment were roughly 3-5 times that of the night period values.

Conclusions

- Oxygen use rates found are 0.1-0.3 mg/h/g root-FW.
- The oxygen use per g root-FW does not indicate critical supply conditions as root and plant growth decrease before the oxygen use per g root-FW does.
- A decrease in the oxygen use per plant of 20% decreased fresh weight production with 30%.