Gerbera cultivation on coir with recirculation of the nutrient solution: a comparison with rockwool culture.
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Abstract
An experiment with Gerbera 'Aurelia' was set up to evaluate flower production and flower stem quality in an open and a closed growing system. For both systems two substrates, coir and rockwool, were evaluated.
No major differences were detected between the nutrient composition of the drainage water for both cultivation systems and both substrates. Re-use of the drainage water resulted in fertilizer savings of ± 35 %. No differences in flower production and in flower quality were found with re-use of the drainage water in comparison with an open drain system.
The choice of the substrate however, influenced the flower quality but not the number of flowering stems. For Gerbera 'Aurelia' grown on coir the flowering stems were periodically shorter than for plants grown on rockwool, yet flower stem weight was superior for plants grown on coir than for those grown on rockwool.

1. Introduction
Gerbera, one of the leading cut flowers in Europe, is mainly cultivated on rockwool without re-use of excessive drainage water. In intensive glasshouse cultures closed systems have to be developed to reduce fertilizer leaching into the environment. However re-use of the drainage water could result in the built-up of nutrients to excessive levels resulting in negative effects on crop production. Furthermore rockwool itself causes waste problems after the cultivation cycle. Alternatives for rockwool can be organic substrates or substrates - such as PUR, perlite, expanded clay - that can be used for many years. Coir, an organic substrate originating from the coconut fruit (Cocos nucifera L.), seems an acceptable substrate although limited information about the performance of coir as growing medium is published (Meerow, 1994). The objectives of this experiment were primarily to investigate the possibilities of coir as a growing medium for Gerbera and secondly, to evaluate the re-use of the drainage water in a closed system, using coir and rockwool as growing media.

2. Materials and Methods
Gerbera 'Aurelia' was grown on rockwool slabs (thickness of 7.5 cm and width of 12.5 cm) and on a layer of 6-7 cm coir, placed in gullies with internal width of 15 cm. The experimental set-up was a randomized block design with 2 replicates. The experiment was carried out from July 1994 till March 1996. The planting density was 8 plants.m². The minimum air temperature was 18°C in the daytime and 17°C at night. The ventilation started at 20°C.
The experiment was conducted in a 250 m² greenhouse in which eight 2000-1 tanks were positioned, four for the nutrient solutions and four for collecting drainage water. Preparation of the nutrient solutions (with rainwater) and the re-use of the drainage water in the nutrient solution was fully automated. The average composition of the nutrient solution was 11.5 mmol.l⁻¹ NO₃⁻, 1.25 mmol.l⁻¹ H⁺²⁻, 1.0 mmol.l⁻¹ S04²⁻, 0.75 mmol.l⁻¹ NH₄⁴⁺, 5.5 mmol.l⁻¹ C, 3.2 mmol.l⁻¹ Ca²⁺ and 1 mmol.l⁻¹ Mg2⁺ The minor elements were supplied as 30 umol.l⁻¹ Fe-
DTPA, 0.8 umol.l⁻¹ Cu, 28 umol.l⁻¹ B, 0.5 umol.l⁻¹ Mo, 9 umol.l⁻¹ Mn and 4 umol.l⁻¹ Zn. After preparation, the nutrient solution was stocked in a tank. Each of the four nutrient tanks supplied one substrate (rockwool or coir) and one system (open or closed). The drainage water from each substrate of the closed systems was collected separately. Every two weeks each drainage solution was analyzed for pH, EC and mineral elements. Analyses are made by spectrocolorimetry (NO₃⁻ and H₂PO₄⁻) and by ICP (K, Na, Ca, Mg, Fe, Cu, B, Mn and Zn). The analysis results were introduced into the computer. New solutions were prepared using up to 50% of the drainage water, the decision for the percentage of re-used drainage water depended on its composition.

The plants were fertigated with drip irrigation. The irrigation frequency was based on solar irradiation (threshold value 2 MJ.m⁻²). In winter (November-February) the irrigation was based on time (1 irrigation every 2 hours, from 8 a.m. till 2 p.m). The adjustments to these irrigation regimes were made based on the drainage amounts. The average daily drainage percentage ranged from 30-40%.

The physical properties of the substrates were determined by the ISHS reference method (Gabriels and Verdonck, 1991). Once every two weeks, after the second irrigation of the day, leachates for both systems and for both substrates were collected and analyzed as described above.

Plant data were collected once or twice a week, 50 plants per replicate were analyzed. The harvested flowers were counted, stem length, stem weight and flower diameter were measured. Plant data were examined by analysis of variance. Mean separation was calculated by Tukey's studentized range test (P=0.05).

3. Results and discussion.
3.1. Physical characteristics of the substrate.

The particle sizes of the coir at the beginning and after 11 months of the culture are given in Fig 1, the dominant particle class is 0.50-2.00 mm. The mean diameter of the particles changed from 0.93 mm ± 2.39 at the start to 0.93 ± 1.52. The decrease of the standard deviation indicates a homogenization of this substrate. The physical characteristics at the end of the growing cycle are summarized in Table 1. Differences in air volume and easy available water suggest that a different irrigation strategy is necessary for each substrate. However, based on the drainage percentages, the irrigation needed mainly substrate specific adjustments in periods with low light intensity and subsequently a low crop transpiration.

3.2. Analysis of the drainage water.
No substantial differences between the leachate composition from the coir and from the rockwool were found for both open and closed growing systems. The pH ranged from 4.7 to 6.5 in the rockwool leachate and from 5.2 to 6.5 in the coir leachate. The EC of the leachate fluctuated from 1.7 to 2.2 dS.m⁻¹ (25°C) for rockwool and from 1.5 to 2.2 dS.m⁻¹ (25°C) for coir. Nitrogen immobilization by coir was not observed. The concentration of the mono- and bi-valent ions was within the advised range for these elements (Fig 2). Only H₂PO₄⁻ was found at a higher concentration in the percolate of both substrates and both systems (Fig 2).

3.3. Crop production and quality parameters.
The flower production of Gerbera 'Aurelia' was not significantly influenced by the substrate (coir or rockwool) or by the growing system (open or closed) (Table 2). Flower stem quality is determined by the stem length, the stem weight and the flower diameter. These quality parameters were not affected by re-using the drainage water in comparison with an open drain system (Table 2). The choice of the substrate however had a significant effect on these parameters. Gerbera 'Aurelia' grown on coir had significantly shorter flower stems and
significantly higher flower stem weights than those grown on rockwool (Table 2, Fig 1).
Shorter flower stems for Gerbera could indicate an increase of the EC in the root environment
(de Kreij and van Os, 1989). Yet harmful levels (EC > 4 dS.m⁻¹) were not encountered.

3.4. Fertilizer savings
The mineral consumption for the growing systems and for the substrates was calculated by the
input of minerals by preparing the nutrient solution and the mineral composition of the
drainage water. Re-use of the drainage water resulted in a fertilizer saving of 30-35 % for the
major elements (Table 3).

4. Conclusion
This experiment demonstrates that coir is an acceptable substitute for rockwool as a growing
medium for Gerbera cultivation. When preparing the nutrient solution with rainwater the re-
use of the drainage water up to 50 % of the nutrient solution does not result in accumulation
of certain ions up to harmful levels. Growing Gerbera in a closed system results in a fertilizer
saving of 30-35 %.

Acknowledgements
The authors are grateful to Prof. R. Hartman, University of Ghent, for the physical
characterization of the substrates.

References
- De Kreij, C. and van Oss, P.C. 1989. Production and quality of Gerbera in rockwool as
  affected by electrical conductivity of the nutrient solution. Proc. 7th Int. Cong.
  Soilless Culture, 225-264.
- Gabriels, R. And Verdonck, O. 1991. Physical and chemical characterization of plant
### Table 1: Physical characteristics of the substrates after 20 months of culture (ISHS reference method). Mean of four samples and standard deviation.

<table>
<thead>
<tr>
<th>Growing medium</th>
<th>Bulk density (g/cm³)</th>
<th>Total porosity (vol %)</th>
<th>Air volume (%)</th>
<th>Water volume (%)</th>
<th>Easy available water (%)</th>
<th>Water buffering capacity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>rockwool</td>
<td>0.057±0.00</td>
<td>97.9±0.1</td>
<td>33.6±0.8</td>
<td>64.3±0.8</td>
<td>61.8±1.1</td>
<td>0.54±0.3</td>
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<tr>
<td>coir</td>
<td>0.067±0.00</td>
<td>95.7±0.1</td>
<td>16.9±4.2</td>
<td>78.7±4.2</td>
<td>29.8±4.5</td>
<td>4.71±1.8</td>
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</table>

### Table 2: Production and flower quality of *Gerbera 'Aurelia'* (July 94 - March 96).

<table>
<thead>
<tr>
<th>Growing medium</th>
<th>Growing system</th>
<th>N° of Stem flowers/plant (cm)</th>
<th>length</th>
<th>Stem weight (g/100 cm)</th>
<th>Flower diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>rockwool</td>
<td>open</td>
<td>38.0</td>
<td>64.2</td>
<td>33.5</td>
<td>11.3</td>
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<tr>
<td></td>
<td>closed</td>
<td>36.3</td>
<td>64.0</td>
<td>32.7</td>
<td>11.2</td>
</tr>
<tr>
<td>coir</td>
<td>open</td>
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<td>62.1</td>
<td>34.0</td>
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<tr>
<td></td>
<td>closed</td>
<td>37.6</td>
<td>60.7</td>
<td>34.8</td>
<td>11.1</td>
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<td>growing medium</td>
<td>ns</td>
<td>***</td>
<td>**</td>
<td>ns</td>
<td>ns</td>
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<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
</tbody>
</table>

ns **- ***: not significant, significant for 0.01 and 0.001.

### Table 3: Consumption of the nutrient elements (kg/I 000 m²) by *Gerbera 'Aurelia'* for the four treatments, for a period of 312 days.

<table>
<thead>
<tr>
<th>Element</th>
<th>Rockwool</th>
<th>Coir</th>
<th>Rockwool</th>
<th>Coir</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>250</td>
<td>162</td>
<td>242</td>
<td>154</td>
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<tr>
<td>P</td>
<td>54</td>
<td>35</td>
<td>52</td>
<td>33</td>
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<td>K</td>
<td>301</td>
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<td>Ca</td>
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<td>Mg</td>
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