Propagation of Cuttings in Different Media under Different Levels of Drainage©

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The present article describes a part of the experimental work carried out in connection with the master thesis of the author: *Rooting in Cuttings Influence by the Physical Properties of the Medium* (in Danish). This work should be consulted for further details.

INTRODUCTION

When propagating plants by cuttings, sufficient supplies of water and oxygen to the base of the cutting are of vital importance, as both water stress and oxygen deficiency may inhibit the adventitious root formation of the cutting. As the supply of water, as well as oxygen, are related directly to the water content in the propagation medium, the water content therefore becomes of very great importance to the root formation in cuttings (Grange and Loach, 1983; Haissig, 1986; Moe and Andersen, 1993; Hartmann et al., 1997). A suitable propagation medium ought to contain a high level of easily available water and a high air volume. These demands are met by media of peat as well as by some inorganic media, but the actual conditions are influenced by a number of the physical and chemical properties of the media, such as porosity and the degree of decomposition (Puustjarvi, 1973; Verdonck et al., 1981; Hartmann et al., 1997; Karlsen and Ammar, 1999). The physical properties of the majority of commercially used propagation media are quite identical, for that reason the actual usage of the media is important, as well as the media itself. Thus the practical conditions of the rooting, e.g., levels of drainage or the strategy of irrigation, will be of greater importance than an alternative composition of the rooting media. To investigate the influence of drainage on root formation, the rooting characteristics of two different propagation media were tested in combination with three levels of drainage (0, 12, and 24 cm).

MATERIALS AND METHODS

The experiment was conducted at the greenhouse section of the Royal Veterinary and Agricultural University, Copenhagen, in September through November 2000, and consisted of two parts: (1) a drainage experiment with the objective to test the water release properties of the media at three levels of drainage, and (2) a rooting experiment using cuttings of *Hibiscus rosa-sinensis* 'Classic White'. Both media were commercially available propagation blocks (Ellegaard, Esbjerg, Denmark) with a nominal size of 40 mm × 40 mm (diameter). The first medium was graded, light, speedling peat, and the second consisted of two-thirds water-absorbent and one-third water-repellent rockwool granulate, mixed with 5% clay and 5% lignite (Grodania, Glostrup, Denmark). Both media were packed in a cylinder of fungicide-treated vlies-paper and placed in plastic trays (31.5 cm × 50.8 cm) with 60 blocks per tray. One tray of each medium was used for each level of drainage. The trays are a part of a propagation system along with the blocks, and the holes for the blocks are provided with a draining system consisting of a small hole and four channels at the bottom. The drainage levels of 0, 12, and 24 cm were established in low plastic vessels of internal dimensions of 123.5 cm × 54 cm × 5 cm with an outlet in one corner. The plates for 12- and 24-cm drainage treatments were constructed of polystyrene covered by plastic, and measured 30 cm × 103 cm, equaling two trays of blocks. Hydraulic contact was established using Vatex irrigation mats. During both experiments, a water level of 2 cm was maintained, chosen as the water level that existed in the middle of a 40-mm block at 0-cm drainage. The experimental setup is pictured in Fig. 1. The experiments was conducted in tents constructed of white plastic, using a temperature setpoint of 22°C at day and 21°C at night. Artificial light was given 10 h day^{-1} (08.30 to 18.30), using two high-pressure sodium lamps (Philips SON-T Plus 400W) placed above the set-up. During the entire experiment a standard fertiliser mixture was used, with a conductivity of 0.725 mS cm^{-1} and a pH of 5.5. The irrigation strategy in the rooting experiment was determined from the observations of the drainage experiment, as it was decided to completely irrigate all media every 48th h, followed by an adjustment of the water level in the vessels to the original level (2 cm). The rooting of the cuttings was monitored regularly in the rooting experiment, and a recording was taken when 2/3 of the cuttings in a tray had rooted. Thus peat at 0- and 12-cm drainage was recorded 24 days after placing the cuttings; peat at 24 cm and rockwool at 0- and 12-cm drainage were recorded after 27 days, and rockwool at 24-cm drainage was recorded after 31 days. Each recording was conducted using 20 cuttings of every combination of media and drainage, and the following root formation data was recorded: whether rooting occurred or not,

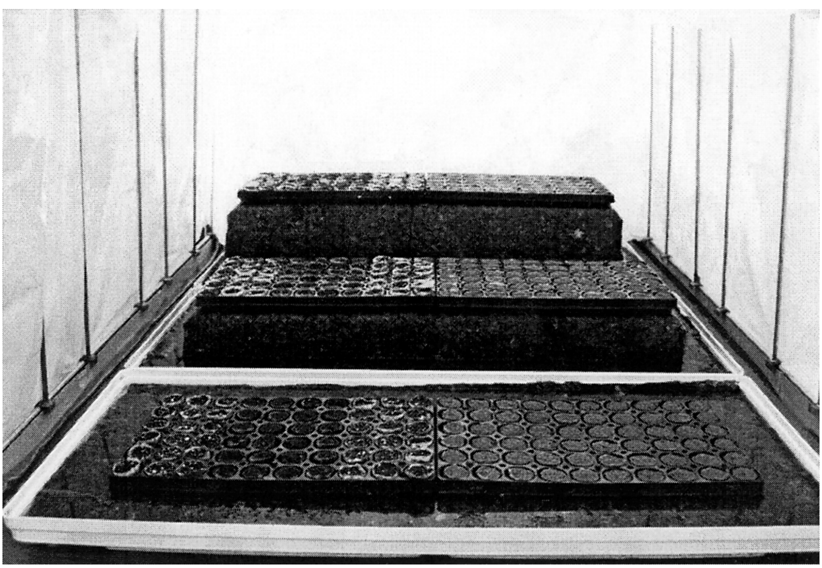

Figure 1. Experimental set-up.

number of roots, length of the longest root, and dry weight of roots. Only roots greater than 0.2 cm were included in the recordings.

In the drainage experiment, weighing at 24, 48, 72, and 120 h after full irrigation determined the water content of the blocks.

Recordings and Statistics. When the results were recorded, the effects of the media were compared across the levels of drainage, i.e., a summarised effect of media, whereas the effects of drainage are only compared for each medium. Different letters on the bars of the figures indicate statistical differences at the 5% level. These indications are only valid within comparable treatments, i.e., between media or drainage within a medium.

RESULTS AND DISCUSSION

Drainage Experiment. The different water contents at the different levels of drainage show that the experimental setup was functioning appropriately (Fig. 2). Both media have approximately the same water content at 0-cm drainage, indicating a uniform porosity, corresponding to previously published characterisations (Karlsen and Ammar, 1999). It must be noted that the volumetric water content of approximately 0.7 at 0-cm drainage does not represent the total porosity, as the water level was maintained at the middle of the blocks. A part of the total porosity was, therefore, filled with air but only in the top half of the blocks. An increase in drainage to 12 cm resulted in decreasing water content for both media, indicating an acceptable air content during normal usage. The water content in rockwool at 12-cm drainage, however, is higher, resulting in a lower air content than in peat. At 24-cm drainage no differences in water content between the media were recorded. Apparently both media have a high level of easily available water shown by the fact that approximately half of the water content at 0-cm drainage is released at 24-cm drainage. This is consistent with a previous experiment with the rockwool granulate (Jørgensen, 1998), and was likewise expected for the peat, as a light peat was used. At 12- and 24-cm drainage, both media showed slightly decreasing water content

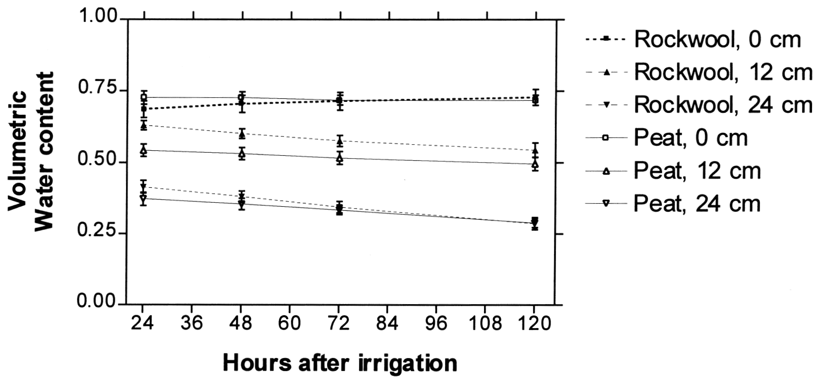

Figure 2. Volumetric water content of the propagation media in the drainage experiment. Vertical lines represents 95% confidence intervals.

with time. The most likely cause of this is evaporation, as hydraulic equilibrium at these low levels of drainage is normally reached in 24 h (Jensen et al., 1996). As the decrease is not significant during the first 48 h following a full irrigation, the used strategy of irrigation ensured an approximately constant level of water content in the rooting experiment.

Rooting Experiment. The results of the rooting experiment are shown in the Figs. 3 to 6. Overall, the cuttings in peat had an increased root formation compared to cuttings in rockwool which could be observed on all parameters. A straightforward explanation could be different water content and the resulting differences in oxygen supply of the media. The drainage experiment, however, showed relatively small differences in water content, suggesting that other factors should be considered. A possible explanation could be a different oxygen diffusion coefficient between the media, similar to the experimental data for peat and rockwool obtained by Gislerød (1982). The effect of drainage is not particularly noticeable, but apparently 24-cm drainage resulted in slower root formation in both media, as shown by the different times of recordings. The rooting percentage of cuttings in peat was inversely proportional to the level of drainage, whereas no effect was observed on the number of roots. On the other hand, the growth of the roots was lowered at 0-cm drainage. The only effect of drainage on cuttings in rockwool was an increasing number of roots the higher the drainage. However, the root formation of cuttings in peat was higher than in rockwool when the media were compared across the levels of drainage, as previously mentioned. The increased number of roots at low water content could be a reaction to moderate water stress, which has been reported to stimulate root formation (Rajagopal and Andersen, 1980). The water content is apparently of relatively little importance in relation to the rooting of cuttings of *Hibiscu*s in rockwool, indicating that the strategy of irrigation is less critical in this medium. When using peat, on the other hand, it would appear that excessive water content should be avoided as it decreases the growth of the roots considerably, whereas root initiation is increased. A lack of oxygen, caused by the high water content, is a possible explanation. Of course this condition would affect root initiation, but the effects of oxygen shortage are greater on the subsequent growth of the roots (Eliasson, 1981; Haissig, 1986). Even though the cuttings in peat were more sensitive to excessive irrigation, the general estimate is that *Hibiscus* cuttings are relatively insensitive regarding the water content of the media. This is in accordance with previously published information (Bertram, 1989), and supports the notion that the water content is not necessarily the main reason for differences among propagation media. Other parts of the experiment (not included in this paper) have shown that the subsequent growth of the potted plants is directly proportional to differences in root formation, as a decreased root formation resulted in decreased growth of the plants (Hansen, 1990). An implication of this is that root formation potentially is of great commercial importance to the grower.

CONCLUSIONS

It can be concluded that the water content of the medium affects root formation in cuttings, but other factors are apparently contributing as well. The drainage experiment showed that the experimental setup resulted in differences in volumetric water content between levels of drainage, but the differences between the media

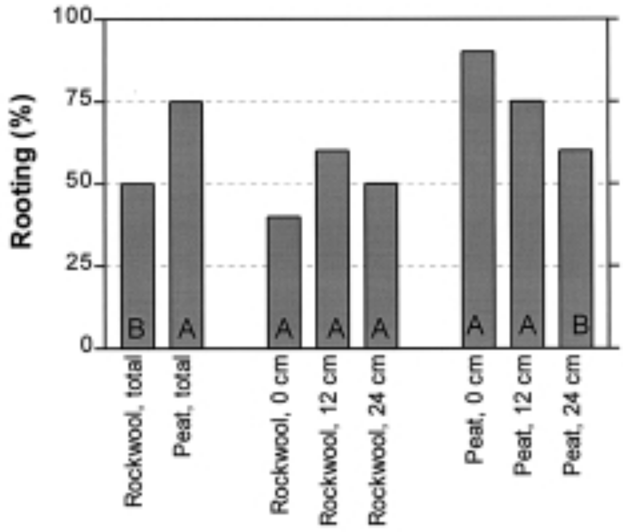

Figure 3. Rooting percentage.

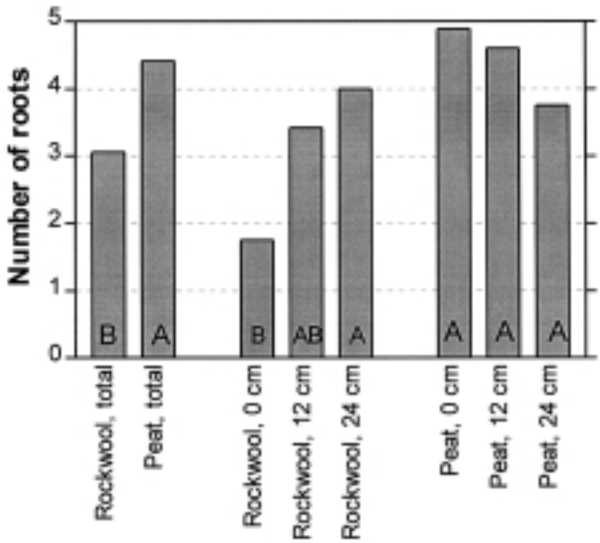

Figure 4. Average number of roots.

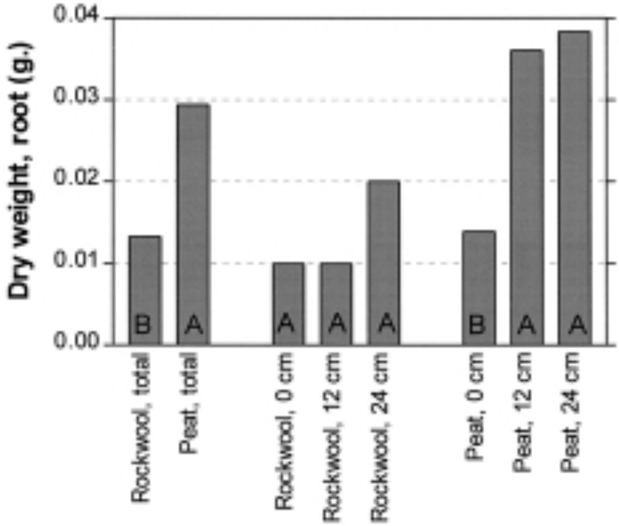

Figure 5. Average dry weight of roots.

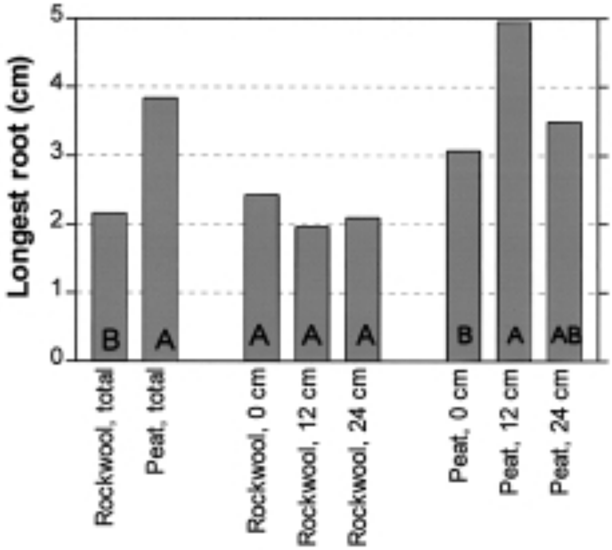

Figure 6. Average length of the longest root.

were relatively small. No distinctive effect of drainage on root formation was observed, however, cuttings in peat showed decreased rooting at 0-cm drainage and 24-cm drainage resulted in a slower rooting.

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