

# Determination of volume weight and water content of wood fiber substrates with different methods

N. GRUDA and W. H. SCHNITZLER\*

received: 13.02.1999, accepted: 08.07.1999

*Keywords:* physical properties, wood fiber substrates, volume weight, water content, ISHS method, positive and negative pressure method.

## 1 Introduction

Wood fiber substrates have been introduced for several years in horticulture. Their use in seedling and transplant production is still not very popular. The most frequently applied mixtures are based on peat (GRUDA, 1999). To evaluate wood fiber substrates for their suitability for plant production physical, chemical and biological characteristics are usually determined. Chemical-biological characteristics of wood fiber substrates (N-immobilization) have been reported by GRUDA and SCHNITZLER (1997; 1999).

The physical characterization of substrates gives important information on numerous parameters but particularly on the water/air relation in the substrate. This information is necessary for the correct control of water supply (BOHNE and GÜNTHER, 1997). The physical characteristics of substrates are important since they cannot be changed during the culture (VERDONCK, 1983).

The determination of volume weight (VW) or bulk density is a precondition for calculating nutrient contents of substrates. In contrast, other physical properties of substrates are rarely analyzed, although, with such data available recommendations for vegetable growth and production can be improved. Consideration has to be due to higher expenditures for physical compared to chemical analyses. In addition, different equipment in the laboratories and the application of different methods makes the transfer of data and information more difficult.

The ISHS method (International Society for Horticultural Science) can serve as an international standard of investigations for the physical properties of substrates as suggested by VERDONCK and GABRIELS (1992). The LUFA method provided by the Verband Deutscher Landwirtschaftlicher Untersuchungs- und Forschungs-Anstalten (German Association of Agricultural Laboratory Research Institutes) is considered as standard for the investigation of the VW of horticultural substrates in Germany. The disadvantage of the ISHS method is the relatively large amount of time for analysis. The advantage is that VW is determined at a defined volumetric water content (WC) of the substrates (pF = 1,0). Whereas with LUFA method, the water content is not adjusted by an objective measurement.

The condition established for the determination for VW of a substrate according to ISHS and LUFA method does not reflect the condition in the pot during cultivation. This needs to be considered when the mineral nutrient content in a pot is calculated and when the WC of a substrate in pots is determined.

The standard method for determination of volumetric WC at pF = 1-2 and other derived parameters for physical characterization of substrates is the original ISHS method which is based on non-compacted substrates. For the determination of the WC in substrates under pot

---

\*Dr. N. GRUDA and Prof. Dr. W. H. SCHNITZLER, Institute of Vegetable Science, Techn. University München-Weihenstephan, Alte Akademie 10, D-85350 Freising, Germany

conditions a modified ISHS method was suggested by BOHNE and GÜNTHER (1997). In addition, some laboratories use the same techniques as for soil analysis (BRÜCKNER, 1997).

The aim of this study is to investigate the comparability of the available methods for determination of volume weight and water content in organic substrates.

## 2 Material and methods

Volume weight and volumetric water content at three different water potentials were determined with 'Toresa nova' (Tn), a wood fiber substrate with a finer texture and 'Toresa + brown coal' (TnBk), a mixture both from Intertoresa AG (Switzerland) as well as the peat substrate 'Statohum' from Gebr. Patzer GmbH & Co. KG (Germany).

### *Volume weight (VW)*

The VW of substrates was determined by three procedures: a) LUF A method, b) ISHS method and c) pot method. For all three methods the VW was determined by the ratio of dry weight at 105 °C of substrate (g) and substrate volume (cm<sup>3</sup>).

#### *a) LUF A method*

Transparent plastic cylinders (250 ml) were filled up to the edge with the substrate. The required water content of the substrate was adjusted before by observation. It must be moist enough to be adhesive after pressing (when tightly compacted in a fist, it must have a moist touch but no water may exude). The cylinder was successively dropped ten times from 10 cm height. The volume and the dry matter of the compressed substrate was then determined (VDLUF A, 1991).

#### *b) ISHS method*

According to VERDONCK and GABRIELS (1992) the substrate must be saturated with water first: fill slowly with water until the level reaches up to 1 cm under the top of the container. After this remove the container and leave for 48 h on the sandbox, applying a suction of 50 cm (pF = 1.7). Mix the sample, fill rings with a big spoon in increments of approximately 100 ml without causing compaction and fill up to the top of the removable ring. Transfer the filled double rings into laboratory water bath and after repeated moistening for 24 hours place them immediately to the sand boxes. The rings are slightly pressed for good contact with the sand surface. Cover the sand boxes and apply the suction from 10 cm (pF = 1.0) for 48 hours. Take the double rings from the sand box and remove the upper ring slowly, exposing the uppermost part of material. Using a sharp knife strike off the material level with the top of the test ring without causing compaction. Volume and dry matter as well as the VW of the substrate of the lower ring was then determined.

#### *c) Pot method*

The VW of the substrates or substrate mixtures for 4x4x4 cm press pots and for plug trays (77 pots) was determined after pressing and filling respectively. Only one substrate (Toresa nova) was examined in the plug trays. The substrate's volume as well as substrate dry matter was determined by using 2x10 pots for each treatment. Consequently, the VW corresponded with the conditions which prevailed in the pot.

### *Volumetric water content (WC) at different water potentials*

The volumetric WC of substrates was determined using three procedures: a) modified ISHS method, b) positive pressure method and c) negative pressure method. Principle of measurement of all three methods is the saturation of the substrate sample with water and a further drainage to certain levels of water potential, i.e. at each level of water potential all water has left the substrate sample which is held back at less tension than the applied water potential.