hm/doc/sdbpottin

GLASSHOUSE CROPS RESEARCH AND EXPERIMENT STATION NAALDWIJK, THE NETHERLANDS

METHODS FOR PHYSICAL ANALYSIS OF POTTING SOIL AND PEAT

by F.M. Leijn-van Dijk
S.S. de Bes

1e ongewijzigde druk

Naaldwijk april 1987

Series: "Analytical Procedures" nr. 2.

C O N T E N T S

PREFACE

During a number of years now the physical laboratory carries out many physical analyses in potting soil and in peat, both for research purposes and for practical use. The analysis methods used herein have been developed by the physical laboratory by optimizing the basic instructions of the Institute for Soil Fertility in Haren (the Netherlands).
Although these instructions have surely not reached a definitive state, because in future still more adjustments and extensions are to be expected, it is nevertheless useful to publish a volume of instructions now.
Taking into account that:

- changes will not occur at short notice because of the necessary preceding research;
- both national and international interest is shown for the applied methods;
- within a short time handing over of certain tasks will take place bacause of the fact that analyses for practice will be carried out more and more by private laboratories.

The publishing of such a volume of methods at this moment is justified.

Each method describes a more or less complete analysis package. For the physical analysis of potting soil one can choose now between two possibilities, namely:

- an extensive package, for which one analytical method is given, being a reference method;
- a limited package, for which two methods are given, being a reference method and a simplified method.

Both packages can be supplemented by the determination of the shrinkage.
The choice of the package depends on the purpose and thus has to be made by the sender of the sample. Which analytical method shall be used will be determined by the physical laboratory.
For the benefit of the physical analysis of peat also the instruction for the determination of the bulk density has been inserted, from which the waterholding capacity can be calculated.

As auxiliary instructions are included methods for the determination of moisture and organic matter and directions for the use of sand-boxes.

With this volume we try to give an overview of the methods used according to the present views and also to give a helping hand to those persons who consider the application of the described methods. As soon as necessary arises revision of this volume will take place. Therefore users of this manual should make sure regularly whether revision has taken place.

Finally we wish to thank Mrs. Spierings for the English translation.

The authors.

A. EXTENSIVE PHYSICAL ANALYSIS OF POTTING SOIL - REFERENCE METHOD

1. Field of application

Samples of potting soil for practice and research purposes of which a moisture characteristic is required.

2. Contents of the analysis

The determination of the bulk density, the pore space; the volume percentages of water and air and the A-figure af pF-values of 0.5 - 1.0 - 1.5 - 1.7 and 2.0 respectively.
Duration of the analysis: 13 days.

3. Work plan in short

Fill a cylinder-set with a content of 500 cm^3 in the standard way with potting soil. Saturate during at least 24 hours on a sand-box. Press with a pressure of 0.1 kg/cm^2 after pF 2.0 has been set during at least 24 hours. Resaturate during at least 24 hours, then set to pF 0.5 for at least 24 hours.
Determine the weight of the moist potting soil. Set to pF 1.0 - 1.5 - 1.7 and 2.0 in the same way and weigh the moist potting soil after each step. Determine the weight of the dry soil after a drying period of 27 hours.

4. Execution

4.1. Equipment

Sand-box:
Inside measures 60 x 30 x 40 cm with at the bottom an inlet and outlet system for water.
Conditioned according to the instruction G: 'The filling and conditioning of the sand-box for physical analysis'. If the sand-box is constructed of PVC, make a wooden frame around the whole box for reinforcement.

press on which has been put a weight of 3.0 kg. Drain off the water in the sand-box by means of the level cylinder set to pF 2.0 and raise the water from the bottom by placing the waterlevel in the decanter bottle 2.5 cm above the sand surface.
When the sand surface is covered with a few mm of water, then stop the inlet of water and close the cock of the sand-box.
Any air bubbles under the nylon cloth should be removed with a wet sponge. Place the cylinder-set with potting soil in the sand-box and press lightly on the nylon cloth to secure a good contact.
When all the cylinder-sets have been placed in the sand-box, bring the waterlevel to 5 cm above the sand surface by adding water from the top. In order to prevent formation of holes in the sand surface the water should enter the sand-box via a thin small metal sheet placed on the sand surface.

After saturation during at least 24 hours, set to pF 2.0 (= 100 cm) and keep this underpressure for at least 24 hours.
During the setting and maintaining of the underpressure a petridish filled with water should be placed on the sand surface and the sand-box should be kept closed.

Take the cylinder-sets out of the sand-box and press the potting soil once again with a pressure of 0.1 kg/cm^2 with the press.
Raise the water from the bottom and replace the cylinder-sets in the pF-box in the same way as explained above. Add water from the top till a level of 5 cm above the sand surface. After saturation during at least 24 hours, set to pF 0.5 (= 3.2 cm) and keep this underpressure for at least 24 hours.

Take the cylinder-sets out of the sand-box.
Separate both cylinders and saw off smoothly the potting soil in the lower cylinder in the following way: fasten the cylinder-set in the cylinder clamp and place the vertical PVC wall of the clamp against the bottom of the cylinder-set and fix it. Push aside the 3.5 cm broad rubber band, hold the potting soil at the open end and saw off the potting soil in the lower cylinder with the little saw.
Then weigh immediately the cylinder with the potting soil (say

'b_1' gram). Replace the cylinders with potting soil in the sand-box in the same way as described above, but without raising the water from the bottom. When all the cylinder-sets have been placed inside the sand-box again, set to pF 1.0 (= 10 cm) and keep this underpressure for at least 24 hours. Thereafter weigh the cylinders with potting soil again as explained above (say 'b_2' gram).
In the same way set to pF 1.5 (= 31.6 cm), pF 1.7 (= 50.1 cm) and pF 2.0 (= 100 cm) successively and weigh the cylinders every time after maintaining the underpressure for at least 24 hours (say 'b_i' gram).

Finally remove the 1 cm broad rubber band and dry the cylinders with potting soil at $105^{o} \pm 3^{o}$ C during minimal 27 hours. Determine the dry weight (say 'c' gram). Carefully remove the surrounding cylinder. Eventually the shrinkage of these lumps of potting soil can be determined according to method D: 'The determination of the shrinkage of potting soil'.

4.4. Calculations

In the formulas below the different symbols have the following meaning:

c = weight of the cylinder with potting soil after drying at 105^{o} C for 27 hours (g)

a = weight of the empty cylinder (g)

V = volume of the cylinder, fixed at 250 cm^3

s.g. = specific gravity of the potting soil (g/cm^3) according to:

$$\frac{410.75}{155 + 1.1 \times \% \text{ organic matter}}$$

b_i = weight of the cylinder with potting soil for the various pF-values (0.5, 1.0, 1.5, 1.7, 2.0) (g)

Bulk density:
Expressed in grammes of dry soil per dm^3 by this formula:

$$\frac{1000 \times (c - a)}{V}$$

Give the average results accurately to 1 g of dry soil per dm^3.

Pore space:

Expressed in volume percentage by the formula:

$$\frac{V - (c - a) / s.g.}{V} \times 100\%$$

Give the average results accurately to 0.1%.

Volume percentage of water for pF_i:

Expressed in volume percentage according to:

$$\text{Volume } \%_i \text{ of water} = \frac{b_i - c}{V} \times 100\%$$

Give the average results accurately to 0.1%.

Volume percentage of air for pF_i:

Expressed in volume percentage according to:

$$\text{Volume } \%_i \text{ of air} = \text{pore space} - \text{volume } \%_i \text{ of water}$$

Give the average results accurately to 0.1%.

A-figure for pF_i:

Expressed in grammes of water per 100 gram of dry soil by this formula:

$$A_i = \frac{b_i - c}{c - a} \times 100$$

or this formula:

$$A_i = \frac{\text{water } \%_i}{\text{Bulk density}} \times 1000$$

Give the average results accurately to 1 g of water per 100 g of dry soil.

B. LIMITED PHYSICAL ANALYSIS OF POTTING SOIL - REFERENCE METHOD

1. Field of application

Samples of potting soil for practice and research purposes of which is known that a limited analysis will suffice.

2. Contents of the analysis

The determination of the bulk density, the pore space; the volume percentages of water and air and the A-figure at pF-value 1.5.
Duration of the analysis: 8 days.

3. Work plan in short

Fill a cylinder-set with a content of 500 cm^3 in the standard way with potting soil. Saturate during at least 24 hours on a sand-box. Press with a pressure of 0.5 kg/cm^2 after pF 2.0 has been set for at least 24 hours. Resaturate during at least 24 hours, then set to pF 1.5 for at leat 24 hours.
Determine the weight of the moist and of the dry potting soil by weighing. Drying time is 23 hours.

4. Execution

4.1. Equipment

Sand-box:
Inside measures 60 x 30 x 40 cm with at the bottom an inlet and outlet system for water.
Conditioned according to the instruction G: 'The filling and conditioning of the sand-box for physical analysis'. If the sand-box is constructed of PVC, make a wooden frame around the whole box for reinforcement.

Lid:

Wood, faced with plastic foam.

Blokzijl-sand:

Air entrance value of approx. 150 cm water, this corresponds to pF 2.2.

Cylinders:

Stainless steel, height 5.0 cm, contents 250 cm^3.

Press:

Own design with a bar of 1.96 kg.

Weights:

3.00 and 23.39 kg.

Fall installation:

A wooden base, falling height 5.0 cm.

Level cylinder:

Plastic, connected with the sand-box by means of a tube, to set the water level in the box.

Decanter bottle:

Glass, connected with the sand-box by means of a tube, for the watersupply to the box.

Cylinder clamp:

Own design, with two clamps to hold the cylinder set horizontally with a movable vertical wall of PVC at one side.

Little saw:

Iron.

Stove:

With exhauster; adjustable to 105° C $\pm$ 3° C.

Bands:

Rubber, 3.5 and 1 cm broad.

Polyester film:

Heidelberger Film.

Nylon cloth:

To cover the sand in the sand-box.

4.2. Material for analysis

Fieldmoist, homogenized potting soil.

4.3. Procedure

Determine the organic matter content and the moisture content (A-figure) according to method F: 'Determination of moisture and organic matter'.
The A-figure should be at least 1.2 times higher than the organic matter content. In case the A-figure is lower, add so much water that the A-figure reaches at least 1.4 times the organic matter content.
Keep the sample after wetting for 24 hours in a closed plastic bag. The amount of water to be added can be estimated with the following formula:

$$X = \frac{M\ (1.4 \times H - A)}{100 + A}$$

in which:
X = minimal amount of water to be added (ml)
M = amount of potting soil with A-figure A (g)
H = organic matter content (weight %).

Mix the potting soil thoroughly before each subsampling. Particles bigger than 2 cm should be crushed.
Attach two stainless steel, numbered and weighed (correct to 0.1 g; say 'a' gram) cylinders to eachother with a 3.5 cm broad rubber band. Attach to one side of this cylinder-set a piece of polyester film by means of a 1 cm broad rubber band.
Now fill the set evenly with homogenized potting soil to the rim with a spoon containing approximately 48 ml. Fill this spoon with potting soil and level it off with one movement of the finger.
After each addition let the set fall down 5 times from a height of 5 cm on the wooden base of the fall installation.
Let the set fall an extra 5 times from 5 cm height after the last addition. If the potting soil has sunk, then refill to the rim, but without letting the set fall again. Fill two cylinder-sets with the same number of spoons of potting soil for each sample.
Now press the potting soil with a pressure of 0.1 kg/cm^2 with the press on which has been put a weight of 3.0 kg. Drain off the

water in the sand-box by means of the level cylinder set to pF 2.0 and raise the water from the bottom by placing the waterlevel in the decanter bottle 2.5 cm above thes and surface.
When the sand surface is covered with a few mm of water, then stop the inlet of water and close the cock of the sand-box.
Any air bubbles under the nylon cloth should be removed with a wet sponge. Place the cylinder-set with potting soil in the sand-box and press lightly on the nylon cloth to secure a good contact.
When all the cylinder-sets have been placed in the sand-box, bring the waterlevel to 5 cm above the sand surface by adding water from the top. In order to prevent formation of holes in the sand surface the water should enter the sand-box via a thin small metal sheet placed on the sand surface.

After saturation during at least 24 hours, set to pF 2.0 (= 100 cm) and keep this underpressure for at least 24 hours.
During the setting and maintaining of the underpressure a petridish filled with water should be placed on the sand surface and the sand-box should be kept closed.

Take the cylinder-sets out of the sand-box and press the potting soil with a pressure of 0.5 kg/cm^2 with the press on which has been put a weight of 23.39 kg. Raise the water from the bottom and replace the cylinder-sets in the sand-box in the same way as explained above. Add water from the top till a level of 5 cm above the sand surface.
After saturation during at least 24 hours, set to pF 1.5 (= 31.6 cm) and keep this underpressure for at least 24 hours.

Take the cylinders-sets out of the sand-box. Separate both cylinders and saw off smoothly the potting soil in the lower cylinder in the following way: remove the nylon cloth and the 1 cm broad rubber band, fasten the cylinder-set in the cylinder clamp and place the vertical PVC wall of the clamp against the bottom of the cylinder-set and fix it. Push aside the 3.5 cm broad rubber band, hold the potting soil at the open end and saw off the potting soil in the lower cylinder with the little saw.

Place the lower cylinder with potting soil on a filter paper, remove carefully the cylinder and then weigh immediately the lump of potting soil (say 'b' gram). Dry for at least 23 hours at 105° ± 3° C. Determine the dry weight (say 'c' gram).
If necessary the shrinkage of these lumps of potting soil can be determined according to method D: 'The determination of the shrinkage of potting soil'.

4.4. Calculations

In the formulas below the different symbols have the following meaning:

c = weight of the lumps of potting soil after drying at 105° C for 23 hours (g)
V = volume of the cylinder, fixed at 250 cm^3
b = weight of the lump of potting soil at pF 1.5 (g)
s.g. = specific gravity of the potting soil (g/cm^3) according to:

$$\frac{410.75}{155 + 1.1 \times \% \text{ organic matter}}$$

Bulk density:
Expressed in grammes of dry soil per dm^3 by this formula:

$$\frac{1000 \times c}{V}$$

Give the average results accurately to 1 g of dry soil per dm^3.
Pore space:
Expressed in volume percentage by this formula:

$$\frac{V - c / s.g.}{V} = 100\%$$

Give the average results accurately to 0.1%.

Volume percentage of water for pF 1.5:

Expressed in volume percentage according to:

$$\frac{b - c}{V} \times 100\%$$

Give the average results accurately to 0.1%.

Volume percentage of air for pF 1.5:

Expressed in volume percentage according to:

pore space - volume % of water.

Give the average results accurately to 0.1%.

A-figure for pF 1.5:

Expressed in grammes of water per 100 gram of dry soil by this formula:

$$\frac{b - c}{c} \times 100$$

or this formula:

$$\frac{\text{volume \% of water}}{\text{Bulk density}} \times 1000$$

Give the average results accurately to 1 g of water per 100 g of dry soil.

C. LIMITED PHYSICAL ANALYSIS OF POTTING SOIL - SIMPLIFIED METHOD

1. Field of application

Samples of potting soil with a composition of which is known that the time, needed to reach equilibrium in the limited analysis, can be reduced.

2. Contents of the analysis

The determination of the bulk density, the pore space; the volume percentages of water and air and the A-figure at pF 1.5. Duration of the analysis: 4 days.

3. Work plan in short

Fill a cylinder-set with a content of 500 cm^3 in the standard way with potting soil. Saturate during at least 4 hours on a sand-box. Press with a pressure of 0.5 kg/cm^2 after pF 2.0 has been set for at least 16 hours. Resturate during at least 4 hours, then set to pF 1.5 for at least 16 hours. Determine the weight of the moist and of the dry potting soil by weighing. Drying time is 23 hours.

4. Execution

4.1. Equipment

Sand-box:

Inside measures 60 x 30 x 40 cm with at the bottom an inlet and outlet system for water.
Conditioned according to the instruction G: 'The filling and conditioning of the sand-box for physical analysis'. If the sand-box is constructed of PVC, make a wooden frame around the whole box for reinforcement.

Lid:

Wood, faced with plastic foam.

Blokzijl-sand:

Air entrance value of approx. 150 cm water, this corresponds to pF 2.2.

Cylinders:

Stainless steel, height 5.0 cm, contents 250 cm^3.

Press:

Own design with a bar of 1.96 kg.

Weights:

3.00 and 23.39 kg.

Fall installation:

A wooden base, falling height 5.0 cm.

Level cylinder:

Plastic, connected with the sand-box by means of a tube, to set the water level in the box.

Decanter bottle:

Glass, connected with the sand-box by means of a tube, for the watersupply to the box.

Cylinder clamp:

Own design, with two clamps to hold the cylinder set horizontally with a movable vertical wall of PVC at one side.

Little saw:

Iron.

Stove:

With exhauster; adjustable to 105^{o} C $\pm$ 3^{o} C.

Bands:

Rubber, 3.5 and 1 cm broad.

Polyester film:

Heidelberger Film.

Nylon cloth:

To cover the sand in the sand-box.

4.2. Material for analysis

Fieldmoist, homogenized potting soil.

4.3. Procedure

Determine the organic matter content and the moisture content

(A-figure) according to method F: 'Determination of moisture and organic matter'.
The A-figure should be at least 1.2 times higher than the organic matter content. In case the A-figure is lower, add so much water that the A-figure reaches at least 1.4 times the organic matter content.
Keep the sample after wetting for 24 hours in a closed plastic bag. The amount of water to be added can be estimated with the following formula:

$$X = \frac{M\ (1.4 \times H - A)}{100 + A}$$

in which:
X = minimal amount of water to be added (ml)
M = amount of potting soil with A-figure A (g)
H = organic matter content (weight %).

Mix the potting soil thoroughly before each subsampling. Particles bigger than 2 cm should be crushed.
Attach two stainless steel, numbered and weighed (correct to 0.1 g) cylinders to eachother with a 3.5 cm broad rubber band (say 'a' gram). Attach to one side of this cylinder-set a piece of polyester film by means of a 1 cm broad rubber band.
Now fill the set evenly with homogenized potting soil to the rim with a spoon containing 48 ml. Fill this spoon with potting soil and level it off with one movement of the finger.
After each addition let the set fall down 5 times from a height of 5 cm on the wooden base of the fall installation.
Let the set fall an extra 5 times from 5 cm height after the last addition. If the potting soil has sunk, then refill to the rim, but without letting the set fall again. Fill two cylinder-sets with the same number of spoons of potting soil for each sample.
Now press the potting soil with a pressure of 0.1 kg/cm^2 with the press on which has been put a weight of 3.0 kg. Drain off the water in the sand-box by means of the level cylinder set to pF 2.0 and raise the water from the bottom by placing the waterlevel in the decanter bottle 2.5 cm above thes and surface.

When the sand surface is covered with a few mm of water, then stop the inlet of water and close the cock of the sand-box.
Any air bubbles under the nylon cloth should be removed with a wet sponge. Place the cylinder-set with potting soil in the sand-box and press lightly on the nylon cloth to secure a good contact.
When all the cylinder-sets have been placed in the sand-box, bring the waterlevel to 5 cm above the sand surface by adding water from the top. In order to prevent formation of holes in the sand surface the water should enter the sand-box via a thin small metal sheet placed on the sand surface.

After saturation during at least 4 hours, set to pF 2.0 (= 100 cm) and keep this underpressure for at least 16 hours. During the setting and maintaining of the underpressure a petridish filled with water should be placed on the sand surface and the sand-box should be kept closed.

Take the cylinder-sets out of the sand-box and press the potting soil with a pressure of 0.5 kg/cm^2 with the press on which has been put a weight of 23.39 kg. raise the water from the bottom and replace the cylinder-sets in the sand-box in the same way as described above. Add water from the top till a level of 5 cm above the sand surface.
After saturation during at least 4 hours, set to pF 1.5 (= 31.6 cm) and keep this underpressure for at least 16 hours.

Take the cilinders-sets out of the sand-box. Separate both cylinders and saw off smoothly the potting soil in the lower cylinder in the following way: remove the nylon cloth and the 1 cm broad rubber band, fasten the cylinder-set in the cylinder clamp and place the vertical PVC wall of the clamp against the bottom of the cylinder-set and fix it. Push aside the 3.5 cm broad rubber band, hold the potting soil at the open end and saw off the potting soil in the lower cylinder with the little saw.

Place the lower cylinder with potting soil on a filter paper, remove carefully the cylinder and then weigh immediately the lump of potting soil (say 'b' gram). Dry for at least 23 hours at 105^{o}

$\pm$ 3° C. Determine the dry weight (say 'c' gram).
If necessary the shrinkage of these lumps of potting soil can be determined according to method D: 'The determination of the shrinkage of potting soil'.

4.4. Calculations

In the formulas below the different symbols have the following meaning:

c = weight of the lumps of potting soil after drying at 105° C for 23 hours (g)
V = volume of the cylinder, fixed at 250 cm^3
b = weight of the lump of potting soil at pF 1.5 (g)
s.g. = specific gravity of the potting soil (g/cm^3) according to:

$$\frac{410.75}{155 + 1.1 \times \% \text{ organic matter}}$$

Bulk density:
Expressed in grammes of dry soil per dm^3 by this formula:

$$\frac{1000 \times c}{V}$$

Give the average results accurately to 1 g of dry soil per dm^3.
Pore space:
Expressed in volume percentage by this formula:

$$\frac{V - c / s.g.}{V} = 100\%$$

Give the average results accurately to 0.1%.
Volume percentage of water for pF 1.5:
Expressed in volume percentage according to:

$$\frac{b - c}{V} \times 100\%$$

Give the average results accurately to 0.1%.

Volume percentage of air for pF 1.5:

Expressed in volume percentage according to:

pore space - volume % of water.

Give the average results accurately to 0.1%.

A-figure for pF 1.5:

Expressed in grammes of water per 100 gram of dry soil by this formula:

$$\frac{b - c}{c} \times 100$$

or this formula:

$$\frac{\text{volume \% of water}}{\text{Bulk density}} \times 1000$$

Give the average results accurately to 1 g of water per 100 g of dry soil.

D. THE DETERMINATION OF THE SHRINKAGE OF POTTING SOIL

1. Application

The determination of the shrinkage of potting soil can only be done after an instruction for physical analysis of potting soil has been carried out, with the exception of the determination of moisture and organic matter content.

2. Principle

The determination of the change of volume of potting soil by drying compared with the volume under standardized circumstances.

3. Execution

3.1. Equipment

A sliding gauge.

3.2. Procedure

Measure of both lumps the height in quadruplicate. Measure the diameter in triplicate, namely at the top, in the middle and at the bottom. Give the measurements accurately to 0.1 cm. Calculate the average height and diameter accurately to 0.1 cm.

3.3. Calculation

$$\% \text{ shrinkage} = \frac{V - 0.25\pi . d^2 . h}{V} \times 100\% \text{ or } \frac{1000 - \pi . d^2 . h}{10}$$

in which:

- d = average diameter of lump of potting soil after drying at 105° C (cm)
- h = average height of lump of potting soil after drying at 105° C (cm)
- V = volume of the cylinder, fixed at 250 cm^3.

Give the shrinkage percentage accurately to 1%.

Note: The shrinkage is expressed as change of volume (in %) of potting soil by drying compared with the volume of moist potting soil obtained after the execution of extensive or limited physical analysis.

E. THE DETERMINATION OF THE BULK DENSITY IN PEAT

1. Equipment

Cylindrical tubes:
Polyethylene, length 20 cm, inside diameter between 5.5 and 5.8 cm, with a grooved brom at one side in order to fix with a rubber band a nylon cloth or other non corrosive material.
Cylindrical weights (or weights mounted on a circular disc):
With a diameter of approx. 2 mm less than the inside diameter of the tubes. The pressure exerted by these weights should be 10 g/cm^2.
Fall installation:
A wooden base, falling height 5.0 cm.
Drying stove:
Adjustable to 40° C, with air inlet and outlet.
Evaporation tray:
Polyethylene.
Mesh size of 2 cm.

2. Preparation of the samples

Determine the moisture content, preferably the same day, but in any case within 3 days. The fieldmoist samples are spread out in the evaporation trays and homogenized as well as possible. Only particles bigger than 2 cm are crushed. (Only samples with very many coarse parts are being sieved).
The spreading out in the trays should be done as airily as possible, so the drying will be as efficient as possible,
During one night the samples are dried at 40° C maximum with continuous in- and out-flow of air.
The air-dry samples may contain 15% moisture at maximum.

3. Execution

Fix with a rubber band a piece of nylon cloth at the bottom of the tube. Weigh the tube accurately to 0.1 g (say 'a' gram).
Then fill the tube in 10 more or less equal portions to a height

of 17 cm. After each addition let the tube fall down 5 times from a height of 5 cm perpendicularly on the wooden base of the fall installation.
After a height of approximately 17 cm has been reached an appropiate weight of 10 grams per cm^2 is placed on the material. If the column of soil sinks, fill up again to 17 cm ($\pm$ 0.2 cm), but without letting the tube fall again. Weigh the tube filled with dry soil, but without the weight (say 'b' gram).
Carry out the determination at least three times. Include for eacht series a standard sample. It is better to use a new tube + nylon cloth for each new sample.
The used tubes are cleaned with tap water and air-dried.

Note: The tubes and evaporation trays may never be heated to temperatures higher than 60° C because of the temperature sensibility of the material (polyehtylene).

4. Calculation

4.1. The bulk density is expressed in grammes of oven dry peat per dm^3:

$$V = \frac{(b - a)\ (100 - d) \times 10}{\pi . r^2 . 17}$$

in which:
b = weight of the tube filled with peat
a = weight of the empty tube
V = bulk density (g/l)
d = weight percentage of moisture in the air-dry material
π = 3.14
r = inside radius of the tube (cm)

Give the average results accurately to 1 g of oven dry peat per dm^3.

4.2. The waterholding capacity can be calculated from the bulk density, if required, with this formula:

$$W = \frac{8333}{V} - 17$$

in which:

W = waterholding capacity (g H_2O per 100 g oven dry material)

Give the average results accurately to 10 g of water per 100 g of oven dry material.

F. DETERMINATION OF MOISTURE AND ORGANIC MATTER

1. Equipment

Drying stove: adjustable to 105° C.
Porcelain dishes.
Electrical furnace for ignition:
adjustable to 600° C
Desiccator: with drying agent (silicagel with indicator).

2. Execution

Porcelain dishes, dried and weighed before, are filled with fieldmoist/airdry material and weighed again (accurately to 1 mg). Then the material is dried at 105° C ± 2° C during the night and then weighed again.
The dishes with the dried fieldmoist material are put in the electrical furnace and heated at 600° C for 2 hours.
Cool down to apporx. 100° C; cool further down to room temperature in a desiccator and weigh the dishes with the ashed material again.
Carry out the determinations in duplicate.

3. Calculation

3.1. Moisture

dish + fieldmoist/air dry material	a	gram
dish + material after drying	b	gram
moisture	a - b	gram

dish + fieldmoist/air dry material	a	gram
dish	c	gram
fieldmoist/air dry material	a - c	gram

The fieldmoist/air dry material contains

$$\frac{a - b}{a - c} \times 100\% \text{ moisture}$$

3.2. Organic matter

dish + material after drying	b	gram
dish + material after heating	d	gram
organic matter	b - d	gram

The oven dry matter of the fieldmoist material contains

$$\frac{b - d}{b - c} \times 100\%^{*} \text{ organic matter}$$

Give the average results, both for the moisture and for the organic matter content accurately to 0.1%.

* Percentages by weight.

G. THE FILLING AND CONDITIONING OF THE SAND-BOX FOR PHYSICAL ANALYSIS

1. Equipment

Sand-box:

Inside measueres 60 x 30 x 40 cm with at the bottom an inlet and outlet system for water. If the sandbox is made of PVC, make a wooden frame around the whole box for reinforcement.

Lid:

Wood, faced with plastic foam.

Blokzijl-sand:

Air entrance value of approx. 150 cm water, this corresponds to pF 2.2.

Cleaning the sand: see instruction H.

Nylon cloth:

To cover the sand in the sand-box.

Level cylinder:

Plastic, connected with the sand-box by means of a tube, to set the water level in the box.

Decanter bottle:

Glass, connected with the sand-box by means of a tube, for the water suuply to the box.

2. Procedure

2.1. The filling of the sand-box

Fill the sand-box with approx. 20 cm water, put the Blokzijl-sand mixed with water in the sand-box in small quantities. When the sand layer has a thickness of a few cm siphon the surplus of water out of the sand-box and remove any impurities on the sand surface with a wet sponge. In this way fill the sand-box with sand layer by layer until a height of 11 cm above the water inlet and outlet system has been reached. Leave the sand to settle and siphon the surplus of water out of the sand-box to a level of 0.5 cm above the sand surface. Level off the sand surface and then drain off the water by means of the level cylinder, adjusted to pF 2.0 (= 100 cm). Remove any impurities on the sand surface. Raise the

water from the bottom by placing the water level in the decanter bottle 2.5 cm above the sand surface. When the sand surface is covered with a few mm of water, then stop the inlet of water. Drain off the water and raise it again from the bottom for at least another five times. Finally leave the sand surface uncovered with water and control the packing of the Blokzijl-sand by making a slit of 3 cm deep in the sand and see whether the sand forms a compact layer without slits or holes. Condition the sand-box as described below.

2.2. The conditioning of the sand-box

After each test in which the sand-box has been used, make the box free of air bubbles. Therefore add water to the sand-box from the top to a level of 5 cm and drain it off again by means of the level cylinder, adjusted to pF 2.0.

In order to remove air bubbles which stayed behind in the sand-box, now raise the water from the bottom by placing the water level in the decanter bottle 2.5 cm above the sand surface. When the sand surface is covered with a few mm of water, then stop the inlet of water and make the sand surface level. Drain off the water again by means of the level cylinder adjusted to pF 2.0. Remove any impurities on the sand surface with a wet sponge. Raise the water again at least one time and drain it off again.

Finally bring the water level at 1 cm above the sand surface as described aboven (raising from the bottom), close the cock of the sand-box and cover the sand with a nylon cloth. Regularly control the tube which connects the sand-box with the level cylinder for the presence of air bubbles.

If necessary correct the zero point of the scale for reading the pF-values by equalling this point to a point 2.5 cm above the sand surface in the sand-box.

H. THE CLEANING OF THE BLOKZIJL-SAND

Before the sand-box is filled with Blokzijl-sand, clean the sand with water. Therefore treat the sand in small quantities in buckets.
Stir the sand well with water and leave the sand to settle. Then pour off the water layer and remove the dark coloured layer of contaminated sand. In this way rinse the sand with water until no contaminations remain on the sand surface.

Blokzijl-sand which has never been used before should first be rinsed with water a few times and then strained in water through a sieve with a mesh size of 420 microns. Continue the rinsing as described above.