PROEFSTATION VOOR TUINBOUW ONDER GLAS, NAALDWIJK

Extraction methods for routine tests of peat substrates

S.A. Tooze *

* Master of Science Candidate at The Pennsylvania
State University, U.S.A.

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Introduction

It would be benificial to the growers to have a soil test which could be easily performed by themselves for immediate analysis of the growing medium. The difficulty involved is to have a method of extraction to the soil solution which could be easily prepared with consistent results.
The Research Station at Naaldwijk has used the 1 : 1½ volume-extract for routine analysis for several years with good results. The extract has the advantage of overcoming the variability in peat mixes, requires only a small quantity of water which prevents peat particles from floating without becoming wet, and it is a relatively fast procedure which lends itself easily to routine laboratory work. This procedure has the disadvantage that the medium must first be brought to a moisture level of pF 1.5, a procedure which is done by a visual method described by Sonneveld et al. (1974).
In preparation of the 1 : 1½ volume-extract the media is initially brought to a moisture level of pF 1.5 by the visual method, then 100 ml of the sample is measured in a metal ring with the pressure of 0.1 kg per cm2.
The 100 ml peat is then mixed with 150 ml of water, shaken for 15 minutes, and filtered. The visual estimation of the moisture level of pF 1.5 is periodically checked by the sand-box procedure described by Harst & Stakman (1965).
The saturation extract procedure has been used in the past for analysis of loamless media with good results. The procedure is laborious, however and does not lend itself easily to routine laboratory procedures. It has been used at Naaldwijk as a standard against which other procedures are compared (Sonneveld & Van den Ende, 1971).
Container capacity was first described by White (1964) as the point at which drainage from medium placed in a container essentially ceases.
The moisture level is greater than that at field capacity because the container acts as a barrier of free water drainage. The point of container capacity as described by White can be reached by placing a container filled with soil on a capillary matting saturated with water and allowing the moisture to equilibrate. This moisture level is one that can be easily standarized when using one media type and pot size.

In this experiment the analytical determinations of the 1 : 1½ volume-extract are compared with those of the saturation extract and the soil solution. The percent moisture by weight of the pF 1.5 by the visual estimation and the sandbox methods are compared with those obtained by container capacity.

Materials and methods

Fifteen peat samples were collected from different potting soil factories in the Westland, the greenhouse area around Naaldwijk. The samples were collected on the basis of variation in peat type and amendments. The peat types included sphagnum peat of Finnish and Russian origin, and black peat from Germany. Some of the samples contained amendments of perlite, sand, manure or leaf mold.
Each sample was brought to a moisture level of pF 1.5 by the visual estimation and sandbox procedures, and to container capacity. For the container capacity 14 cm plastic growing containers were filled with dry medium and then set in a shallow tray lined with capillary matting. Several cm of water were added to the tray and the containers and tray were covered with polyethylene to prevent evaporation. When the weight of the containers and soil stabilized the soil was determined to be at container capacity (White, 1964). The percent moisture was determined by drying a subsample from each sample in an oven at 105°C until the weight stabilized.
The soil sample were extracted by means of the saturation extract, press extract and the 1 : 1½ volume-extract. For the saturation extract the soil was brought to the point of saturation by adding distilled water while stirring with a metal spatula as described by Richards (1954). The groove technique of Van Dijk (1980), (see also Sonneveld, 1977) was also used to determine the point of saturation.
For the press extract and 1 : 1½ volume-extract the medium was first brought to pF 1.5 by the visual estimation method. The soil solution was extracted by a hydraulic press for the press extract and then centrifuged. The 1 : 1½ volume-extract was carried out as described by Sonneveld et al. (1974). The extracted solutions were analyzed for nitrate, phosphorus, magnesium and sulphate by colorometric procedures, while sodium and potassium were determined by atomic absorption. Conductivity was also measured,

and expressed in mS per cm at 25^{o}C.

Results and discussion

The percent water by weight for the sandbox, visual and container capacity procedure are presented in table 1. The regression equation and correlation coefficients, for the relationship between the sandbox procedure (x) and the visual estimation procedure (y1) or container capacity procedure (y2) are presented in table 2. The range is small, and accounts for the rather low correlation coefficients. The relationship between the sandbox procedure and the container capacity indicates that the moisture level at container capacity approximates pF 1.5 closely enough to use this moisture level for the 1 : 1½ volume-extract. Further research is needed using different types and sizes of containers.

Table 1. The percent water by weight obtained by the sandbox, visual estimation and container capacity procedures for the fifteen samples used.

samples	sandbox (pF 1.5)	visual (pF 1.5) estimation	container capacity
		% water by weight	
1	69.8	74.1	77.4
2	67.2	67.0	71.0
3	77.2	76.9	80.4
4	82.7	78.8	82.9
5	71.3	67.7	71.6
6	76.4	73.1	79.6
7	76.3	75.4	79.9
8	80.8	79.8	82.9
9	77.8	78.6	81.1
10	82.3	81.0	83.2
11	75.5	75.9	78.4
12	75.2	76.8	78.1
13	79.8	78.7	80.8
14	82.7	78.8	80.1
15	78.3	74.8	81.1

Table 2. The regression equantion and correlation coefficient for the relationship between the moisture content data obtained by the sandbox procedure (x) and the visual procedure (y1) or the container capacity (y2)

procedure	regression equantion	correlation coefficient
visual estimation (y1)	y1 = 0.76 x + 17.4	r = 0.867
container capacity (y2)	y2 = 0.69 x + 26.2	r = 0.881

The mean and range values for the extract determinations are presented in table 3. The nutrient concentrations as expected decrease as the ratio of water: media increases. Sonneveld et al. (1974) noted that ions such as nitrate and chloride are inversely proportional to the water: soil ratio, while adsorbed cations may be dissolved by exchange when the solution is dilluted.

Table 3. Average values and limits of the analytical data of the different extracts.

	press extract		saturation extract		1 : 1½ volume extract	
determination	mean	range	mean	range	mean	range
conductivity (mS/cm)	3.08	1.04-6.49	1.50	0.79-2.70	0.88	0.54-1.65
	mmol per l extract					
nitrate	11.45	3.3 -25.1	4.30	1.2 -9.5	2.37	0.6 -5.0
phosphorus	3.89	0.09-11.6	2.33	0.06-8.8	0.92	0.03-2.2
potassium	7.22	1.8 -30.0	3.30	0.6 -10.2	2.13	0.5 -6.0
magnesium	4.10	0.8 -10.1	1.32	0.3 -2.5	0.77	0.3 -1.5
calcium	6.59	2.0 -14.9	2.34	0.8 -4.5	1.35	0.5 -2.4
suplhate	9.91	2.7 -29.1	3.62	1.1 -11.0	2.38	0.4 -5.9
sodium	3.06	2.1 -4.5	1.48	1.1 -2.3	1.25	0.9 -1.8
chloride	2.57	1.0 -7.0	0.92	0.4 -2.7	0.59	0.2 -1.5

The relationship between the analytical data of the press extract, and the saturation extract are presented in table 4. There is a high correlation as expected for nitrate, potassium, sulphate, phosphorus and conductivity. These relationships are nearly linear as can be seen from figure 1 for nitrate. The lower correlations for the remaining ions is accounted for by the narrow range of values for these ions as can be seen in figure 2 for sodium.

Table 4. Regression equations and correlation coefficients for the relationship between the analytical data of the press extract (x) and the saturation extract (y)

determination	regression equation	correlation coefficient
conductivity	y = 0,45 x + 0.2	0.916
nitrate	y = 0.38 x - 0.0	0.970
phosphorus	y = 0.50 x - 0.2	0.973
potassium	y = 0.35 x + 0.8	0.970
magnesium	y = 0.23 x + 0.4	0.769
calcium	y = 0.35 x + 0.6	0.777
sulphate	y = 0.37 x - 0.1	0.956
sodium	y = 0.39 x + 0.3	0.672
chloride	y = 0.24 x + 0.3	0.694

The relationship between the analytical data of the press extract and the 1: 1½ volume-extract is shown in table 5. There are again good correlations for nitrate, potassium, sulphate and phosphorus. The values are slightly lower than those obtained with the saturation extract indicating that with dilution there is a slight loss in accuracy. The correlation between the extracts for the potassium determination is worth noting.
Similar results were obtained by Sonneveld et al. (1974) and they concluded this was due to the cation exchange capacity and moisture absorbing capacity of the peat. The low correlation for conductivity is probably due to the presence of gypsum in the peat mixtures which dissolved during dilution.

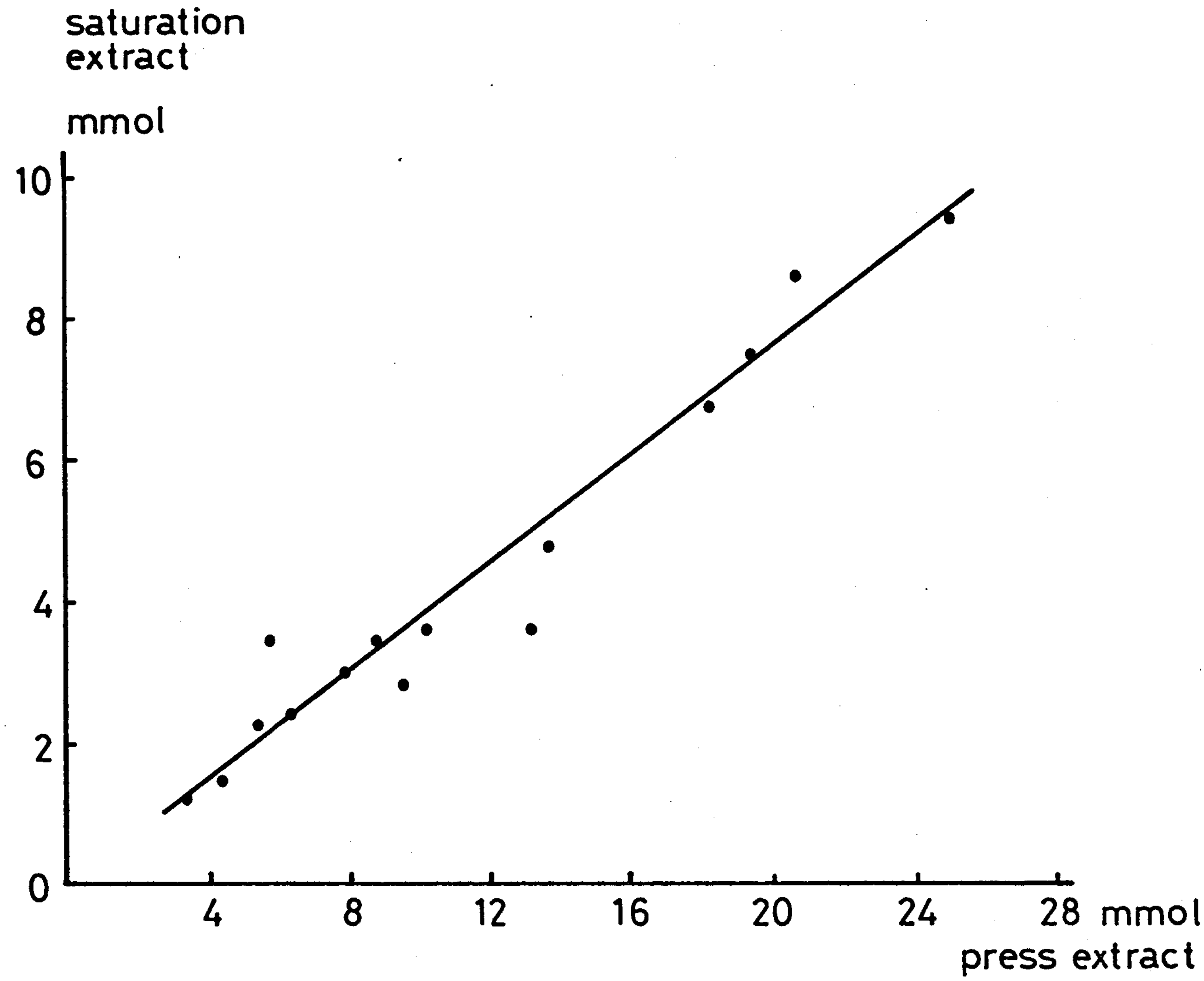

Fig. 1. The relationship between the concentration of nitrate (mmol NO_3) per l extract) extracted by the press extract and saturation extract.

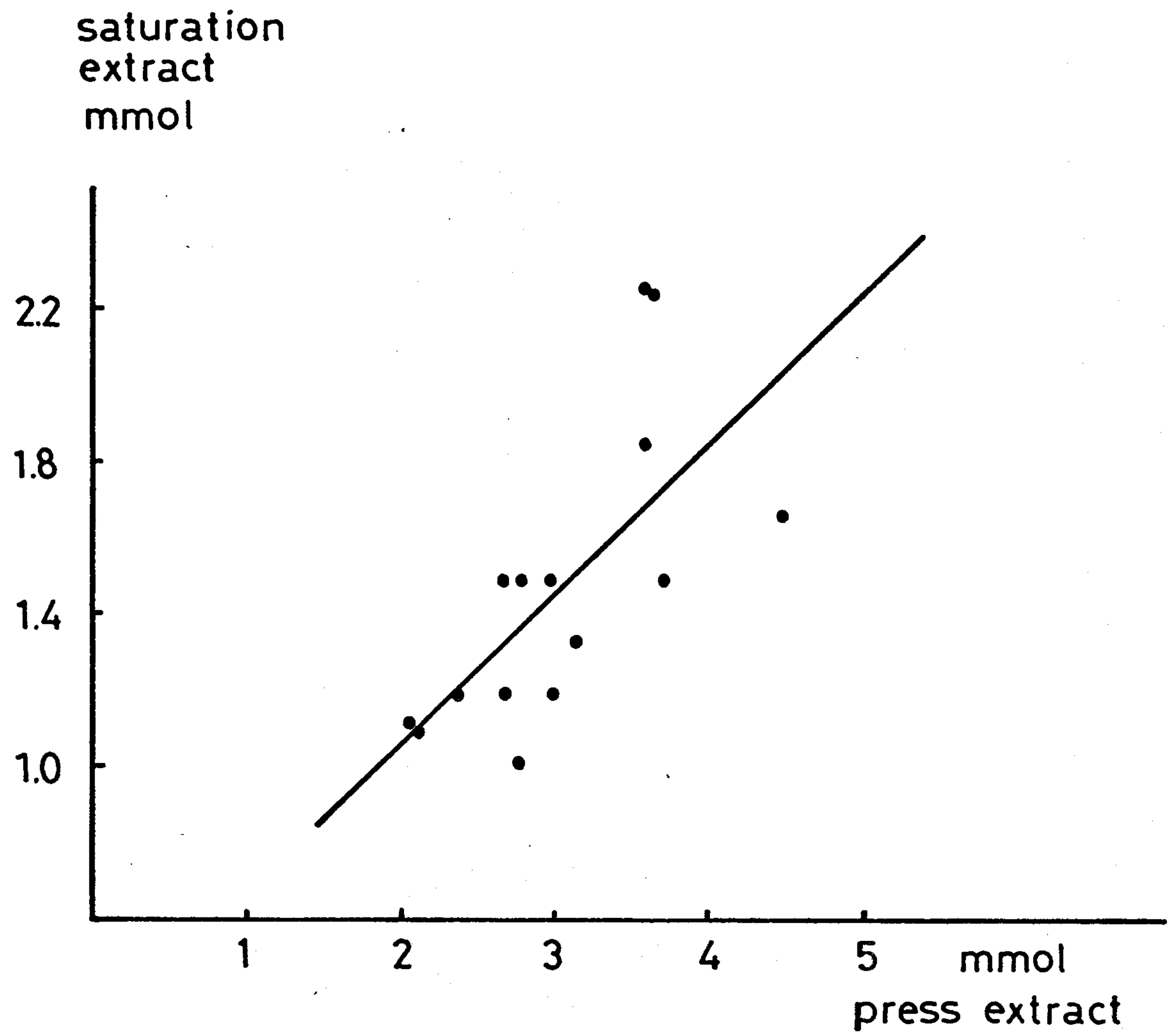

Fig. 2. The relationship between the concentration of sodium (mmol Na per l extract) extracted by the press extract and saturation extract.

Table 5. Regression equations and correlation coefficient for the relationship between analytical data of the press extract (x) and the volume-extract (y)

determination	regression equation	regression coefficient
conductivity	y = 0.21 x + 0.3	0.762
nitrate	y = 0.19 x + 0.2	0.943
phosphorus	y = 0.21 x + 0.1	0.953
potassium	y = 0.18 x + 0.8	0.963
magnesium	y = 0.16 x + 0.4	0.771
calcium	y = 0.12 x + 0.4	0.760
sulphate	y = 0.16 x + 0.8	0.907
sodium	y = 0.31 x + 0.3	0.729
chloride	y = 0.18 x + 0.1	0.848

The relationship between the saturation extract (x) and the 1 : 1½ volume-extract (y) is presented in table 6. The values are similar to those obtained for the relation between the press extract and the 1 : 1½ volume-extract.

Table 6. Regression equations and correlation coefficients for the relationship between the analytical data of the saturation extract (x) and the 1 : 1½ volume-extract (y)

determination	regression equation	correlation coefficient
conductivity	y = 0.61 x + 0.5	0.868
nitrate	y = 0.22 x + 0.5	0.948
phosphorus	y = 0,20 x + 0.4	0.928
potassium	y = 0.41 x + 0.5	0.974
magnesium	y = 0.29 x + 0.4	0.849
calcium	y = 0.41 x + 0.4	0.842
sulphate	y = 0.72 x + 0.4	0.948
sodium	y = 0.61 x + 0.4	0.590
chloride	y = 0.40 x + 0.2	0.634

Conclusions

It would be desirable to have a soil test which could be performed by the grower for analysis of major ions and conductivity. For this purpose an extract is needed which is fast, accurate and allows for small deviations due to human error.
The press extract and the saturation extract give the best approximation of the nutrient status of the medium. Both of these extracts are laborious however, and small deviations in the moisture contents have a great effect on the accuracy of the results. The 1 : 1½ volume-extract using a medium adjusted to a moisture level of pF 1.5 by visual estimation has been shown by Sonneveld et al. (1974) and in this work to be a good approximation of the saturation and press extract. The visual estimation of pF 1.5 however, must be regularly compared with a control to maintain accuracy, a procedure which makes the visual estimation of pF 1.5 inpractical for growers. It was seen in this experiment that for the container size used, the container capacity moisture level closely approximates that of pF 1.5. The container capacity moisture level is easily reproduced by setting containers filled with a medium on a capillary matting saturated with water until the weight stabilizes. If a grower first brought a soil to container capacity moisture level and then used the 1 : 1½ volume-extract, the problem of variability due to human error could be controlled.

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