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NEW STANDARDISED PRODUCT SHEET FOR COMPOST IN DENMARK

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1. ABSTRACT

A Standardised Product Sheet for Compost has been developed by the composting industry in Denmark as a voluntary measurement to improve the quality, use and sale of, as well as confidence in compost. Most of the approx. 130 Danish composting plants are expected to use The Product Sheet.

The Product Sheet itself consists of two pages. The front page covers: place of production and name of the product responsible, raw materials, suggested fields for use cross-referring to specific user guides, nutrients, soil improving properties, physical properties and sample taking and quality control. All nutrient contents are given in kg/m^3 and kg/ton marketable compost. Liming effect is based upon Ca-total, since no difference to Scheibler $CaCO_3$ could be shown. The back page of the Product Sheet covers guarantee parameters: weeds, visible impurities, degree of stability, heavy metals, sanitary treatment and organic pollutants. The degree of stability is designated not-ready, fresh, stable or very-stable, and shall as minimum be calculated on the basis of the analysis methods 'Total oxygen demand in 96 hours' and the 'Solvita compost test'. The user guides have been written to cover the following four user segments: private garden owners, landscape gardeners, farmers, or Christmas tree and fruit growers. The user guides are further subdivided to cover three types of compost made of yard waste, biodegradable household waste or sewage sludge.

The informative value of the Product Sheet was tested by four composting plants in the Spring 1998. Eighty percent of all users found the detailed declaration and user guides to be an advantage. Even amongst those who weren't in doubt about the optimal use, thirty eight percent found the detailed information to be an advantage. Thirty one percent of the interviewees had as a result changed their method of use. The majority within all user segments now felt more confident about their environmental concerns in using compost thanks to the guarantee parameters.

Keywords: compost, quality, standard, declaration, analysis methods, sampling, control, user, manual.

2. INTRODUCTION

The project was initiated in 1996 by the Working Group on Biological Treatment of Waste within the industry association Danish Waste Management Association (ISWA in DK). It should culminate in a voluntary measurement as a way to improve the quality, use and sale of, as well as confidence in compost. At the same time the project should improve the service provided from the professional laboratories to the composting plants.

2.1 The main features of the Product Sheet

A two-page compost declaration form has been made (see figure 1 and 2). The form is easily filled out by the composting plants and understood by the compost users. Additionally 12 different suggestions for user guides are provided as possible information material. A basic

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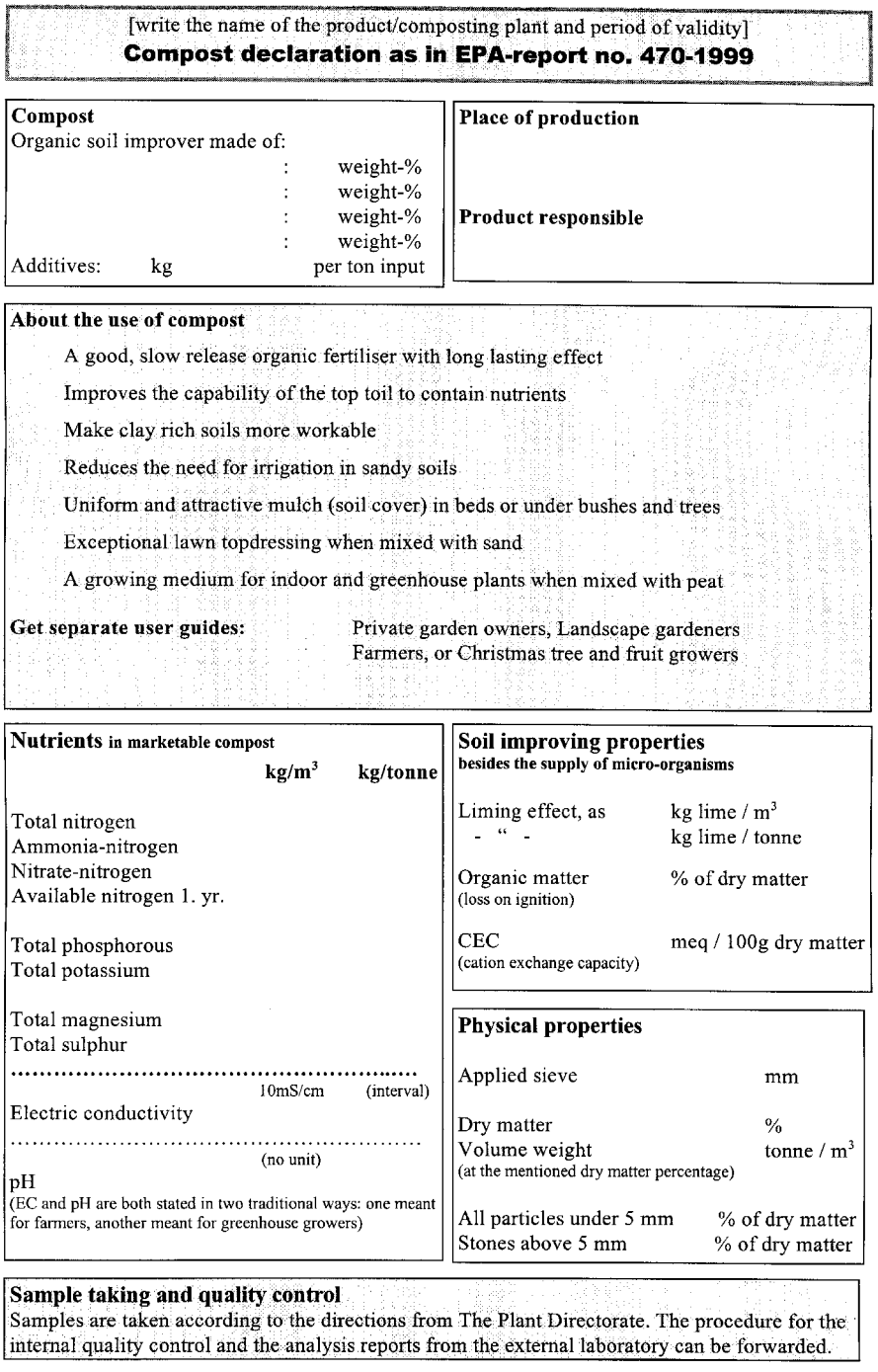
package of analyses, incl. descriptions of the analysis methods, improves the exchange of information between the commercial laboratories and the composting plants



[write the name of the product/composting plant and period of validity]

Compost declaration as in EPA-report no. 470-1999

Compost
Organic soil improver made of:
: weight-%
: weight-%
: weight-%
: weight-%
Additives: kg per ton input

Place of production

Product responsible

About the use of compost

A good, slow release organic fertiliser with long lasting effect

Improves the capability of the top toil to contain nutrients

Make clay rich soils more workable

Reduces the need for irrigation in sandy soils

Uniform and attractive mulch (soil cover) in beds or under bushes and trees

Exceptional lawn topdressing when mixed with sand

A growing medium for indoor and greenhouse plants when mixed with peat

Get separate user guides: Private garden owners, Landscape gardeners
Farmers, or Christmas tree and fruit growers

Nutrients in marketable compost

	kg/m³	kg/tonne
Total nitrogen		
Ammonia-nitrogen		
Nitrate-nitrogen		
Available nitrogen 1. yr.		
Total phosphorous		
Total potassium		
Total magnesium		
Total sulphur		
.....		
	10mS/cm	(interval)
Electric conductivity		
.....		
	(no unit)	
pH		

(EC and pH are both stated in two traditional ways: one meant for farmers, another meant for greenhouse growers)

Soil improving properties
besides the supply of micro-organisms

Liming effect, as	kg lime / m³
- " -	kg lime / tonne
Organic matter (loss on ignition)	% of dry matter
CEC (cation exchange capacity)	meq / 100g dry matter

Physical properties

Applied sieve	mm
Dry matter	%
Volume weight (at the mentioned dry matter percentage)	tonne / m³
All particles under 5 mm	% of dry matter
Stones above 5 mm	% of dry matter

Sample taking and quality control
Samples are taken according to the directions from The Plant Directorate. The procedure for the internal quality control and the analysis reports from the external laboratory can be forwarded.

Figure 1. The front page of the new standardised Product Sheet. Content of nutrients, liming effect etc. are displayed with measurement units in accordance with the different traditions of the user groups.

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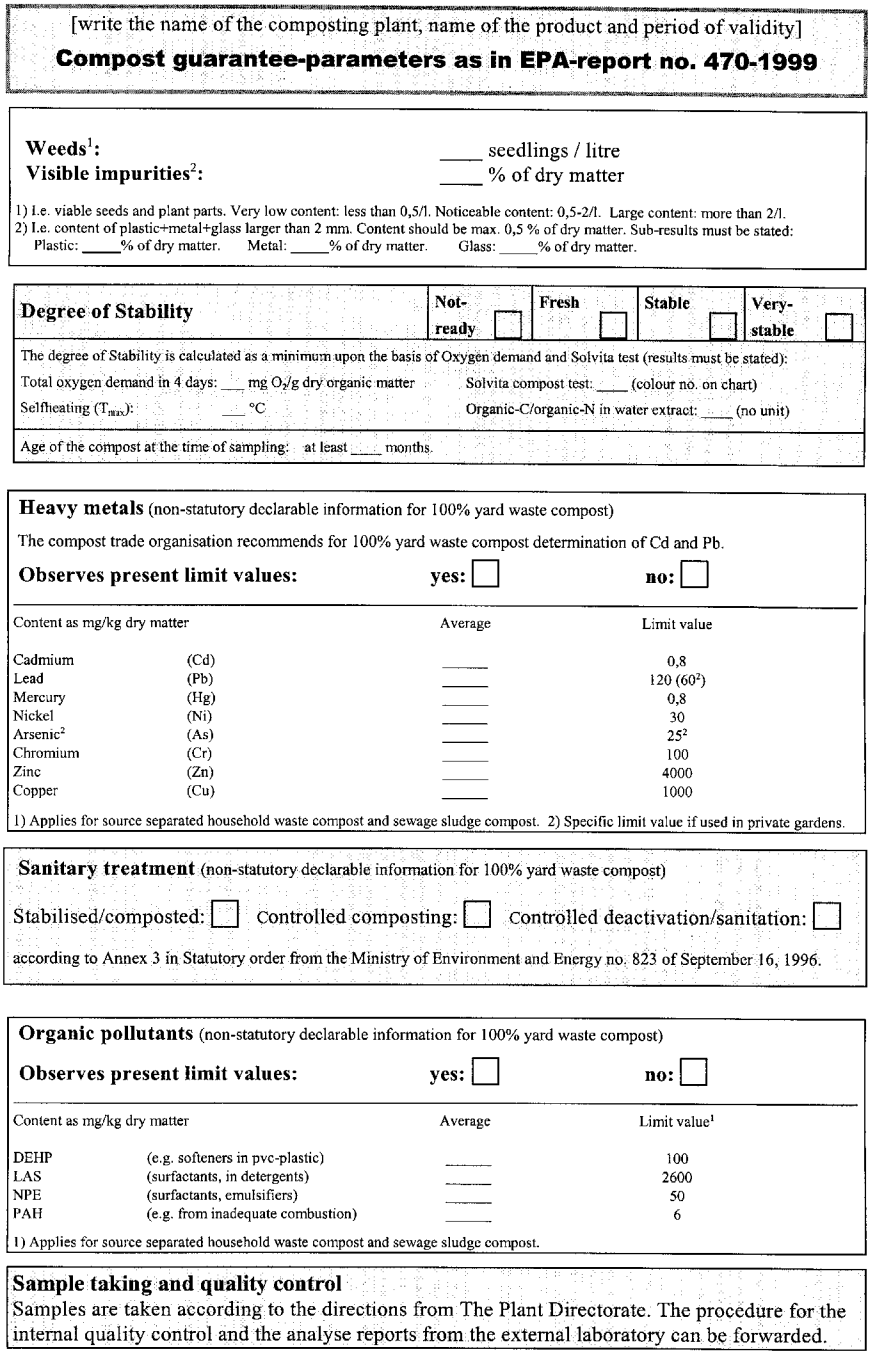

[write the name of the composting plant, name of the product and period of validity]

Compost guarantee-parameters as in EPA-report no. 470-1999

Weeds[1]: ____ seedlings / litre
Visible impurities[2]: ____ % of dry matter

1) I.e. viable seeds and plant parts. Very low content: less than 0,5/l. Noticeable content: 0,5-2/l. Large content: more than 2/l.
2) I.e. content of plastic+metal+glass larger than 2 mm. Content should be max. 0,5 % of dry matter. Sub-results must be stated:
Plastic: ____% of dry matter. Metal: ____% of dry matter. Glass: ____% of dry matter.

Degree of Stability	**Not-ready** ☐	**Fresh** ☐	**Stable** ☐	**Very-stable** ☐

The degree of Stability is calculated as a minimum upon the basis of Oxygen demand and Solvita test (results must be stated):
Total oxygen demand in 4 days: ___ mg O_2/g dry organic matter Solvita compost test: ____ (colour no. on chart)
Selfheating (T_{max}): ___ °C Organic-C/organic-N in water extract: ____ (no unit)

Age of the compost at the time of sampling: at least ____ months.

Heavy metals (non-statutory declarable information for 100% yard waste compost)

The compost trade organisation recommends for 100% yard waste compost determination of Cd and Pb.

Observes present limit values: **yes:** ☐ **no:** ☐

Content as mg/kg dry matter		Average	Limit value
Cadmium	(Cd)	____	0,8
Lead	(Pb)	____	120 (60[2])
Mercury	(Hg)	____	0,8
Nickel	(Ni)	____	30
Arsenic[2]	(As)	____	25[2]
Chromium	(Cr)	____	100
Zinc	(Zn)	____	4000
Copper	(Cu)	____	1000

1) Applies for source separated household waste compost and sewage sludge compost. 2) Specific limit value if used in private gardens.

Sanitary treatment (non-statutory declarable information for 100% yard waste compost)

Stabilised/composted: ☐ Controlled composting: ☐ Controlled deactivation/sanitation: ☐

according to Annex 3 in Statutory order from the Ministry of Environment and Energy no. 823 of September 16, 1996.

Organic pollutants (non-statutory declarable information for 100% yard waste compost)

Observes present limit values: **yes:** ☐ **no:** ☐

Content as mg/kg dry matter		Average	Limit value[1]
DEHP	(e.g. softeners in pvc-plastic)	____	100
LAS	(surfactants, in detergents)	____	2600
NPE	(surfactants, emulsifiers)	____	50
PAH	(e.g. from inadequate combustion)	____	6

1) Applies for source separated household waste compost and sewage sludge compost.

Sample taking and quality control
Samples are taken according to the directions from The Plant Directorate. The procedure for the internal quality control and the analyse reports from the external laboratory can be forwarded.

Figure 2. The back page of the standardised Product Sheet provides information about the guarantee-parameters, incl. the new Degree of Stability asked for by the landscape gardeners.

2. METHODS AND RESULTS

The project has been carried out in four steps: 1) Selection of analysis parameters and methods, as well as of participating composting plants. 2) Analysis of compost from the chosen plants with the chosen methods. 3) Preparation and discussion of the Product Sheet, incl. the user guides. 4) Testing of the Product Sheet, incl. the user guides.

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The possible compost analysis parameters and methods were compiled from international literature and from key persons within Danish agriculture, horticulture etc. and compared to the official Danish analysis requirements for compost. The selection of the parameters focused upon the qualities of the compost as a means of fertilisation and soil improvement. Specific parameters for top soil substitutes/mixtures and growing media were disregarded. When selecting methods, the existence of reference values for compost was emphasised. Adaptation to the terminology and tradition of the individual user segments was also a major contributory factor for choice of analysis method and of measurement unit displayed.

The composting plants was chosen with reference to ensure variation for input materials, composting method, size of plant as well as for geographical position. A stable production and previous agricultural use of the compost was also a requirement. Furthermore, the plant should be willing to use the Product Sheet as information material during the Spring 1998 and to collect the reaction of the users towards the sheet. No Danish plants composting sewage sludge could fulfil the demands for participation at that time. The chosen plants are described in table 1. Compost from the selected plants was analysed with the selected methods to get a general view of Danish compost, especially with regard to analysis parameters and methods new for Denmark. Some of the results from the analyses are also shown in table 1.

2.1 Different user guides provided

User guides have been written to cover the following four user segments: private garden owners, landscape gardeners, farmers, or Christmas tree and fruit growers. The user guides are further subdivided to cover three types of compost made of yard waste, biodegradable household waste or sewage sludge. These subdivisions are partly due to fact that Danish legislation differs on allowed use (amount, areas, crops) according to raw materials and sanitary treatment. The user guides can be used directly by the composting plant or incorporated into the information material of the individual plant. Simple formulas for the calculation of compost allowance are also set up.

2.2 One manual for plants and another for laboratories

A short version with the strictly relevant parts of the project report has been forwarded to all Danish composting plants (see Part 2 as mentioned in Carlsbaek, 1999). Most plants are expected to have their compost analysed accordingly to a recommended *Composting industry' basic analysis package* and to use the Product Sheet as part of their information material. The mentioned analyses package has to be completed to be able to fill in the Product Sheet form for yard compost, the compost product in Denmark with the fewest statutory requirements.

In a similar way, part 3 of the project report is targeted at the professional laboratories. Here references to the official or otherwise standardised Danish analysis methods are provided, and the new methods (e.g. liming effect, weeds, visible impurities, degree of stability) are described in Danish.

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Table 1. Description of the selected composting plants and some of the analyses of their compost (mean of two measurements from one composite sample per plant; the results of the well-known methods, e.g. N-total and Cd, are typical for the plant).

		House1	**House2**	**House-yard**	**Yard1**	**Yard2**	**Yard3**
Type of plant		con-tainer	drum+ windrow	windrow	madras	wind-row	wind-row
Amount of waste	1,000 tonne per yr.	1.3	10	1.4	54	11	1.4
House-waste [1)]	weight%	80	91	46	0	0	0
Yard-waste [2)]	weight%	20	straw: 2	54	100	100	100
Other "waste"	weight%	lime: 8	paper: 7	0	0	0	0
Compost-age	months	2	6	7	24	8	13
Dry matter	%	75	41	59	66	52	66
Organic matter	% of dry matter	46	65	36	22	33	17
OrgC/orgN [3)]		3.2	6.5	1.2	2.7	0.7	0.2
OrgC/totN [3)]		0.60	0.68	0.18	0.59	0.18	0.10
OrgC [3)]	g/kg dry matter	10.3	17.1	2.8	5.1	1.6	0.5
HA-index [4)]		0.5	0.5	0.8	0.7	0.7	0.6
Barley25 [5)]	% of control	83	90	96	98	99	109
Barley50 [5)]	% of control	63	50	92	85	104	100
Ca-total	as kg $CaCO_3$/tonne	64.3	15.4	24.7	22.2	8.7	6.7
Scheibler $CaCO_3$	kg $CaCO_3$/tonne	69.3	15.6	22.9	28.8	4.0	1.6
N-total	kg/tonne	13	10	8.7	5.3	4.4	3.3
N-water-soluble	kg/tonne	0.3	2.2	1.0	0.5	0.1	0.1
S-total	kg/tonne	1.4	1.5	1.4	0.8	0.6	0.4
pH		8.5	8.3	8.3	8.4	8.4	8.2
CEC	meq/100 g dry matter	63	104	61	48	48	39
Cd	mg/kg dry matter	0.38	0.36	0.63	0.76 [8)]	0.37	0.22
Pb	mg/kg dry matter	30	35	32	65	54	16
DEHP	mg/kg dry matter	24	21	11	0.63	0.54	< d.l.
LAS	mg/kg dry matter	69	76	61	< d.l. [9)]	< d.l.	< d.l.
NPE [6)]	mg/kg dry matter	3.4	2.3	1.5	< d.l.	< d.l.	< d.l.
PAH [7)]	mg/kg dry matter	0.5	0.5	0.8	0.9	0.5	0.6

1) Source separated biodegradable MSW. 2) Leaves, branches etc. from parks and gardens. 3) In water extract. See Chanyasak & Kubota (1981) and Hue & Liu (1995). 4) Humic acid index, see Adani et al. (1995). Considerable uncertainty of analysis, often 0,2 in difference between results of two analyses of compost from the same composite sample. 5) Pflanzenverträglichkeit, as in BGK (1998, p23). 6) Nonylphenol + mono- and di-ethozylates. 7) Σ of 9 components. 8) High level caused by waste from city areas. 9) d.l.: detection limit.

2.3 Analysis methods for stability

The results from the tested analysis methods for compost stability was compiled in one table, and a score system was establish as to rank the results and to compare the different methods. The four methods recommended in the Product Sheet are all economically feasible, giving reproducible results and with a fair amount of reference values for compost. Figure 3 shows some results from three of the methods. Apparently no single method provides a true and fair picture of the full range of stability of all types of compost and therefore, at least two analysis methods must be used to determine the stability. The analysis methods 'Total oxygen demand in 96 hours' and 'Solvate compost test' are included in the recommended *Composting industry' basic analysis package*. For internal control 'Solvate compost test' and 'Selfheating' are recommended. A guide how to calculate the Degree of Stability has been developed (see table 2). Since the declaration of the stability was asked for by the landscape gardeners, differentiation among the more stable composts was prioritised when developing the Degree of Stability system.

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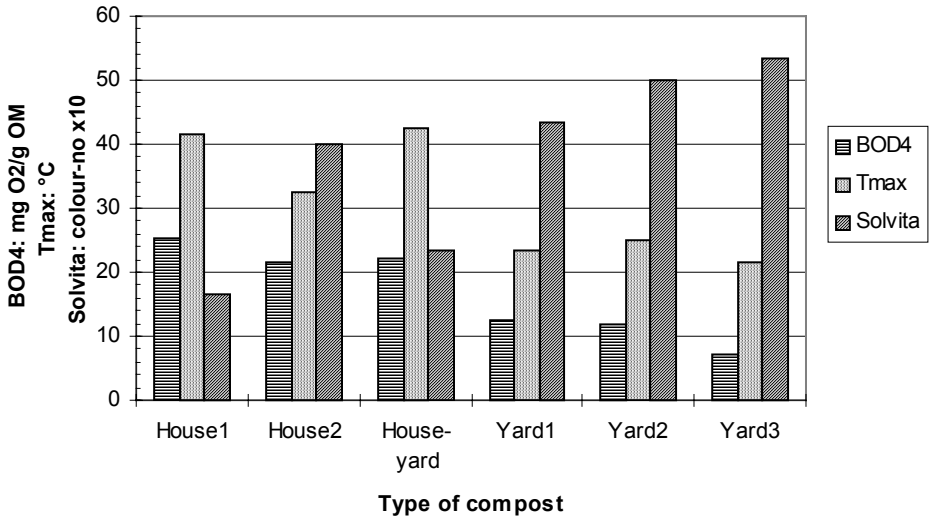

Figure 3. Microbial activity related methods for stability determination applied to different types of composts. Methods: BOD4 and Tmax as in BGK (1998, p93, p19), BOD4 also with an Oxi-Top® (WTW 1995), Solvita® as in Woods End (1997). BOD4 and Tmax mean of two measurements, Solvita mean of three measurements, from one composite sample per plant. Details for type of compost in table 1.

Table 2. The principle behind the calculation of Degree of Stability. For the Product Sheet, independent laboratory results from the methods 'Total oxygen demand' and 'Solvita' are required as a bare minimum.

Method of analysis	**Result**			
'Organic-C/organic-N in water extract' (no unit)	☐ > 7,0	☐ ≤ 7,0		do not count here
'Total oxygen demand in 96 hours' (mg O_2/g OM)	☐ > 40,0	☐ 40,0- 16,1	☐ 16,0 - 6,1	☐ ≤ 6,0
'Solvita compost test' (colour-no. on chart)	☐ 1	☐ 2 - 3	☐ 4 - 5	☐ 6 - 8
'Selfheating' (max. temperature in °C)	☐ > 60,0	☐ 60,0 - 40,1	☐ 40,0 - 30,1	☐ ≤ 30,0
(no. of crosses in the column)	—	—	—	—
Achieved Degree of Stability	**Not-ready** ☐	**Fresh** ☐	**Stable** ☐	**Very-stable** ☐

2.4 Volume weight and particles < 5 mm

The European Committee for Standardization is now finally agreeing upon a standard for the determination of density of soil improvers and growing media (CEN, 1999). This coming standard will be used for the Product Sheet. The necessary apparatus is shown in figure 4.

The content of 'All particles < 5 mm' is easily determined when analysing for content of 'Stones > 5 mm'. When assessing the compost as a possible mulch a low content of fine particles is desirable. For the ordinary mulches of wood or bark chips, a content lower than 5-10 weight% of particles < 5 mm is recommended.

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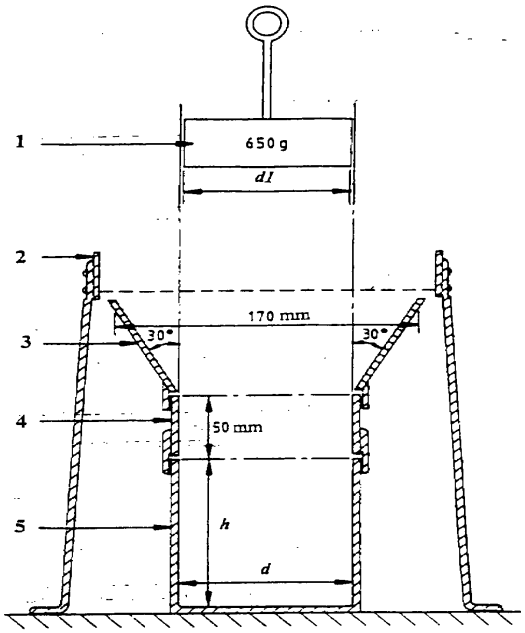

Figure 4. The apparatus for laboratories for the determination of compost density (CEN, 1999). 1: Plunger. 2: Sieve, supported at the edge. 3: Funnel. 4: Collar, removable extension of the cylinder. 5: Test cylinder. d: diameter 100 mm ± 1 mm. h: height 127 mm ± 1 mm. d_l: diameter 95 mm ± 1 mm.

3. USERS REAKTIONS TOWARDS THE PRODUCT SHEET

The informative value of the Product Sheet was tested by four composting plants among their compost users during the Spring of 1998. The satisfaction with the Product Sheet and user guides was staggering: 80% of all users within all segments found the detailed declaration and user guides advantageous. See others results from the survey in table 3.

Table 3. Some of the reactions from the compost users towards the standardised Product Sheet, which was handed out together with the compost.

	% of all answers
Have been in doubt until now about the best use of the compost	**33**
Have not been in doubt until now	59
An advantage with the user guide	80
Not an advantage	16
Coherence in answers: Have been in doubt... and an advantage...	26
Have not been in doubt... **although** an advantage...	38
Hadn't felt confident about the environmental concerns in using compost	**26**
Had felt confident	66
Now feeling more confident because of the 'guarantee parameters'	44
Still not feeling confident	47
Coherence in answers: Hadn't felt confident... now feeling more confident...	9
Had felt confident... **although** felling more confident now...	32

In general, there was a pronounced need for information; e.g. 31% of all users had actually changed their way of using compost due to the Product Sheet. Answers were collected from 80 private garden owners, 14 landscape gardeners and 3 farmers, all of whom had used compost from the plant in question.

ACKNOWLEDGEMENTS

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LIST OF REFERENCES

Adani, F., Genevini, P. L. & Tambone, F. (1995). A new index of organic matter stability. *Compost Science & utilization*, 3 (2), 25-37.

BGK (1998). Methodenbuch zur analyse von kompost, 4. auflage. Bundesgütegemeinschaft Kompost e.V., Köln, Germany. 154 pp.

Carlsbaek, M., Broegger, M., Jensen, L. M., Klarskov, K. & Skovsende, S. (1999). [Standardised product sheet for compost. Part 1: General part, incl. testing of methods. Annex to part 1: Testing of new and old analysis methods for compost at Danish Land Development Service Laboratory. Part 2: Guidelines for composting plants. Part 3: Guidelines for laboratories.]. Report no. 470. In Danish (see www.mst.dk/199905publikat/87-7909-329-9/default.htm). EPA, Danish Ministry of Energy and Environment, København, Denmark.

CEN (1999): Soil improvers and growing media - sample preparation for chemical and physical tests, determination of dry matter content, moisture content and laboratory compacted bulk density. Final draft PrEN 13040, July 1999. Work Item 00223068 CEN/TC 223. 14pp. (possible producer of apparatus for density determination: Middleton Engineering, tel +44 1458 860264).

Chanyasak, V. & Kubota, H. (1981). Carbon/organic nitrogen ratio in water extracts as measure of composting degradation. *Journal of fermentation technology*, 59 (3), 215-219.

Hue, N. V. & Liu, J. (1995). Predicting compost stability. *Compost Science. & Utilization*, 3 (2), 8-15.

WTW (1995). Instruction manual for OxiTop BOD single measuring system. 2pp.

Woods End (1997). Woods End Research Laboratory's Solvita compost maturity test. Guide to testing compost maturity. 8pp. Getting the best results with your compost test. 1p. Solvita validation/certification (www.woodsend.org/solvita.htm).