# ASCP Guidelines 2001

# Quality criteria for composts and digestates from biodegradable waste management

## Published by the Association of Swiss Compost Plants (ASCP) in collaboration with the Swiss Biogas Forum

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# Part A: Summary

With theses guidelines, the ASCP, in collaboration with the Swiss Biogas Forum, intend to define the characteristics a compost must possess, for its use in agriculture, in horticulture and market gardening, landscaping or in covered cultures. Covered cultures and private gardening require the highest quality and degree of maturity. Slightly lower standards suffice for commercial horticulture. The minimal requirements of the Federal Research Station of Liebefeld (FAC), which are recalled here, apply for agricultural and other use.

The present guidelines are intended as complementary to the FAC (1995) instructions and recommendations, and in no case do they replace them. The minimal quality requirements have been amended and the meaning of the terms "rotted" and "digestate" has been further specified.

The distinction between digestate (with no post-maturation) and compost, based on product specificity and the $NH_4$-N content is new. Several hundreds of analyses have clearly shown that digestates without post-maturation contain higher levels of $NH_4$-N than compost, well over 300 mg per kilo fresh weight. As a further practical criterion for the definition of the term "rotted" in the definition of a compost, the guidelines propose that, except for wood, no other feedstock be recognisable visually or by smell. For example, it must not be possible to recognise the species of leaves. Compost complying with all the requirements of the present guidelines can be obtained from digestates which have undergone state-of-the-art aerobic composting.

A further novelty of these guidelines, going considerably farther than any of the standards formulated by the FAC, are the quality requirements for compost used in horticulture and landscaping, both for outdoor and covered cultures. Beside chemical and physical parameters, normalised biological tests are also proposed. With increasing maturity, the salt content and pH decrease. The nitrate to ammonium ratio should increase due to nitrification. The decreasing solubility of the humic substances that form during maturation will result in an increasingly lighter colour of the aqueous extracts. The advanced maturation also drastically improves the stability and plant compatibility of the product.

To obtain a high quality finished product requires not only state-of-the-art processing, but also a correct choice of feedstocks. Only materials with low levels of pollutants should be used. This excludes wastes susceptible of being highly contaminated, such as sewage sludge, or waste from street cleansing. The ASCP and Biogas Forum recommend that the feedstock and additives be declared. The ASCP Guidelines will be put into practice in the coming years through the "Training-Quality-Controlling" concept.

## Summary table for the different qualities of composts and digestates from biodegradable waste

| Criteria | Agricultural use | | Compost for horticultural use | Compost for covered cultures and private gardening |
|---|---|---|---|---|
| | *Digestate* | *Compost* | | |
| Minimal quality | Complies with minimal quality requirements according to (FAC 1995) | | | |
| Heavy metals | < Osubst limits | | | |
| Impurities | Complies with minimal quality requirements according to (FAC 1995) | | | |
| Hygienization | Fulfilled | Complies with minimal quality requirements according to (FAC 1995). with temperature protocol | | |
| Nutrients: N, $P_2O_5$, $K_2O$, Mg, Ca | X | X | X | X |
| Decomposition | | Feedstock unrecognisable, except for wood | | |
| DW (Dry matter) | X | X | > 50 % | > 55 % |
| OM (Organic matter) | X | X | < 50% | < 40 % |
| pH | X | X | < 8.2 | < 7.5 |
| particle size | X | X | < 25 mm | < 15 mm |
| Bulk density | X | X | X | X |
| Colour of extract (humus number) | | | recommended | |
| Salinity | X | X | < 4 mS/cm | <2.5 mS/cm |
| Total N | X | X | > 10 g/kg DW | > 12 g/kg DW |
| C/N ratio | | | X | X |
| $NH_4$-N | X | < 300 mg/kg FW | | |
| $NO_3$-N | X | X | > 40 mg/kg FW | > 50 mg/kg FW |
| $NO_3$-N / $NH_4$-N ratio | | | >2 | > 20 |
| $NO_2$-N | | | < 5 mg/kg FW | < 2.5 mg/kg FW |
| Germinating weed seeds | | | < 1 per litre | < 1 per litre |
| Plant compatibility: | | | | |
| Cress (open) | | | > 70 % of ref. | > 90 % of ref. |
| Cress (closed) | | | > 25 % of ref. | > 50 % of ref. |
| Salad | | | > 50 % of ref. | > 70 % of ref. |
| Bean | | | | > 70 % of ref. |
| Ray grass | | | | > 70 % of ref. |
| Disease suppressivity test | | | | recommended |

**Shaded cells: minimal requirements**

**X: must be specified**

# Part B: Guidelines

## 1 Introduction, aims and definitions

### *1.1 Introduction*

In 1995 the FAC of Liebefeld published the Guidelines and Recommendations with respect to Waste Fertilizers (FAC 1995), which are at present being revised. They contain the minimal requirements for composts and set out the guidelines for control. Each year, the list of recognised laboratories for compost quality control is published. Since 1995 however, many new developments have appeared in the treatment of biodegradable waste. Anaerobic digestion has become established and part of the digestate is marketed without post-maturation. Based on the existing minimal requirements, a definition for the term "rotted" is proposed and a separate classification suggested for digestates without post-maturation.

### *1.2 Aims*

The quality requirements set out in this document should allow to clearly and simply differentiate the various end-products resulting from the treatment of biodegradable waste. They should also promote well adapted and high-quality products. The result of anaerobic digestion without successive post-maturation is newly defined as digestate, and must comply with the minimal requirements for composts as to impurities, heavy metals and hygienization. If the digestate is composted, either singly or mixed with other compostable wastes, compost of any of the quality grades described here may be obtained. The present directives contain the requirements for compost used in agriculture, horticulture and for covered cultures and private gardening.

To obtain a high quality finished product, not only is state-of-the-art processing required, but also a correct choice of feedstocks. Only materials with low levels of pollutants should be used. This excludes wastes susceptible of being highly contaminated, such as sewage sludge, or waste from street cleansing. The ASCP and Biogas Forum recommend that the feedstock and additives be declared. The ASCP Guidelines will be put into practice in the coming years through the "Training-Quality-Controlling" concept.

Once a high level of quality has been reached it must be regularly verified. Heavy metal and nutrient contents must be analysed on a regular basis by a recognized laboratory. For plants treating more than 1000 tonnes of biodegradable waste per year, at least four such analyses must be carried out annually. The maturity criteria, above the FAC minimal requirements can be analyzed in specialized external laboratory, or, in part, in a small on-site laboratory. Specific training courses for the personnel of biodegradable waste treatment plants will be organised by the ASCP. As well as the chemical tests, maturity and phytotoxicity tests will also be taught and practised during these courses. A similar course is in preparation for anaerobic digestion plants.

The compost quality levels set out in the ASCP guidelines can be reached in any well-operated treatment plant using up-to-date procedures. Most maturity criteria can be checked directly on-site in a small laboratory.

These guidelines form an essential part of the ASCP concept "Training-Quality-Control", which is now actively being put into practice: a better training of the compost plant workers results in a better quality compost, with a better long-term market value. Controls must ensure that the quality levels remain high in the long term. Over the next two years the ASCP intends to set up such a control system.

### *1.3 Definition and differentiation of end-products from biodegradable waste management*

Biodegradable waste management is part of the Swiss waste management concept. The end-products are thus defined as fertilizers from waste (O. on fertilizers, art. 3, let. a). Therefore, these guidelines do not apply to manure composts, other special composts and cultivation substrates containing compost.

**Compost,** according to the Ordinance on Substances (Annex 4.5, Definitions), „is correctly rotted and aired, and is used as fertilizer, as a soil improvement agent, as substratum protection against erosion in recultivation or for artificial potting compost".

**Digestate** results from plant or animal wastes appropriately degraded in the absence of air (anaerobically) (ASCP proposal, a definition of its uses after the Osubst is still lacking).

The **end-products** are in particular:

1. Composts = Biodegradable wastes rotted in the presence of air (aerobically) , with or without previous anaerobic digestion.
2. Digestates from the biodegradable waste treatment (anaerobic digestion without post-maturation), in solid or liquid form (such as the press water).

### *1.4 Application*

The minimal quality requirements (following FAC 1995 and detailed under 2.1) apply to all composts and digestates form biodegradable waste management that are used as fertilizers or soil improvement agents. The criteria detailed here do not replace the minimal legal requirements, but complete them. A compost that for example does not comply with the heavy metal concentration limits cannot be used, even if the other requirements outlined here are fulfilled.

## 2 Quality requirements for composts and digestates from biodegradable waste management for agricultural use

### *2.1 Requirements*

Generally, the current dispositions of the Ordinances on Fertilizers and on Environmentally Hazardous Substances apply. Additions have been made to the minimal requirements of the FAC, to ensure that the compost has effectively undergone a biological degradation process. In the Ordinance on Environmentally Hazardous Substances, compost is defined as "rotted material". However the practical significance of the term "rotted" is missing. The following definition is therefore introduced here:

**After biological degradation, a compost contains no biodegradable wastes recognisable visually or by smell, except for wood. The ammonium content after rotting must be lower than 300 mg $NH_4$-N per kg of fresh weight.**

#### 2.1.1 Heavy metal content

The minimal quality requirements (FAC 1995) cover the three aspects of heavy metals, hygienization and impurities. The limit values for heavy metals are defined in the Ordinance on Environmentally Hazardous Substances. The limits for single elements are listed in Table 1:

**Tab. 1**: Heavy metal concentration limit values for compost and digestate from biodegradable waste management (Osubst Annex 4.5)

| Element | Limit values in grams per tonne of dry weight |
|---|---|
| Lead (Pb) | 120 |
| Cadmium (Cd) | 1 |
| Chromium (Cr) | 100 |
| Copper (Cu) | 100 |
| Nickel (Ni) | 30 |
| Mercury (Hg) | 1 |
| Zinc (Zn) | 400 |

### 2.1.2 Impurities

The impurities tolerated in composts and digestates were defined by the FAC in 1995. They are divided into stones, total impurities, of which plastic and aluminium sheeting form a subgroup. Table 2 lists the limit values for each of these categories.

**Tab. 2**: Limit values for impurities in compost (FAC 1995)

| **Parameter** | **Limit value** | **Observations** |
|---|---|---|
| Stones > 5mm in diameter | 50 g per kg dry weight | Smaller stones and sand are not considered impurities |
| Impurities such as metals, glass, plastics >2mm ø | 5 g per kg dry weight | |
| Plastics and aluminium sheeting >2mm ø | 1 g per kg dry weight | |

### 2.1.3 Hygienization

Properly sanitized compost or digestate should contain negligible levels of organisms pathogenic for man, animals or plants (FAL 1999).

**Tab. 3a**: Hygienization requirements for compost (FAC 1995)

| **Requirements for compost** | **Observations** |
|---|---|
| At least 3 weeks over 55°C | Valid for the entire windrow, including the edges |
| or at least 1 week over 65°C | Applies mainly to in-vessel composting |
| or another equivalent process which guarantees the same hygienization | Such as pasteurisation, steaming etc. |

**Tab. 3b**: Hygienization requirements for digestate from biodegradable waste management (proposed by the Biogas Forum)

| **Requirements for digestate *** | **Observations** |
|---|---|
| At least 24 hrs. hydraulic retention time at 53°C or higher | Absence of short-circuit flows must be demonstrated |
| At least 14 days hydraulic retention time below 53°C plus successive heating (post-maturation) to at least 55°C for 10 hrs or at least 60° for 5.5 hrs | During post-maturation the temperature must be reached in the entire windrow, also in the edges |
| or another equivalent process which guarantees the same hygienization | Such as pasteurisation, steaming etc. |
| * *The requirements are based on the Danish (Statutory Order, Ministry of Environment & Energy No.823) and Swedish (RVF-Quality Assurance System) guidelines.* | |

# 3 Quality criteria for composts used in horticulture, market gardening and landscaping

## *3.1 Introduction*

Besides the minimal quality requirements, composts destined for horticulture, market gardening or landscaping must comply with additional conditions, so that their use does not cause problems. Since in these cases composts are often applied in large quantities as soil im-

provement agents, they must demonstrate better plant compatibility and must not lead to nitrogen fixation in the soil.

The older the compost, the more nutrients are bonded into stable humic substances. These composts are considered important soil improvement agents with slow release of nutrients. The stable humic substances and particularly developed aggregate structure of composts having undergone prolonged maturation make them especially adapted to sandy or heavy soils.

Each lot of compost destined for horticulture, market gardening or landscaping must comply with the ASCP guidelines for physical, chemical and biological parameters individually.

**Tab. 4**: Physical, chemical and biological requirements for composts destined for horticulture, market gardening or landscaping (ASCP guidelines)

| **Parameter** | **Prescribed value** (X: value must be specified) | **Method** |
|---|---|---|
| DW in % of fresh weight | > 50 % | TS * |
| OM in % of dry weight | < 50 % | D-AS * |
| pH | < 8.2 | $H_2O$GH-pH * |
| Particle size | < 25 mm | mesh size [mm] |
| Density | X | D-VG * |
| Colour of extract (humus number) | A simple determination method still needs to be developed | |
| Salinity | < 4 mS/cm | $H_2O$GH-Sal * |
| Total N | > 10 g/kg DW | Kjeldahl |
| C/N ratio | X | calculated |
| $NH_4$-N | < 300 mg/kg FW | in $H_2O$GH-Ex * |
| $NO_3$-N | > 40 mg/kg FW | in $H_2O$GH-Ex * |
| $NO_3$-N / $NH_4$-N | > 2 | in $H_2O$GH-Ex * |
| $NO_2$-N | < 5 mg/kg FW | in $H_2O$GH-Ex * |
| Weed seed germination test | < 1 per litre of compost | AD-KF * |
| Plant compatibility tests: | | after Fuchs and Bieri, AgrarForschung 7(7): 314-319, 2000, Tab. 4. |
| Cress (open) | > 70 % of reference | |
| Cress (closed) | > 25 % of reference | |
| Salad | > 50 % of reference | |

**X: must be specified**

***: Reference method of the Federal Agricultural Research Stations**

# 4 Quality criteria for composts used in covered cultures and private gardening

## *4.1 Introduction*

Composts used in covered cultures must both be of excellent quality and highly stable. Besides the minimal quality requirements, they must show perfect plant compatibility (no phytotoxicity). A positive biological activity (measured as disease suppressivity potential) is desirable.

Not all plants have the same requirements, so different composts may be produced depending on their destination. Therefore, certain quality criteria must be specified for each lot of compost, even if no limit value has been set for these parameters. This so that the user can choose the type of compost required correctly and determine the right additives to mix with it.

Every lot of compost destined for covered cultures and private gardening must comply with the ASCP guidelines for physical, chemical and biological parameters individually.

Given the very diverse needs of the users, no requirements will be given here for composts intended for the production of potting soils.

**Tab. 5**: Physical, chemical and biological requirements for composts destined for covered cultures and private gardening (ASCP guidelines)

| **Parameter** | **Prescribed value** (X: value must be specified) | **Method** |
|---|---|---|
| DW in % of fresh weight | > 55 % | TS * |
| OM in % of dry weight | < 40 % | D-AS * |
| pH | < 7.5 | $H_2OGH$-pH * |
| Particle size | < 15 mm | mesh size [mm] |
| Density | X | D-VG * |
| Water-holding capacity | X | FAW-Nr.113 * |
| Colour of extract (humus number) | A simple determination method still needs to be developed | |
| Salinity | < 2.5 mS/cm | $H_2OGH$-Sal * |
| Total N | > 12 g/kg DW | Kjeldahl |
| $NH_4$-N | < 300 mg/kg FW | in $H_2OGH$-Ex * |
| $NO_3$-N | > 50 mg/kg FW | in $H_2OGH$-Ex * |
| $NO_3$-N / $NH_4$-N | > 20 | in $H_2OGH$-Ex * |
| $NO_2$-N | < 2.5 mg/kg FW | in $H_2OGH$-Ex * |
| $SO_2$ | < 0.5 | semi-quantitative using lead-acetate paper |
| Weed seed germination test | < 1 per litre of compost | AD-KF * |
| Plant compatibility tests: | | |
| Cress (open) | > 90 % of reference | after Fuchs and Bieri, Agrar-Forschung 7(7): 314-319, 2000, Tab. 4. |
| Cress (closed) | > 50 % of reference | |
| Salad | > 70 % of reference | |
| Bean | > 70 % of reference | |
| Ray grass | > 70 % of reference | |
| Disease suppressivity test | X | after Fuchs |

**X: must be specified**

***: Reference method of the Federal Agricultural Research Stations**

# Part C: Explanations

## 5 Explanations for single paragraphs

### Para. 1.4 (Application):

A study should be carried out to determine when a post-maturated digestate can be defined a compost. On the basis of the present quality criteria for composts, the $NH_4$-N content must be lower than 300 mg per kg of fresh weight and no feedstocks except wood must recognisable visually or by smell (by smell one intends that of the waste feedstocks themselves, not those due to the biological degradation processes).

Press water from the anaerobic digestion of biodegradable waste, on condition that no sewage sludge or other waste has been added, is also considered a digestate. Like sewage sludge and liquid manure, press water cannot be used in S1 groundwater protection zones (Osubst annex 4.5 figure 33).

Wastes used in agriculture without transformation into compost or digestate, such as rape, marmite are defined as type IV fertilizers: other fertilizers and products rated as fertilizers excluding manure, type I (mineral), type II (compost), and type III (sewage sludge) fertilizers. Type IV fertilizers are not subject to the Ordinance on Environmentally Hazardous Substances, but to the Ordinance on Fertilizers. A brochure has been published on this subject: „Wegleitung zur Bewertung und Zulassung von Düngern und diesen gleichgestellten Erzeugnissen“ (Practical instructions for the evaluation and homologation of fertilizers and assimilated products, FAL 1999). It specifies that information is required on nutrients, contaminants, hygiene, impurities, etc.

**Para. 2.1 (Requirements for biological degradation)**:

Ammonium is a truly important fertilizer. Practice of compost control has also shown that it is a good overall criterion of maturity for aerobic composting. Generally high during the thermophilic phase, the ammonium content then sinks during maturation. Furthermore, the ammonium content can be easily measured on-site.

When fixing this limit value we considered a maximum of 500 mg $NH_4$-N per kg of dry weight. In practice, the dry weight is not always determined. On average, experience has shown that composts have a dry weight of 45 – 50%. For practical reasons, a maximal limit value of 300 mg $NH_4$-N per kg of fresh weight was therefore set in these guidelines.

At present, the competent Federal authorities have not yet defined what criteria allow to consider a digestate with post-maturation as a compost. The two weeks of aerobic post-treatment proposed by the FAC are somewhat arbitrary, as the quality of the treatment is not taken into account – rapid desiccation counts as composting. As long as no specific indications for these products exist, the same criteria as for compost should apply.

**Para. 2.1.3 (Hygienization)**:

The hygienic properties could also be determined by analysis, but this procedure has been shown to be very costly and time consuming, while on-site temperature measurements can be easily carried out by the plant personnel. At the same time, these control measurements are valuable, in that they help to render the personnel aware of the biological processes going on. It is however essential that written records of the temperature evolution be kept.

One could wonder at the short time required in anaerobic digestion to reach an adequate degree of hygienization, that is a low germ count. Though the mechanisms responsible have not yet been elucidated, studies, in particular those carried out in Switzerland by Dr Metzler, have shown that three factors are involved:

1. The temperature, which should preferably remain over 52°C,
2. The temperature distribution, which is very uniform in a reactor,
3. The relatively high ammonium content, which in the form of gaseous ammonia can penetrate cell pores.

To be exact, one must remark that mesophilic anaerobic digestion cannot generally guarantee a proper hygienization. Therefore, hygienically doubtful feedstocks should be pasteurised before digestion. Otherwise the digestate must be adequately heated after fermentation, before it can be marketed.

**Para. 3. 3 Quality criteria for composts used in horticulture, market gardening and landscaping: explanations relating to the choice of parameters**

The criteria listed here complete the minimal legal requirements for composts and ensure a problem-free application in horticulture and landscaping. The analytical methods for maturity controls should be simple enough that they can be carried out in a few hours or at most a few days in an on-site laboratory. However, once more experience will have been accumulated, some criteria may be revised.

### *pH:*

The ammonium released by protein degradation causes the pH to rise above 8 during the first stages of composting, as ammonium reacts like an alkali. Only during maturation, when the ammonium is nitrified to nitrate will the pH sink once more below 8. Thus, a high pH is generally the sign of an insufficiently mature compost, adapted for agricultural use.

### *Organic matter (OM, volatile solids):*

Part of the initial organic matter is liberated as $CO_2$ by the micro-organisms. Therefore the OM content steadily decreases during composting. At the onset, the organic matter is composed of carbohydrates, proteins, lipids and ligneous compounds. After composting, most of the organic matter is in the form stable of humic substances. If large amounts of clay or soil are mixed to the feedstocks, the percentage of organic matter decreases and the analysis of the OM content becomes less significant.

### *Intensity of extract colour (humus number):*

Chemical building blocks, originating from the original organic matter, in particular the ligneous compounds, condense into short-chain, water-soluble, dark humic substances (fulvic acids). Only after maturation are these short chains further condensed into longer chains by microbial action. These humic acids can then further condense into still longer humins, which are no more soluble.

The humus number is determined by aqueous extraction of a compost sample. The darker the extract, the more soluble humic substances the compost contains. During maturation, the extract becomes lighter in colour, as the proportion of less soluble longer humic chains increases. A simple determination method still needs to be developed.

### *Salinity:*

In our climate, salinity plays only a minor role for composts used in open fields, as the salt is washed out by precipitation. However, if high loads are applied or in drier climates, salinity may play a more important role. Some plants cannot grow in soils above 2.5 mS/cm (millisiemens/cm: electrical conductivity of a compost extract, which rises with increasing salt concentration). Even plants considered to be robust do not germinate well in soils with a salt content above 4 mS/cm. Salinity will be kept low if only feedstocks with low salinity are used.

### *C/N ratio:*

Micro-organisms can only degrade the organic carbon present in the compost if they have enough nitrogen for growth. If nitrogen is lacking, that is, when the C/N ratio is high, the composting process is inhibited.

When a compost with a high C/N ratio is used, the micro-organisms will sequester some of the nitrogen available in the soil to degrade the organic carbon of the compost. This may result in a nitrogen block and consequently in a nitrogen deficit for the plants.

Organic carbon availability also plays a decisive role. Thus, the organic carbon of fine sawdust is more rapidly available than that of coarsely shredded wood. Consequently, the risk of a nitrogen block will be higher with sawdust than with wood chips. It is therefore difficult to estimate the risk of a nitrogen block only on the basis of the C/N ratio. This is why the ASCP guidelines do not set a maximum value for the C/N ratio. However, since it is useful as an estimate of the long-term availability of nitrogen in the compost, its value should be specified when the compost is intended for horticulture, landscaping and covered cultures.

If the C/N ratio is not explicitly indicated in the official analysis report, it can be calculated from the total nitrogen and the organic matter content, using the following formula given in the Swiss reference methods ($C_{org}$ 1997):

$$\frac{\text{organic matter [\% DW]}}{1.725 \text{ (= conventional humus factor) x total nitrogen [\% DW]}}$$

***$NO_3$-N / $NH_4$-N ratio:***

During the first stages of composting, ammonium is released by protein degradation. During the maturation process, it is then nitrified to nitrate. Therefore the nitrate-N / ammonium-N ratio rises during composting. Ratios below 2 are typical of young composts. These contain relatively high amounts of rapidly degradable organic compounds and therefore stimulate the microbial activity of the soil when used in agriculture. There is a danger of a nitrogen block from this activity if fresh composts are applied without a supplement of nitrogen fertilizer. In mature composts, where the nitrate / ammonium ratio is above 2, the organic matter is in the form of humic compounds that are less easily degradable. The microbial activity will not be as intensively stimulated and no nitrogen block is to be feared.

If the ratio lies below 2, the compost must absolutely be further matured before use in horticulture or landscaping. For use on covered cultures, the ratio should be higher than 20.

As this ratio is particularly useful to distinguish mature from young composts, it may be used to determine for what use a compost is best adapted. As this analysis must absolutely be carried out on fresh material, it must be done in the laboratory within 2 to 3 days. Composts that have not yet reached the degree of maturity required, must be matured longer with frequent turnings. However, the temperature of the windrow should not exceed 45°C, as nitrification is inhibited by high temperatures.

***Nitrite:***

When oxygen deficiency occurs inside a windrow, the ammonium cannot be completely nitrified to nitrate. This leads to the accumulation of nitrite, the intermediary of nitrification. In unaerated storage heaps, nitrate may be reduced to nitrite. This ion is toxic for most living organisms. At the onset of composting, when high amounts of ammonium are present, the nitrite levels are generally still high. If nitrite concentrations are high, the turning frequency should be increased and storage heaps should be aerated.

**Para. 4. 4 Quality criteria for composts used in covered cultures and private gardening:**

Compost destined for covered cultures must have reached a specific degree of maturity. This signals that the product has a relatively high stability, both chemical and biological. The degree of maturity can be measured by a combination of parameters: **content of organic matter, colour of the aqueous extract** (a measure of the stability of the humic substances) and **$NO_3$-N / $NH_4$-N ratio**. This ratio is only significant if the amount of available nitrogen is sufficient. Therefore, the **$NO_3$-N content** should be greater than 50 mg / kg FW. The nitrogen dynamics are not controllable with lower levels and this may lead to serious problems with cultures. High **levels of nitrite** indicate that the nitrification rate is very high, and thus that the product is still unstable, or they may be a sign of insufficient aeration during composting or storage. In this case, the **concentrations of sulphides** are also high. Such compost often cause problems in cultures, especially with delicate nurse crops.

The **salinity** and **pH** are also two decisive criteria for covered cultures and substrate production. If the salinity is too high, sensitive plants may suffer damage. If the pH is too high, nutrient blocks may occur.

A minimum **dry weight** is required to allow handling of the compost. A high **plant compatibility** and **freedom from weeds** are also indispensable. The test of plant compatibility proposed to date in the reference methods of the Federal Agricultural Research Stations are not strin-

gent enough for composts used on covered cultures. We therefore suggest that the recently published methods of Fuchs and Bieri (AgrarForschung 7(7): 314-319, 2000) be used.

Besides these criteria, which must comply with certain limit values, others may be important for the producer of potting soils. These will help him choose the best compost for his scope, and define the additives required, as well as give important indications as to how the substrate should then be used. These criteria are: **particle size, bulk density, water-holding capacity** and **disease suppressivity.** These criteria should allow the user to choose the best compost for his needs, and thus guarantee a successful application of the product.

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