# Pesticides in Mosses

TDE Protocol — Bioindicators | Analytical and Decision-Making Criteria

Status: Operational TDE criterion, to be applied using an analytical method validated for the matrix and within the framework of the integrated territorial assessment.

## 1. Purpose

Multi-residue pesticide analysis in mosses is intended to identify environmental pressures arising from current or past deposition, including deposition originating from activities outside the TDE agricultural area. Moss results are not intended to directly predict concentrations in food products or to assign responsibility for any contamination.

## 2. Determinations and Matrix

• Broad multi-residue analysis by GC-MS/MS and LC-MS/MS, without separating historically used from currently used pesticides.

• Reporting for each individual substance and for sums required by regulatory residue definitions (including parent substances and metabolites, where applicable).

• Terrestrial moss sampled and prepared according to a standardised procedure, recording the species, location, date, portion collected and dry-matter fraction.

• Original result retained in mg/kg dry matter; additional result calculated in mg/kg as received, using the actual moisture content of the sample.

## 3. TDE Reference Rule

TDE guidance value for each pesticide = 50% of the current EU maximum residue level (MRL) for the food category “Mosses and lichens”.

This value is compared with the moss result expressed on an as-received basis. The regulatory residue definition must be followed, including sums of compounds where required. MRLs may change: for each monitoring campaign, the regulatory version consulted and the date of verification must be recorded.

The 50% rule is a voluntary TDE screening criterion; it is not a food safety limit applicable to moss sampled for biomonitoring, nor a toxicological threshold or an environmental background value.

## 4. Conversion and Verifiability

C(as received) = C(dry matter) × dry-matter fraction, where dry-matter fraction = 1 − mass fraction of moisture.

Illustrative example: a result of 20 µg/kg dry matter, with an actual moisture content of 80%, corresponds to 4 µg/kg as received. The 20% dry-matter fraction is hypothetical and is not a fixed conversion factor applicable to all mosses.

Because moss hydration varies considerably with weather conditions, collection and preparation must be standardised. Dry-matter results remain the scientific reference for temporal comparisons and comparison with the literature; the as-received result is used only for the conventional comparison with the food MRL.

## 5. Summary Decision Tree

| Analytical finding | TDE action |
|---|---|
| ≤ 50% of the MRL and favourable environmental evidence | The result is compatible with TDE; continue assessment of the other matrices. |
| > 50% of the MRL | Investigate the substance, compare with other indicators and reach a reasoned decision on admission, suspension or exclusion. |
| High value even below 50% of the MRL | A negative assessment remains possible where this indicates agricultural or environmental pressure incompatible with TDE objectives. |
| Persistent compounds or multiple residues | Interpret the profile, concentrations and persistence; consider historical sources and/or atmospheric transport. |
| LOQ higher than or close to the guidance value | The result does not support a robust conclusion; require a more sensitive method or an additional indicator. |

## 6. Rationale and Limitations of the Criterion

Mosses intercept atmospheric deposition and can integrate exposures over periods longer than the growing cycle of a food crop. Residues may be retained, degraded, washed out or diluted by growth. Consequently, a moss result does not represent a deposited dose per unit area and cannot be interpreted as an equivalent residue concentration in a food crop.

The MRL percentage was chosen to provide a simple, verifiable rule for TDE qualification. It does not replace integrated ecological assessment, which also considers soils, waters, other organisms, territorial exposure and substance profiles. In particular, a high EU MRL does not imply that high environmental concentrations are acceptable for TDE.

The mere detection of pesticides banned long ago, such as DDT and its metabolites, does not prove recent use; nevertheless, their presence remains relevant to assessing overall environmental quality.

## 7. Regulatory and Technical References

1. European Parliament and Council. Regulation (EC) No 396/2005 of 23 February 2005 on maximum residue levels of pesticides in or on food and feed of plant and animal origin, as amended.
https://eur-lex.europa.eu/eli/reg/2005/396/oj

2. European Commission. EU Pesticides Database: MRL searches by product and residue; an information tool to be checked against current acts published in the Official Journal of the European Union.
https://food.ec.europa.eu/plants/pesticides/eu-pesticides-database_en

3. European Commission. Maximum Residue Levels — definition and framework for the application of food MRLs.
https://food.ec.europa.eu/plants/pesticides/maximum-residue-levels_en

4. European Commission. EU legislation on Maximum Residue Levels — legislation, annexes and the general default value where applicable.
https://food.ec.europa.eu/plants/pesticides/maximum-residue-levels/eu-legislation-mrls_en

5. ICP Vegetation / UNECE. Mosses as biomonitors of air pollution: biomonitoring protocols and sample comparability.
https://icpvegetation.ceh.ac.uk/

Documentary note: Exploratory studies on DDT in Romanian mosses and on pesticides in French lichens are not the source of the 50% threshold, which is a TDE management criterion.