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Pesticides in Tree Bioindicator Leaves

Scientific and technical note and operational criterion for territorial qualification • TDE Bioindicators • Version 1.0 • 9 November 2026

Scope: a territorial protocol applicable to different agricultural areas. Reference to black locust (Robinia pseudoacacia L.) is illustrative and does not require exclusive use of this species.

1. Purpose and interpretation principle

Multi-residue testing of leaves is intended to establish whether pesticides are present in the area at levels detectable by vegetation exposed to the outdoor environment. It does not assess leaf edibility or quantitatively demonstrate transfer of contaminants into grain or other crops. Leaves serve as a sentinel matrix complementing soil, water and other available bioindicators (bees, pollen, mosses).

TDE principle: environmental quality does not require absolute chemical absence of every molecule, but sufficiently low anthropogenic pressure supported by consistent evidence. Progressive improvements in analytical LOQs must not automatically change an earlier territorial assessment made using transparent, stable criteria.

2. Adopted TDE criterion

Unit: mg/kg of fresh leaves (fresh weight). Concentration X applies to each individual quantified substance in the multi-residue analysis, not to the sum.

Concentration X	Leaf criterion result	Application
X < 0.01 mg/kg	FAVOURABLE — TDE	The leaf pesticide criterion is met; integrated territorial assessment is still necessary
0.01 ≤ X ≤ 0.05 mg/kg	INTEGRATED ASSESSMENT	Consider available environmental markers, identity of substance, spatial distribution and plausibility of transport from outside the area
X > 0.05 mg/kg	TDE EXCLUSION	Exceedance by a single substance results in non-eligibility under this criterion, subject to checking analytical validity

Boundary values: X = 0.01 and X = 0.05 mg/kg conventionally belong to the integrated assessment band. Where the laboratory reports “< LOQ”, direct classification is possible only if LOQ ≤ 0.01 mg/kg for the relevant matrix.

The TDE threshold is voluntary and conventional: it is NOT a legal limit, a toxicological risk level or a legal application of food MRLs to black locust.

3. Rationale: comparison with food MRLs

Regulation (EC) No 396/2005 sets MRLs for combinations of active substance and food commodity. The general default is 0.01 mg/kg when no specific MRL has been set; many

specific MRLs are higher. Black locust leaves can only be compared conceptually with leafy vegetables (e.g. spinach), not as biologically or legally equivalent matrices.

A uniform criterion of 0.01 / 0.05 mg/kg per substance was preferred to substance-specific percentages of spinach MRLs. This avoids hundreds of different thresholds and keeps the focus on environmental pressure, rather than food-law compliance.

4. Empirical evidence in the literature

Published studies show that plant-protection residues are measurable on non-target vegetation, including some distance from fields; values depend on species, exposure, season, compound and weight basis. The following figures are not background concentrations for black locust in TDE areas.

Study / matrix	Documented result	TDE relevance
Brühl et al., 2024 — wild vegetation, Val Venosta	Mean sum 0.10448 mg/kg; mean fluazinam 0.04352; trifloxystrobin 0.02088; penconazole 0.01279 mg/kg. Maximum methoxyfenozide 1.37085 mg/kg	Demonstrates discrimination of vegetation exposed to intensive cultivation; means are not TDE thresholds
Linhart et al., 2019 — playground grasses, South Tyrol	45% of 71 sites with at least one residue; maximum reported phosmet 0.069 and fluazinam 0.26 mg/kg	Shows values above 0.05 mg/kg in areas not directly treated
Pompe et al., 2026 — ryegrass and leaf beet, Bavaria	216 vegetation samples; method LOQ categories 0.01 and 0.001 mg/kg; more frequent residues close to crops	Supports sentinel plants; does not imply direct equivalence between leaf concentration and deposition
Beghini et al., 2025 — tree leaves, Verona	Pesticides in more than 70% of samples; folpet-phthalimide in 55.3%	Relevant to leaf biomonitoring near cultivated land
Cebotari et al., 2018 — black locust flowers, Moldova	Several residues reported, including very high mean difenoconazole (8.75 mg/kg)	Exploratory comparison only: flowers, not leaves; method and tabular data require further assessment

Warning: comparing published concentrations properly requires checking fresh/dry weight, pretreatment, methods and individual LOQs. Never convert dry-weight concentrations into fresh-weight values without the measured moisture content.

5. Interpretation and integration across matrices

If X < 0.01 mg/kg for all measurable substances, the leaf criterion is positive. In the 0.01–0.05 mg/kg band consider, where available, soil (particularly historical and persistent pesticides), bees/pollen, mosses, water and agricultural practice information. An unavailable optional matrix must not be treated as a negative analytical result.

At X > 0.05 mg/kg, TDE non-eligibility applies after verifying substance identity, units, matrix, potential sample contamination and measurement uncertainty. Leaf findings alone cannot prove the absence of local pesticide applications; that claim also requires documentation of farming practices, land use and surrounding sources. Leaf residues may originate from atmospheric deposition, direct contact, resuspension or plant uptake.

6. Sampling-plan requirements

The number of points, seasons, species and compositing methods must be defined in the general TDE sampling plan. Requirements include a widespread comparable plant species, intact unwashed leaves, standardised leaf age, height, exposure and season, weather and farming records, comparison sites, and sample transport and preservation.

Analytical requirement already established: LC-MS/MS + GC-MS/MS multi-residue testing validated for leaves, with LOQ no higher than 0.01 mg/kg fresh weight for substances being assessed. Substances absent from the method or with a higher LOQ must be declared in the report; their absence must not be inferred from “not detected”.

7. Final decision

APPROVED TDE CRITERION: < 0.01 mg/kg favourable; 0.01–0.05 mg/kg integrated assessment; > 0.05 mg/kg exclusion. Applied to each individual substance in sentinel leaves, on a fresh-weight basis. EU MRLs are a conceptual reference, not the legal basis for these thresholds. The criterion is proportionate and does not demand absolute absence at ultratrace levels.

8. Bibliography and regulatory references

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9. Cebotari V., Buzu I., Postolachi O. (year to be verified). Pesticide residues in melliferous flowers from sites with diverse anthropic impact. Scientific Papers – Animal Science Series. Abstract: https://uaiasi.ro/firaa/en/journal/vol-71/Valentina_Cebotari2.html. Reports no detectable residues in black locust flowers collected from woodland (69 substances tested); not used to establish thresholds.

Editorial note: the bibliography was verified against accessible publisher and database pages as at the document date. TDE thresholds are project decisions, not direct conclusions from the cited studies.