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Research Article

Official Controls to Ensure the Legitimate Application of Plant Protection Products

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Abstract
Plant protection products (PPPs) are widely used in plant production to prevent plants from several threats and thus ensure the supply with plant based food and animal feed. To minimise adverse effects of PPPs on human and animal health as well as the environment there are strict rules for the authorisation of plant protection, their placing on the market, use and control within the EU. Article 68 of REGULATION (EC) No 1107/2009 [1] points out that the member states shall carry out official controls in order to enforce compliance with these rules. Official controls can follow different ways. This article describes the method of taking samples of soil, plant material, spray solution, etc. and running chemical analysis to monitor and ensure the legitimate application of plant protection products.

Keywords: control application pesticide chemical analysis.

Introduction

Official controls to ensure the legitimate application of plant protection products can be done for example by on-site control at operator's farm, check on documentation or sample taking combined with chemical analysis of pesticide residues. A very effective approach combines all of these methods. Several aspects can be checked by sample taking combined with chemical analyses, e.g.:

- Ban on use
- Indication approval
- Compliance with the application instructions related to
  - Water conservation (distance to surface waters, slope, drainage, soil class, etc.)
  - Bee conservation
  - Time of application
  - Quantity of applications
- Organic farming (ban on chemical-synthetic pesticides).

Dependent on the specific aspect samples of soil, plant material (leaves, etc.) and/or spray solution can be the proper choice for the corresponding control activity.

In Germany a harmonised control program is run by its federal states. The state Baden-Wuerttemberg takes and analyses about 500 - 600 samples per year to monitor the legitimate application of PPPs.

Materials and methods

Samples of soil, plant material and spray solution are risk-based planned and taken by authorised and especially trained staff. The pesticide residue analysis is carried out by official laboratories (OFLs) specialised in this field of matrices and analytical tasks.

Suitable analytical methods are e.g.:

- Plant material (leaves, etc.) – VDLUFA MB VII Method No. 3.3.7.1 [2]: Accelerated solvent extraction (ASE) with acetone/n-hexane, removal of organic solvent, elution with ethyl acetate/cyclohexane, gel permeation chromatography (GPC), removal of organic

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solvent, elution with acetonitrile, GC-MS/MS and LC-MS/MS

- Soil – VDLUFA MB VII Method No. 3.3.7.2 [3] (modified QuEChERS [4, 5] approach): Liquid liquid extraction (LLE) with water/acetonitrile, phase separation by adding salt mixture, dispersive solid phase extraction (dSPE), GC-MS/MS and LC-MS/MS
- Spray solution – in-house method (association method in preparation): extraction/dissociation/elution with acetone/acetonitrile, dilution, GC-MS/MS and LC-MS/MS.

The evaluation of the analytical results is quite challenging. There are no threshold values like e.g. maximum residues levels (MRL) in food and animal feed control. In addition pesticide residues can result beside direct application from other sources like e.g.:

- Drift from neighbouring farmed areas
- Run-off of pesticides eluted by water or bound to soil particles
- Residues in application device from former applications
- Relevant contamination of active ingredient deriving from chemical synthesis (e.g. Folpet (CAS# 133-07-3) in Captan (CAS# 133-06-2)).

For evaluation a case-by-case consideration has to be carried out each time individually. Thereby the main question which has to be answered is: *Did a usual (according to application rate, time of application, used techniques, water amount, etc.) application took place which was not allowed e.g. due to a ban of use, in the corresponding crop (indication approval) and/or due to a violation of the application instructions, etc.?*

To answer the question the analytical results have to be compared with theoretical values for a usual application. If the height of the analytical result is comparable to the theoretical value it is a strong evidence for a usual application. Other sources lead to significantly lower amounts typically. Furthermore available additional information from sampling documentation (e.g. used PPPs and application device, crop and its development stage, sampling rate, time of application, surrounding farmed areas, water amount, etc.) can be useful when justifying specific aspects.

Theoretical amounts for soil and spray solution can be calculated by using the usual respectively maximum allowable application rate in $L \cdot ha^{-1}$ respectively $kg \cdot ha^{-1}$. In the case of spray solution the used water amount has to be known or estimated. In case of soil the depth of sample taking is kept at a defined known value (e.g. 5 cm). Deriving a theoretical amount for plant material is more difficult. The most effective way in this case is carrying out residue trials.

Results and discussion

559 controls were carried out in Baden-Wuerttemberg in 2024. Tab. 1 shows the number of controls and violations for each control activity.

Table 1. Control activities and results in the year 2024

Control activity	Controls	Violations	
	No.	No.	Percentage
Ban on use			
Atrazine outside of water protection areas	16	0	0.0
Atrazine/Terbuthylazine/S-Metolachlor inside of water protection areas	101	11	10.9
Glyphosate inside of water protection areas	9	8	88.9
Indication approval			
Berry fruit	45	7	15.6
Pome fruit/stone fruit	42	3	7.1
Rapeseed	24	0	0.0
Vegetables	13	0	0.0
Ornamental plants	10	0	0.0
Compliance with the application instructions			
Distance to surface waters	160	47	29.4
Slope/drainage/soil class Chlortoluron	51	1	2.0
Bee conservation	65	2	3.1
Organic farming			
Ban on chemical-synthetic pesticides	19	1	5.3
Specific Regulation Baden-Wuerttemberg			
Application restriction Captan	4	0	0.0
Total	**559**	**80**	**14.3**

The ratio of violations for most control activities ranges from 0 till about 10 %. Only the activities 'indication approval in berry fruit', 'distance to surface waters' and 'Glyphosate inside of water protection' areas show significantly higher results.

Conclusions

The ratio of violations in 2024 was moderate till satisfying for most of the control activities. Choosing the right plant protection products in berry fruit cultivation should be improved. The number of violations regarding distance to surface waters was way too high. Especially in spatial cultures (Pome fruit, stone fruit, etc.) growers did not follow the application instruction to a sufficient extent. Training and monitoring is particularly necessary here. The high ratio of violations regarding the application of Glyphosate inside of water protection areas was unacceptable – even if the use was newly banned and all samples were taken due to recent occurrences. Information and the control intensity have to be intensified.
All violations were tracked and fined. The control program will be continued.

References

1. **European Parliament and Council** (2025), *Regulation (EC) No. 1107/2009 of the European Parliament and of the Council of 21 October 2009 concerning the placing of plant protection products on the market and repealing Council Directives 79/117/EEC and 91/414/EEC*. Retrieved April, 7 2025, from https://eur-lex.europa.eu/eli/reg/2009/1107/oj/eng.

2. **Verband Deutscher Landwirtschaftlicher Untersuchungs- und Forschungsanstalten e. V. (Association of German Agricultural Inspection and Research Institutes)** (2011), Method No. 3.3.7.1: Bestimmung von Pflanzenschutzmittelwirkstoffen in ausgewaehlten be- und verarbeiteten Futtermitteln mittels chromatographischer Verfahren und massenspektrometrischer Detektion (Determination of pesticides in processed animal feed by chromatography and mass selective detection). *Handbuch der Landwirtschaftlichen Versuchs- und Untersuchungsmethodik (VDLUFA Method Book). Bd. VII Umweltanalytik*, 4th edition, VDLUFA-Verlag, Darmstadt, Germany.

3. **Verband Deutscher Landwirtschaftlicher Untersuchungs- und Forschungsanstalten e. V. (Association of German Agricultural Inspection and Research Institutes)** (2014), Method No. 3.3.7.2: Bestimmung von Pflanzenschutzmittel-Wirkstoffen in Böden mittels gas- und fluessigkeitschromatographischer Verfahren und massenspektrometrischer Detektion (Determination of pesticides in soils by chromatography and mass selective detection). *Handbuch der Landwirtschaftlichen Versuchs- und Untersuchungsmethodik (VDLUFA Method Book). Bd. VII Umweltanalytik*, 4th edition, 1st supplement, VDLUFA-Verlag, Darmstadt, Germany.

4. **CVUA Stuttgart** (2025). *Home of the QuEChERS Method* Retrieved April, 7 2025, from https://www.quechers.eu/.

5. **Nagel, T. G.** (2009). The QuEChERS Method – A new Approach in Pesticide Analysis of Soils. *Journal of Horticulture, Forestry and Biotechnology* (ISSN: 2066-1797), 13, 391, https://www.usab-tm.ro/Journal-HFB/romana/Lucrari_2009_paginate/89.pdf