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Topic 2 - Product and process quality in Organic Agriculture: methods and challenges

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SOLVING PHOSPHITES EMERGENCY IN ORGANIC FRUIT AND VEGETABLES: THE PARTICIPATORY BIOFOSF PROJECT

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Abstract:

Quality and safe food is an imperative in organic production. Recently, in EU market some organic fruits and vegetables were positive (>0.01 mg/kg) to phosphonic acid (i.e., phosphite), despite fosetyl-Al or phosphite are not allowed as plant protection products in Reg. EC n.889/2009. In 2016, the Italian Ministry of Agricolture funded the BIOFOSF project to the Council for Agricultural Research and Economics, which promoted a partecipatory approach among researchers, farmers and control bodies for solving this issue. The endogenous production of phophonic acid was not observed, while it was evidenced that its origin is due only to external inputs. A contamination of some plant protection products (PPP) and organic fertilizers allowed in organic farming was found, thus suggesting a deep revision of their official control system.

Introduction:

Until 2018, under the Directive for “Requirements for Certification Bodies of products obtained with organic farming method” (ACCREDIA RT-16), in Italy the detection of phosphonic acid (PHY) residues >0.01 mg/kg in organic products, without simultaneous detection of ethylphosphonic acid (ET-PHY) deriving from fosetyl-aluminum use (FOS, not allowed in organic farming) was considered a "false positive" and the same goods were not decertified and the operator not sanctioned. From 2014, several Italian organic products were found contaminated by PHY>0.01 mg/kg (DM n.309/2011): in 2016, the Italian Ministry of Agriculture funded the BIOFOSF project *"Strategy for solving phosphite issue in organic fruit and vegetable products"* to the Council for agricultural research and economics (CREA) to understand the origin of phosphonic acid residues in organic food and to verify if the revision of the RT-16 interpretation was needed.

Material and methods:

The BIOFOSF project considered the following hypothesis to justify the presence of PHY residues in organic fruit and vegetables:

- use of PPPs not allowed in organic farming;
- endogenous production by plants;
- occurrence of PHY in organic fertilizers and amendments (animal/vegetable origin).

The project promoted a strong participatory approach, where diverse actors of the organic sector (researchers, organic associations, organic producers, associations of fertilizers manufacturers, Italian Ministry of agriculture) joined together within the BIOFOSF Advisory Board, to agree all project phases (crops to be tested, experimental field protocols, mode of sampling, lab methodologies, interpretation of results).

CREA experimental field trials - In randomized 3-blocks design systems, the CREA-Centre for Cereals and Industrial Crops (Bologna, IT) carried out a field trials on potato cv Sarpo Mira by comparing organic management (without supplying neither potassium phosphite, K-PHY, nor ethyl-phosphonate derivates, FOS) to the corresponding integrated systems (supplying K-PHY or FOS). In both the organic/integrated management, organic fertilization was carried out applying the following fertilizers: hydrolyzed proteins (HYD); meat meal (MM); hydrolyzed proteins + soft ground rock phosphate (HYD + P); pelleted poultry manure (PM).

To clarify the admissibility of the RT-16 “false positive” interpretation, the CREA- Research Centre for Agriculture and Environment (Rome, IT) evaluated the dynamic of FOS degradation in rocket salad, after application of FOS-Al at a dose of 2.0 Kg/ha.

Organic producers’ field trials – Under the supervision of the CREA, organic producers under Federbio IT association carried out tests on two pear cultivars (Abate Fetel and William’s, Agrintesa) grafted on BA29, kiwi fruit, cv Hayward (Apofruit Italia) and tomato, cv Cikito (Biotropic), using only fertilizers (organic fertilizers, mix of micronutrients, hydrolysed proteins and seaweeds extracts) and PPPs (CuO, Bordeaux mixture) allowed in organic farming. In all the field trials, PHY and ET-PHY content were determined in soils, leaves, tubers/berries/fruits, and used fertilizers and PPPs (based on Cu) by applying the EU reference method “CVUA EU-RL-SRM QuPPe (Quick Polar Pesticides, LC-MS/MS), Ver. 8.1, Method 1.3 (2015)”. In addition, segments of young and old tree branches from two cultivars (Abate and William’s) of pear trees were sampled to evaluate the long-term effect of PHY contamination in tree crops.

Statistics - Dynamic of FOS degradation was studied by applying alternative regression models. In field trials, all data of ET-PHY and PHY contents in soils, leaves, tubers/berries/fruits were statistically evaluated by two-way ANOVA, considering as fixed factors the fertilization (FERT) and the PPP treatments.

Results:

CREA field trials – Regarding the field experiment on potato, no PHY residues were found in soil at the beginning and the end of the experiment in all the treatments, also after addition of K-PHY to soil. In Figure 1 (A1-A2), PHY and ET-PHY content in potato tubers after 105 and 150 days after planting (DAP) are reported: after adding FOS-Al, ET-PHY was registered only in the leaves at 105 DAP, while PHY was detected in leaves and tubers at both 105 and 150 DAP. In K-PHY treatment, only PHY residues were found in leaves and tubers at 105 and 150 DAP. In CNT treated with CuO, ET-PHY and PHY were not found in leaves and tubers. A slight effect ($P<0.01$) of poultry manure was observed in terms of PHY increase in leaves at 105 DAP, not recorded at 150 DAP.

In Figure 1 (B1-B2), FOS degradation in rocket salad is reported. Data referred to the percentage of ET-PHY and PHY recovered in rocket leaves after 10 days from FOS-Al supply, taken as 100% the starting recovery. Regression model applied to ET-PHY dynamic showed that it was not detectable after 20 days.

Organic producers' field trials – Tomato laeves and berries did not evidence any contamination by PHY, while in kiwi and pear fruit PHY>0.1 mg/kg was found, even if the applied organic fertilizers and PPPs were all allowed in organic farming (Annex I-II to Reg. EC N.889/2008). In Figure 2, PHY content in William's and Abate pear leaves and fruits recorded in 2016 and 2017, together with the same content in young (I year) and old (III years) tree branches, sampled in 2017, are reported.

PHY and ET-PHY contents in FERT and PPPs used in all the BIOFOSF experimental trials evidenced the presence of PHY in 14% of the total 22 mineral fertilizers, in 32% of the total 25 organic fertilizers (i.e., one poultry manure >1.5 mg/kg PHY; seaweeds extracts >10 mg/kg PHY) and in 40% of the used Copper-based PPPs (i.e., one Bordeaux mixture: >60 mg/kg PHY and >20 mg/kg ET-PHY).

Discussion:

The BIOFOSF field trials demonstrate that PHY is rapidly oxidized in soil, while PHY residues detected in vegetables and fruits are due only to external inputs containing FOS-derivates or PHY salts, having no evidences of endogenous PHY production by the tested crops.

The degradation of FOS/ET-PHY into PHY is very fast after foliar application, since ET-PHY completely disappeared after 20 days; the observed trend shows that PHY concentration in rocket leaves is a resultant of both the ET-PHY degradation and contemporary partial oxidation of PHY into phosphate.

Due to the storage of PHY in the lignocellulosic tissue of tree branches, it takes several years to detoxify fruit trees.

Based on BIOFOSF results, from 2018 the RT-16 "false positive" interpretation is not anymore acceptable for vegetables and fruit crops contaminated by PHY, even if it was maintained for processed food. At the end, since the undecleared presence of PHY found in several fertilizers and PPPs, a deep revision of the modalities for fertilizers/PPP official control is needed.

References:

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- Quick Method for the Analysis of numerous Highly Polar Pesticides in Foods of Plant Origin via LC-MS/MS involving Simultaneous Extraction with Methanol - QuPPe-Method - Version 9.1, May 2016.
- Trinchera A (2018): Phosphonic acid and Fosetyl-Al residues: Experience from Italy. Better Training for Safer Food: Training activities on strengthening Member States' response to Union audits. Towards More Effective Pesticide Residue Controls in Organic Production 24 Oct 2018, Grange (Ireland).

http://www.salute.gov.it/imgs/C_17_corsiFormazioneVeterinaria_230_listaFile_itemName_3_file.pdf

Image:

Figure 1. A1-A2: ET-PHY (A1) and PHY (A2) content in potato tubers after 105 and 150 DAP as affected by fertilization (HYD, MM, HYD+P, PM) and PPP (FOS-Al, K-PHY, CuO taken as CNT) treatments. Different letters represent significant differences (Tukey HSD test for mean comparison). Levels of statistical significance at P <0.001 (ANOVA). LOQ_{PHY} = 0.1 mg/kg; b LOQ_{ET-PHY} = 0.01 mg/kg. B1-B2: Degradation of ET-PHY (B1) and PHY (B2) in rocket salad leaf tissue during the first 10 days after FOS application.

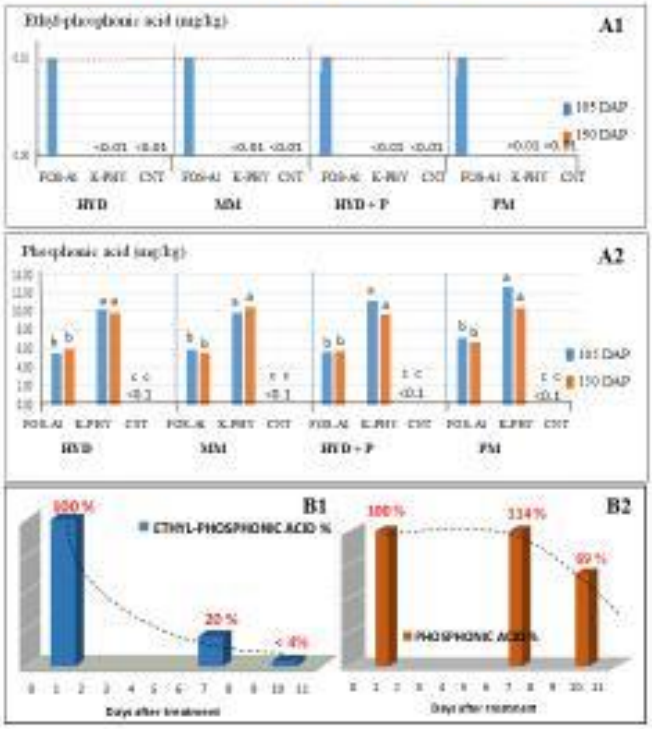
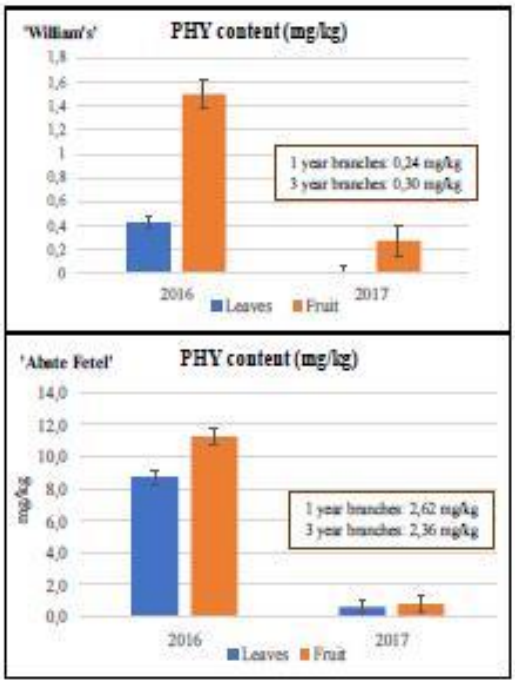


Image 2:

Figure 2. PHY content in leaves, fruits (2016 and 2017) and I-year old and III-years-old branches (2017) of William's and Abate pear cultivars. LOQ_{PHY} = 0.1 mg/kg; b LOQ_{ET-PHY} = 0.01 mg/kg.



Disclosure of Interest: None Declared

Keywords: fosetyl residues, MRL, Organic vegetable production, Pear, phosphonic acid, potato