Translocation of phosphonate from frigoplants to fruits in strawberries

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Abstract

We analysed the phosphonate contents in commercially available strawberry frigoplants and in the fruits grown on these plants. The results show that phosphonates can be translocated from frigoplants to fruits. Thus, strawberry growers may be confronted with phosphonate residues even if they have not applied phosphonates themselves.

Keywords: Phosphonate, residues, strawberry, frigoplants.

Introduction

In conventional agriculture, phosphonates are widely used in various crops as fungicides against oomycete fungi. They are highly mobile within plants and application usually leads to residues in the harvest. There is evidence that phosphonates are stored within plants and may be translocated into fruits in the subsequent growing period(s) (Rizzolli *et al.*, 2016).

In organic farming, the use of phosphonates is currently not allowed. In the past, some organic grower's associations allowed the use of plant strenghteners containing phosphonates. Since October 2013, however, this is not possible any more. There was a discussion whether phosphonates should be authorized as plant protection products in organic farming, but the European Commission has not allowed their use until now. One of the main arguments against phosphonates is the fact that application generally leads to residues (EGTOP, 2014).

Organic strawberry production has is a strong demand for healthy and vigorous young plants for fruit production. Intensive efforts are under way to provide vegetative propagation material in organic quality. Nevertheless, there may be situations where frigoplants of a given strawberry variety are not available in organic quality. If this is the case, growers may obtain a permit for using non-organic seedlings for their fruit production. As a precautionary measure, Bio Suisse determined that if non-organic frigoplants are used, the yield from the year of planting must not be marketed as organic. Bio Suisse also requires that the strawberry fruit must be analysed for pesticide residues and that they may only be cleared for organic marketing by the control body, if no pesticide residues are found. However, Bio Suisse does not specify which pesticides must be analysed for. Because phosphonates cannot be detected by usual pesticide screenings, they might often remain undetected.

Here, we tested the prevalence of phosphonate residues in strawberry frigoplants and their translocation to fruit in the year of planting and in the year after planting. The aim was to determine whether the need to use conventional frigoplants poses a residue risk for organic strawberry growers.

Material and Methods

We investigated conventionally grown frigoplants from four different varieties, obtained from four different companies located in Italy, France and The Netherlands. In April 2016, the frigoplants were planted in the field. In the field, they were organically cultivated and hence received no treatment with phosphonates. In the year of planting, the plants bore fruit between June and August 2016, depending on their ripening time. In the year after planting,

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the plants bore fruit between May and June 2017. Ripe fruits were repeatedly harvested, as usual in commercial strawberry growing.

To obtain the sample of frigoplants, ten plants of each variety were thoroughly washed to remove all soil, and then frozen. To obtain the fruit samples, the calyx was removed from freshly harvested fruit and the fruit were frozen. This was repeated on several harvest dates, until a minimum of 150 g was available for each variety. The samples were analysed for the presence of phosphonic acid and fosethyl-Al by Labor Friedle (Tiengen, Germany). All results are reported in mg/kg.

Results

Fosethyl-Al was not detected in any of the samples and is therefore not further discussed. By contrast, phosphonic acid was frequently detected (see table 1). All frigoplants contained phosphonic acid (range: 1.3 – 24 mg/kg). All fruit from the year of planting contained phosphonic acid (range: 0.02 – 0.34 mg/kg), while none of the fruit from the year after planting contained phosphonic acid.

Due to the small number of replicates, no correlational analysis was performed. However, the results suggest that those varieties with elevated phosphonate levels in frigoplants (>10 mg/kg) had higher residues in fruit (>0.1 mg/kg).

Table 1: Levels of phosphonic acid residues in strawberry frigoplants and fruits (nd = not detected).

Cultivar	Origin	Phosphonic acid (mg/kg)		
		Frigoplants 2016	Fruit 2016	Fruit 2017
Cultivar A	Italy	1.3	0.03	nd
Cultivar B	France	2.0	0.02	nd
Cultivar C	The Netherlands	18.0	0.34	nd
Cultivar D	France	24.0	0.12	nd

Discussion

All frigoplants investigated (covering four producers and three European countries) contained phosphonic acid, while none contained fosethyl-Al. This indicates that phosphonates are widely used in the conventional production of strawberry frigoplants, and that phosphonic acid is stored in the frigoplants.

This study further shows that phosphonates can be translocated from roots to fruits in strawberries. A similar behaviour has been reported for apple (Rizzolli *et al.*, 2016) and grapevine (Kauer, 2011). Measurable residues were found only in the year of planting. There are indications that residues in fruits in the year of planting were highest in those varieties containing high levels of phosphonic acid in the frigoplants.

Consequently, strawberry growers may be confronted with phosphonate residues in the harvest, even if they have not applied phosphonates themselves. This would be particularly problematic in the case of organic growers, because phosphonates may not be used in organic production. We point out that our data were obtained with non-organic frigoplants. Organic growers are obliged to use organic vegetative material. However, if this is not available for the desired varieties, they may obtain a permit for using non-organic seedlings or frigoplants for their fruit production. Bio Suisse requires that in the case of frigoplants, the yield from the year of planting must not be marketed as organic. This study shows that the use of non-organic frigoplants poses a serious risk of phosphonate residues. Blocking the marketing of such harvest as organic in the year of planting (as done by Bio Suisse) is an effective measure to reduce this risk.

Finally, this study indicates that in strawberries grown from conventional frigoplants, residue analyses should not be restricted to pesticide screenings, but should additionally cover phosphonic acid.

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