How to optimize fruit and berry cultivar selection for organic farmers? A comparison of European approaches.

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Abstract

Most of the currently grown commercial fruit cultivars remain unsuitable to low-input or sustainable organic farming systems. The major reason is that they have been developed and selected under high input cultivation, and without sufficient attention to susceptibility to pests and diseases. Some of these cultivars are nevertheless marketed as resistant because they carry genetic markers for major resistance genes but these are unfortunately prone to break-down (most of apple resistant cultivars relay only on the Vf). As a result, new fruit cultivars tend to reveal unexpected and often undesirable traits when grown in commercial organic orchards, and thus fail to bring about the much needed expansion in organic production and market availability. However, research is ongoing, and some institutions in Europe have established specific approaches in their breeding programs for testing new selections and cultivars under entirely organic conditions – sometimes including also evaluation of storage capability, consumer acceptance or suitable characteristics for juice and cider processing.

This paper gives an overview of approaches developed in some European countries, their characteristics, objectives and results. It shows a number of different ways to address a difficult topic. We conclude that it is very desirable to – on a European level – exchange results and ideas to further improve the testing systems, and to increase the distribution of promising cultivars for the European organic fruit sector.

Keywords: organic farming, variety testing, fruit growing, low input, sustainable orchard

Context

One of the key areas for successful establishment of truly sustainable fruit orchards is the choice of cultivar and rootstock (Jamar *et al*., 2012). Yet, modern cultivar breeding and selection has mainly prioritized yield, fruit size, and color. Criteria deemed especially important by organic growers, such as global rusticity and tolerance to pests and diseases, have been neglected for years. This situation has led to a market that is completely dominated by modern cultivars. These cultivars need much attention and input, often requiring expensive technical equipment. The fruit sector has, in addition, become heavily reliant on pesticides and fungicides, and is therefore one of the least attractive for organic farming.

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Lately, the need for a new paradigm for cultivar breeding and evaluation has been addressed (Lateur *et al*., 2006, Brun *et al*., 2011). Time needed for development of new fruit cultivars is quite long, but may be shortened by working closely together with growers, on their farms, and with emphasis on locally-adapted cultivars.

This paper intends to provide an overview of current fruit variety testing programs for organic and low-input farming in Europe. A paper dedicated to breeding for organic farming in Europe has already been published (Warlop *et al*., 2010).

Table1: Key persons active in breeding and cultivar evaluation for organic farming in Europe

Country	***Scientists involved in public organizations***	***Breeding***	***Evaluation***
Belgium	Marc Lateur (CRA-W) Jef Vercammen (PCFruit)	x	x x
Czech Republic	Radek Cerny, Jaroslav Tupy (UEB)	x	x
France	INRA ML Brachet, S. Codarin, A. Garcin (Ctifl) Regional experimental stations (La Pugère, La Morinière, La Tapy, Serfel, Centrex, Sefra, Invenio, Cehm, Grab)	x	x x x
Denmark	Hanne Lindhard Pedersen, Marianne Bertelsen, Martin Jensen (Aarhus Univ.)		x
Germany	Franz Ruess (LVWO) Mathias Riestel, Inde Sattler (Apfel:Gut) Philip Haug, Erhard Karrer (Foeko) Ulrich Mayr (KOB Bavendorf) Andreas Peil (JKI Pillnitz) Gerhard Baab (DLR Rheinpfalz)	x x x 	x x x x x
Italy	Markus Kelderer (Laimburg) Pierangela Schiatti (Prober)		x x
Poland	INSAD	x	x
Sweden	Hilde Nybom, Kimmo Rumpunen (SLU)	x	x
Switzerland	Markus Kellerhals (ACW) Niklaus Bolliger (farmer) Franco Weibel (FiBL)	x x 	 x
Netherlands	Gerjan Brouwer (DLV Plant) Bart Timmermans (LBI) Bertus Meijer (PPO Randwijk) Prisma (growers organization)	 x 	x x x

Table 2: Some trials dedicated to organic farming have been set up in Europe, with various characteristics.

Country	***Trials dedicated to organic production***	***Involvement of fruit growers***	***Number of locations in the country***
Belgium	2 steps	x	2 (+1 in North of France)
France	x		5 for peach, 2 for apple
Denmark	x		1
Germany	3 steps	x	step 1 : 4/step 2 : >10/step 3 : >15
Italy	2 steps	x	2 (valley/mountain)
Poland	x		1
Sweden	x	in minor extent	1
Switzerland	x		1
Netherlands	1 step	x	1 (Randwijk)

Depending on country priorities and the people involved in organic farming research, the fruit and berry crops evaluated in these trials may be quite different.

In France, some trials have been set up between 2000 and 2008 thanks to the Ministry calls for proposals. These involved apple, pear, apricot, peach, and have permitted evaluation of old and new cultivars grown under very low input level. Several publications have been issued from this research (e.g. Brun *et al*., Parveaud *et al*., 2011).

Table 3: Fruit and berry crops concerned in each country

Country	***apple***	***pear***	***peach***	***cherry***	***plum***	***apricot***	***raspberry***	***black currant***	***strawberry***
Belgium	x	(x)	(x)						
France	(x)	(x)	x	(x)	(x)	x			
Denmark	x			(sour)				x	
Germany	x	x		x			x		
Italy	x			x					x
Poland	x			x	x		x	x	x
Sweden	x								
Switzerland	x	x							x
Netherlands	x	x							

(x): secondary species / under construction

Technical choices for plant growing are crucial for a correct evaluation of a new fruit cultivar. Depending on the number of trees or bushes tested for each cultivar, plantation design (neighbouring effects), plant protection strategy, behaviours and answers might be different.

Table 4: Planting characteristics in different trials

Country	***number of cultivars evaluated on each site***	***number of cultivars introduced every year***	***number of trees observed per cultivar***	***length of evaluation per cultivar***	***plantation design***
Belgium	apple: 108 pear: 15	5 to 12	2d step:10 to 15 3d step: 50 - 100	4 to 6 years	blocks (3-6 trees)
France	between 10 and 150		3 to 6		randomized blocks
Denmark	apple: 30 black currant: 15 sour cherry: 20		20		randomized blocks (5 trees)
Germany	15		20-300		
Italy	1st step: 100 2d step: 12 3d step:	1st step: 20	1st step: 5 2d step: 50 3d step: 500[#]		blocks
Poland	14		20		randomized blocks
Sweden	apple: 20 black currant: 10		4	4 to 6 years	randomized blocks
Switzerland		24 maximum	20		blocks
Netherlands	2006 to 2011: apple: 10 pear: 6	<1 no new variety at this time	apple: 10 pear: 10		randomized blocks (10 trees)*

** this may lead to mistakes: for example, problems with insufficient pollination of the pear Concorde were not noticed, due to the availability of many different cultivars on the testing location.*

[#] *in commercial orchard*

Level of plant protection is very important when evaluating cultivars. Although a slight reduction of pesticide application (< 50 %) may affect the most susceptible cultivars visibly, the remaining ones may also be unsuitable for organic production.

Table 5: Plant protection used in cultivar trials

Country	***plant protection strategy applied (% of reduction applied)***	***pre-screening in lab or greenhouse***	***pest and diseases targeted***
Belgium	Organic fungicides only on primary heavy scab infections (max 2-7/year)	Yes (with large diversity of scab races)	apple scab, powdery mildew, neonectria canker, storage diseases
France	pesticide reduction (or no treatment against a specific pest or disease evaluated in dedicated plots)	for Plum Plox virus, aphids + development of molecular markers	moniliosis, downy mildew, peach leaf curl, thrips, moth, canker, Xanthomonas
Denmark	Reduced, organic fungicides		apple scab, canker
Germany	reduction in beginning		apple scab, fire blight
Italy	1st phase reduced conv. management 2nd phase comparison between a reduced conventional and a reduced organic management		any disease and pest which occurs until the end of storage
Poland	fungicide reduction	for apple scab, mildew and fireblight	scab, fire blight, frost
Sweden	1st phase often conv. management, later changed to no chemical spray	black currants: powdery mildew	apple: scab, mildew, canker, storage diseases ; black currants: gall mites
Switzerland	treated for the first 2 years against aphids	for apple scab, mildew and fireblight	scab, fireblight, aphids
Netherlands	Reduced, organic fungicides	x	scab, mildew, long lasting storage

Private breeders have taken part in some worldwide fruit and berry breeding. This may have consequences in terms of the number of cultivars available for testing by public organizations.

Table 6: Funding of national testing programs

Country	***funding from public***	***funding from private***	***comment about future funding***
Belgium	x	x	unpredictable
France	x (call for proposals)		no additional means for a future network devoted to organic/low-input farming
Denmark	x		
Germany	x	x	
Italy	x		
Poland	x		
Sweden	x		very little funding, no stability
Switzerland			
Netherlands	x	Prisma	not well planned (organic being too small)

Conclusion and perspectives

From this rough survey, we can observe that the approaches are very different from one country to another, depending mainly on funds available, but also on the people involved.

In France, there has been much discussion about measures needed to produce better information on cultivar susceptibility to pests and diseases in order to facilitate organic growing. This discussion has defined a number of difficult issues that need to be solved as soon as possible:

- How should the behavioural trial be set up? How far can neighbouring trees influence the damage level of one specific tree? Is a randomized trial still manageable from a practical point of view?
- What is the best level of plant protection, between no treatment and IPM? Should this level be specific for each pest and disease?
- How can we address interactions between different pests or diseases in a behavioural orchard? Do we need to provide dedicated orchards for specific pests/diseases?
- Should we undertake laboratory or greenhouse trials to accelerate the screening?

This comparison is a first step towards a European approach for optimized fruit cultivar evaluations. The Ecofruit network regards this as an essential step for long-term provision of better cultivars for organic fruit growers.

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