

Apfel:gut – Participatory organic fruit breeding

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Abstract

Apfel:gut is a participatory project with the aim to develop new ecological table fruit varieties since 2009. The project is transparent and charitable under the umbrella of the Saat:gut e. V. since 2011. The first open pollinated seedlings are grown since 1997 on a farm of one active project partner.

The modern apple varieties which can mainly be traced back to 6 quite disease-susceptible varieties are chosen maximum as one parent variety. Usually they are crossed with polygenic-resistant or at least less susceptible ancient varieties. This should also bring interesting fruit traits which are lacking in new varieties. Different environments for the selection should result in different “Genotype x Environment Interaction”. In this project the diversity of different organic farms for the growing process should result in more diverse outcome, resulting in a wider genepool to have higher chances to get vital trees and fruits for farmers and consumers.

Keywords: Participatory, organic fruit breeding, diversity

Introduction

The plant breeding is the last step in organic agriculture, which is still dominated by conventional structures (Lammerts van Bueren *et al.* 2008). The apple breeding research focuses on laboratory methods (Brown 2012, S. 347 ff). A part of these techniques include the research of genetically modified fruits. The organic agricultural movement and at least the majority of the Europeans are not willed to accept GMO's. (e. g. Eurobarometer 2000-2010). However, the majority of activities is on marker assisted selection methods and gene mapping which can be interesting for organic breeders.

The modern apple varieties, which dominate the apple market, need many plant protection applications to suppress scab (*Venturia inaequalis*) on trees and fruits, demanded by the market (Gessler *et al.* 2006). In the worldwide resistance breeding of scab resistant apple varieties the main resistance (*Rvi6*) was derived from *Malus floribunda* 821. This monogenic – dominant – resistance is no longer effective through all of Europe (Bus *et al.* 2011), even though the level of scab susceptibility differs strongly between the varieties (Haug and Karrer 2013). One central question for substantially more ecological fruit growing through more resistant varieties seems to be the durability of disease resistances. According to Leach *et al.* (2001) this requires resistances which are stable throughout the breeding process and at least through one life cycle, which happens to be with apples 15 years minimum after planting. Such a durable resistance depends aside resistance genes strongly on preformed defense mechanisms and susceptibility genes (Pavan *et al.*, 2010, Fan and Doerner 2012). With apples yet there seems to be no or very little research into preformed defense mechanisms and susceptibility genes. To get reliable information about the durability of a resistance, many years of observation under field conditions are necessary (Johnson 2000).

Modern apple varieties can mainly be traced back to 6 ancestor varieties which are quite disease susceptible. Breeding with this narrow gene - pool would mean to increase

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inbreeding and the probability for pathogens to adopt, which seems to result in lower "Vitality" of some modern varieties (Noiton an Alspach 1996, Bannier 2011).

Considering this background the project Apfel:gut under the umbrella of the Saat:gut e. V. started the participatory and organic fruit breeding work.

Materials and Methods

The project Apfel:gut uses participatory approaches to develop new varieties. The farmers are actively involved in the selection process of the parent varieties and the seedlings. Crossings are performed on different organic farms, where the resulting seedlings get planted in the 5-7 leaf stage. Open pollinated seedlings have been used to evaluate the breeding value. Selection on fruit quality was yet focused on open pollinated seedlings sown in 1997 from the old fruit research Institute Müncheberg and others. First controlled crossings were done 2009.

While the farms are in the northern half of Germany main diseases are mostly affected by scab and canker (*Nectria galligena*) and mildew (*Podosphaera leucotricha*). The project prefers polygenic resistances against these diseases. Polygenic resistances should be found in old varieties, yet not or very little used (Laurens et al. 2004). Parent varieties in crossings are chosen according to their resistance - susceptibility level to scab, canker and with lower priority mildew, to reduce considerably pesticide - use. For reaching a durable resistance some old varieties were selected which resist on a high polygenic level. Besides other agronomic traits, like a general vitality, even if diseases should occur, the project is heading for more diversity in taste and look of the fruit. It is planned to aim for an holistic organic process demanded on the table fruit market.

Breeding techniques are transparent. Crossings between polygenic, resistant usually old varieties, are done with the lowest susceptible ones of the modern varieties. Seedlings grow on their own roots till they start fruiting on organic farms under field conditions. They get planted in rows with a distance of 30 cm. For three years disease - susceptibility of the seedlings gets evaluated and the most susceptible seedlings of each progeny get pulled out. After three years the healthiest and culture type like growing type are positively selected and planted in one meter distances. Seedlings with good fruit quality are then grafted and evaluated on all four farms. Grafting for apples is done on M 9 and M 25, for pears on Quince A. The seedlings are not sprayed at all and fertilized with compost.

Cooperation: The project cooperated under the "network organic plant breeding" with Föko e. V. AK organic breeding, partners Philipp Haug and Erhard Karrer in southern Germany for crossings in 2012 and 2013 (Ristel and Sattler 2013). This cooperation is going to continue in 2014 and 2015 under the "Baden-Württemberg project". 2013 the MSc-thesis of Matthias Ristel was done in cooperation with Markus Kellerhals, Agroscope Changins-Wädenswil, CH). He analyzed the scab susceptibility of different apple progenies, which were compared in five trials; four of these trials were done in Wädenswil (Ristel 2013).

Results

While the project is still not very old from the fruit breeding point of view, the results must be viewed with care. This paper focuses more on describing what was the first outcome therefore in the first years.

Three pear selections are grafted on Quince A and get planted for testing on all four farms in the spring of 2014. First seedlings of controlled crosses should start fruiting in 2014 (first fruit buds were observed in autumn 2013) or 2015. Before 2020 no varieties will get registered. Level of healthiness of some seedlings bringing already good tasting fruits was

even in 2013 with a very high scab pressure good. In sum there are around 2000 apple seedlings planted on the farms, round 100 pear seedlings and yet only a few apricot and cherry seedlings are grown on the farms.

The results of the MSc-thesis mention above show that there are significant differences between the progenies. For the development of more resistant varieties it is important to know which varieties inherit their resistance to their progenies and which ones don't.

First lines which seem to bring high amounts of healthy seedling are found and new crosses with these lines are performed. More research is needed in how far lines seem to be resistant through preformed defense mechanism and or a loss of susceptibility, besides resistance genes.

Though the first farm started in the end of the 1990's with only open pollinated seedlings, 2014 around 2000 seeds from controlled crosses will be sown. In sum this crosses are out of more than 70 combinations, done with more than forty different parent varieties. Capacities are not big enough to raise open pollinated seedlings parallel. Successful crosses were performed e. g. with: Alkmene, Allurel, Aplerbecker, Ariane, Auralia (syn. Tumanga), Beauty of Bath, Carola, Corinna (working title), Cybell, Dalinco, Delcoros, Deljonka, Dithmarscher Paradies, Discovery, Edelborsdorfer, Fießers Erstling, Finkenwerder Herbstprinz, Französische Goldrenette, Gelber Münsterländer Borsdorfer, Goldrush, Johannes Böttner, Karmina, Käsapfel, Ludevics Rosenapfel, Melrose, Natyra, Oberländer Himbeerapfel, Ostheimer Mostapfel, Pinova (Evelina), PRI 037, Princess Noble, Prinzenapfel, Pristine, Realka, Röl Aroma, Rosana, Roter Ausbacher, Sansa, Santana, Seestermüher Zitronenapfel, Strauwalds neue Goldparmäne, Prima, Topaz, Verler Zitronenapfel (working title), Virginischer Rosenapfel, Wellant, Zlatka (syn. Böhmer Cox).

While fruit breeding is even more a long term undertaking than breeding annual crops, the project is looking for sponsors to ensure a continuation of the work.

Discussion

Looking at the worldwide fruit breeding programs, the Apfel:gut goes quite different ways. Usually time till fruiting is tried to shorten as much as possible. So the breeding goal for high fruit quality gets more important while agronomic traits under field conditions get a lower priority. The project has the aim to make the breeding process transparent, public and ecological. It's a matter of concern to stop the loss of genetic diversity in modern variety development, and again widen the base of new varieties again. Seedlings on their own roots are usually more vigorous than on the common M 9, so they fit better to a more extensive growing system.

Probably one of the most important points seems to be the parental selection for successful development of varieties. The project tries to proof that a selection of old varieties has sometimes only one or two traits which block their cultivation in modern fruit growing. This selection of old varieties should be continued. Keeping this in mind there should be a chance to bring together the best of the old and the new world of fruits.

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