How can we get away from the high use of pesticides in fruit growing?

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Member of Ecological breeding association ‘Apfel:gut e.V.’
Apple orchard 'Obstarchoreutum Olderdissen' (Bielefeld) since 1994

- Collection of 350 varieties of apple, plus some varieties of cherry, plum, apricot

- „Old“ (traditional) und „modern“ apple varieties in mixed plantation

- Extensive care

- No use of chemical pesticides, no use of sulphur and copper against fungi (like in most organic farms)

- Only biological techniques against the maggots of the codling moth
Apple orchard 'Obstarboretum Olderdissen' (Bielefeld) since 1994

In these 25 years I learned that a lot of old apple varieties can be grown without pesticides, but modern apple varieties cannot…!

The question is: Why ....
What is the problem in the apple orchards today?
The beautiful world of apples in the supermarket deceives us...
We have a big problem in fruit growing today with the modern varieties…

... but you only can see it, if you grow our supermarket apples without spraying any pesticides!
Modern fruit growing today:

→ Fruit growing is one of the agricultural crops with the highest use of pesticides (PSM).

→ Contrary to all claims of "integrated cultivation" and more precise use of PSM: The amount of pesticides used per hectare of orchard in Germany is still rising from year to year.

→ Diseases and pests (and what we can do against them) are the dominant topics in the fruit growing journals (right and left flanked by the advertisements of the chemical companies and their pesticides...!).

→ 20 to 35 sprays with various pesticides (fungicides, herbicides, insecticides) from the fruit blossom in springtime to the harvest in autumn are quite common in fruit growing.

→ As fruit consumers, we also eat residues of pesticides. We have limit values for individual PPPs, but not for the cumulative effect of cocktails of various PPPs.

→ Fruit growers today agree: "Fruit growing without the use of pesticides - that's unthinkable!"
The main problem in modern apple orchards is the scab (Apfelschorf)

Jonagold 2008
without spraying pesticides in a normal year

Jonagold 2014
without spraying pesticides, after a wet springtime
**Organic fruit growers** are not allowed to use any systemically acting chemical agents (because they are absorbed by the plant, work "from inside", but also cause residues in the fruits).

Instead of them they prophylactically spray sulphur/Schwefel (and copper/Kupfer) to fruits and leaves, to keep away any fungal infections.

Depending on the weather conditions and the amount of rain, 30-60 sprays can be necessary against apple scab (and other leaf diseases) between fruit blossom and harvest.

For us as fruit consumers that's no problem, because copper and sulphur don't go into the fruit. But copper accumulates in the soil and can have a negative effect on soil life; the spraying of sulphur and copper also change the leaf flora and indirectly damages beneficial insects - with the result that further spraying against other pests (for example: aphids/Blattläuse) becomes necessary.

**To grow apples without intensive (biological) plant protection, for organic fruit growers with today's apple varieties seems completely unthinkable.**
Has the situation always been like this?

Since when have chemical pesticides been available?

What did the fruit growers do in former times, when they had no chemical pesticides?

Let's look back a bit in the apple history…
Variety 'Edelborsdorfer'

- the oldest apple variety in Germany
  (originated in a monastery in the East of Germany, 13th century)
- 800 years long tolerant against scab
- tolerant against cancer (Obstbaumkrebs)
- tolerant against mildew (Mehltau)
All these old varieties are very tolerant against scab, mildew and cancer!
Dramatic differences in vitality between old and modern varieties, even in the leaves (in an orchard without plant protection measures)
What has happened ??
Fruit growing before 1900 was almost exclusively a sideline on farms in Germany (on high stam trees).

Chemical pesticides didn't exist.

Only robust varieties could be grown on a large scale.

Only a part of the varieties were table apples for direct eating. Many varieties were good for the kitchen for cooking or drying, for juice or fruit brandy a.s.o.

Varieties, which are susceptible against diseases (like 'Cox Orange'), were seen as 'Liebhabersorten' ("varieties you must love"), because only for best places and with high maintenance, but not for growing on large scale.

New varieties before 1750/1800 mostly were found as so-called random seedlings, not as a result of targeted breeding. Only robust varieties were able to establish themselves.
- Start of targeted cross-breeding, in which pollination is no longer left to the bees.

- The aim was to find out more aromatic table apples for mass production (for marketing in growing cities).

- The breeders often crossed one of the highly aromatic, but disease-prone “lover varieties” (like 'Cox Orange') with a robust and high yield variety.

- The aim was to find (with a little luck) varieties, which are robust mass carriers and at the same time aromatic dessert apples.

- Only varieties that could be cultivated without spraying (or with only minor plant protection measures), could be established.
To example: ‘Holsteiner Cox’
(Cox Orange‘ x ‘Ananas-Renette‘, 1903)

- Highly tolerant against apple scab
To example: ‘**Alkmene**‘ (about 1930)

(‘Geheimrat Oldenburg‘ x ‘Cox Orange‘)

- Highly tolerant against scab, mildew and cancer (Schorf, Mehltau, Obstbaumkrebs)
The turn to modern fruit growing

In America since the 1930s, in Germany since the 1950s:

Mass cultivation of the apple varieties ‘Golden Delicious’, ‘Jonathan’, ‘McIntosh’ (all originated from America) and ‘Cox Orange’ (old English variety)

What are these new apple varieties?
Obstbau ohne Fungizideinsatz – nur eine Utopie?

Golden Delicious
The „scab-champion“

Jonathan
The „mildew-champion“

Cox Orange
The „cancer-champion“

Mc Intosh
Highly sensitive for scab and mildew
Until 1930 these varieties had no significance - what was suddenly so attractive about them?
The reasons for the triumph of the Golden Delicious:

- extremely high and regular flower set, so a potentially high fruit yield (but only if you spray against scab!)
- the fruit is hard and well transportable
- the fruit has a mild sweet aromatic taste
- the fruit has a long stem (for easier harvest)

But all this was only possible with the use of the new chemical synthetic pesticides!
The formula of modern commercial fruit growing:

high fruit set + intensive chemical plant protection = more work and more costs, but finally more money for the fruit growers
For today's fruit growers, the susceptibility of apples to diverse diseases seems completely normal.

However, it is the result of a historical development that was only possible with the use of synthetic chemical pesticides.
Fundamental turn also in the apple-breeding (since about 1930):

→ All breeders worldwide suddenly only bred with the following 5 highly susceptible parent varieties:

The "grandfathers" of modern apple breeding since 1930:

Golden Delicious
Cox Orange
Jonathan

+ in America also the varieties

McIntosh
Red Delicious

Compilation: Hans-Joachim Bannier
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→ The breeding target "vitality" is no longer the primary focus of breeders!!

→ This development results in an extreme genetic impoverishment (narrowing), that has never existed before.
Today's market varieties and new varieties of apples and their parents and grandparents

- Jonagold (USA) = *Jonathan* x *Golden Delicious*
- Elstar (NL) = *Golden Delicious* x Ingrid Marie (*Cox orange* x unbek.)
- Gala (NZ) = Kidds Orange (*Red Delicious* x *Cox Orange*) x *Golden Delicious*
- Idared (CAN) = *Jonathan* x Wagenerapfel
- Pinova (D) = Clivia (Oldenburg x *Cox orange*) x *Golden Delicious*
- Akane (Syn. Primerouge) (J) = *Jonathan* x Worcester Parmäne
- Delbarestivale (Syn. Delcorf) (F) = Stark Jon Grimes x *Golden Delicious*
- Pink Lady (Syn. Cripps Pink) (NZ) = Lady Williams x *Golden Delicious*
- Fuji (J) = Ralls Janet x *Golden Delicious*
- Nicoter (Syn. Kanzi) (B) = Gala (*Red Delicious, Cox orange, Golden Delicious*) x Braeburn
- Rubinette (Syn. Rafzubin) (CH) = *Golden Delicious* x *Cox orange*
- Melrose (USA) = *Jonathan* x *Red Delicious*
- Summerred (USA) = Summerland (*McIntosh* x *Golden Delicious*) x unbekannt

Compilation: Hans-Joachim Bannier
The result: We observe a

- obviously higher susceptibility of modern (compared to traditional) varieties to scab.
- obviously higher susceptibility of "modern" (compared to traditional) varieties to mildew
- obviously higher susceptibility to Elsinoe leaf spots ('Topaz spots') of "modern" (compared to traditional) varieties
- higher susceptibility to viruses (apple proliferation) with far-reaching consequences for plant hygiene
Great challenge for organic fruit growers…

… the call to the breeders to give us more resistant varieties becomes louder!
How have the breeders tried to solve the problems in the last 40 years?

- They have **not** used robust traditional varieties for their breeding.

- Instead, the Japanese wild apple 'Malus floribunda' was crossed into the susceptible modern varieties.

**Why?**
Why a little wild apple in the modern apple breeding?

• The scab resistance of Malus floribunda can be located on a single gene (monogenic scab resistance)

• Whether the crossbreeding of the 'scab resistance gene' was successful or not, can be checked immediately with today's molecular biological methods.

• So crossbreeding of scab resistance is more "predictable" than using (polygenic) old varieties.

Monogenic scab resistance = acceleration and better manipulability of the breeding!
Pedigree of the varieties 'Topaz' and 'Merkur' (Czech breeding)

Gold. Delic. x Vf

McIntosh x Newtown Pepping  14 – 26 x Jonathan

J. Grieve x Worc. Parmäne

Spartan x 38 OR T16  J.Grieve x Worc. Parmäne

Lord Lambourne x Gold. Delic.

Jolana x Lord Lambourne

Rubin x Vanda

Topaz

Merkur (Zuchtklon UEB 3531-3)

Rajka

Shampion x Katka

Gold. Delic. x Cox Orange

Jolana x Rubin

Spartan x 38 OR T16

L.Lambourne x Gold. Delic.

McIntosh x Newtown Pepping  14 – 26 x Jonathan  J. Grieve x Worc. Parmäne

Golden Delic. x vf
The problem:

• „Nearly 95% of the today’s scab resistant apple varieties are build on the Vf-resistance of Malus floribunda 821“


• So the many scab-resistant breeds of the last 50 years are also all offspring of the very disease susceptible „grandfathers“ Golden Delicious, Jonathan, McIntosh und Cox Orange!

• The worldwide using of ’Malus floribunda‘ in apple breeding promotes further genetic impoverishment
The result:

- Outside in the field the scab resistance of the modern breeding varieties broke down on a broad front.
Breakdown of scab resistance in the varieties ...
First breakdowns of scab resistance in an orchard in Neubeckum (Westfalen), where only modern scab-resistant varieties were planted, cultivated without spraying.

Topaz 2007 in my orchard in Bielefeld (among 300 other varieties, cultivated all without spraying)
Topaz 18.07.2019

My orchard in Bielefeld, without spraying:
Total breakdown of scab resistance – scab on fruits and leaves
The strategy of monogenetic scab resistance in apples has failed completely.

Against a single resistance gene, which is completely "left alone" by the rest of the neighbouring genes of an incestuously overbred apple variety, scab has an easy game to crack the resistance by making small mutations on its part.

We don’t speak about "a little bit of scab", but about a complete breakdown of resistance !

The result:
Fruit growers must continue to use their fungicides...
The counterargument:

"Not the genetic constitution of a variety is the reason, why resistance will collapse, but mass production is the reason. If we would grow the robust old varieties in the mass cultivation of the commercial fruit production, their resistances would also be collapsed soon.

This argument also does not stand up to a fact check:

Many of the old varieties were once just as strong in mass cultivation as the Topaz today (e.g. Holsteiner Cox, Alkmene, Boskoop, Gravensteiner).

None of these varieties have lost their own characteristics in terms of health via the Decades as much as the 'Topaz' lost his resistance.

In addition: many of the modern varieties, whose monogenic scab resistance are now collapsing, have never been in mass production at all - yet her resistance collapses! (e.g. 'Prima', 'Aneta', 'Lotos', Rewena, etc.).
How can we find a way out of this situation?

Some scientists now call for **genetic engineering** to solve the problems...
Take the scab resistance of apples. This property can be achieved by crossing in the Japanese wooden apple, which contains a resistance gene against scab...

With Crispr you can insert the relevant gene from the wood apple into the cultivated apple quickly and specifically - and the result is much better.

"Take the scab resistance of apples. This property can be achieved by crossing in the Japanese wooden apple, which contains a resistance gene against scab...

With Crispr you can insert the relevant gene from the wood apple into the cultivated apple quickly and specifically - and the result is much better."
The same strategy of monogenetic scab resistance, which has just failed, should suddenly be successful with genetic engineering?

It is foreseeable that Prof. Niggli is promising us here “a castle in the air”...
In meantime, apologists for genetic engineering have changed their argumentation. They claim that the collapse of resistance in cultivated plants is quite normal as a law of nature.

They claim, that we need genetic engineering because we can react faster on such breakdowns than with conventional crossbreeding.

Mit CRISPR/Cas könnten "die Resistenzeigenschaften einer Kultursorte schnell und mit vergleichsweise wenig Aufwand (also schneller als mittels klassischer Kreuzungszüchtung) den sich immer wieder ändernden Strategien der Krankheitserreger angepasst werden.“

Die Züchter müssten deshalb mit ihren Sorten (wie im ewigen Wettlauf zwischen Hase und Igel) "den wandlungsfähigen Schädlingen und Krankheitserregern immer einen Schritt voraus sein“.

Resistenzeigenschaften von Pflanzen seien nun einmal „im Verlauf der jahrhundertelangen Züchtung verloren gegangen".

(so the ‚Forum Bio- und Gentechnologie e.V‘, see www.transgen.de)
Prof. Niggli again:

"It usually takes 20 years to breed an apple variety that is resistant to scab. The pathogen often changes after only 5 years so that it can damage the fruit again."

What do you think about the argument that you can breed disease-resistant varieties by traditional crossing?
Such a complete breakdown of resistance has never happened before in the history of apple cultivation –

- neither in the old varieties

- nor in the breeding varieties of the century between 1830 - 1930

- There were susceptible varieties and resistant varieties, but no varieties, which were resistant at first and after a few years suddenly high susceptible.

- The sudden collapse of resistances has only been known to us, since breeders believe that it is possible to make our highly disease susceptible apples healthy by inserting individual genes.
What should a sustainable and ecological apple breeding look like?
Shall we

- continue to save our highly disease-prone and genetically narrowed varieties for a few years by inserting individual genes?

- or make a "system change" and use again vital and polygenetic resistant traditional varieties for our breeding, even if we need more time for the crossbreeding?
Vital, robust varieties, interesting for breeding don't exist only in Kazakh or Kyrgyz wild apple forests, but also in old apple orchards in Europe.
The crossbreeds from 1850 to 1930 show us that this way has produced sustainable results. These apple varieties can be grown without intensive use of fungicides – also today!

- Strauwalds Parmäne (1890)
- Alkmene (1930)
- Holsteiner Cox (1903)
- Discovery (1940)
To example:
Seestermüher Zitronenapfel

- High resistent against Scab, cancer and mildew
- Early, high and regular yield
- Medium-strong growth, with onset yielding weak growth
- Always uniform fruit size, no thinning required!
This way may take longer, but I am convinced that it leads to more sustainable results!

Progress in breeding in this direction has been interrupted for 80 years...

Unfortunately, the government today gives much money for genetic engineering, but no money for ecological sustainable breeding...

With the private breeding association Apfel:gut e.V. since a few years we continue in principle where the breeders stopped in 1930...!
What has been shown here may also apply in a similar form to other agricultural crops.

The fact that we can show it so precisely at the example of apple varieties has to do with the fact that apple trees (as they were planted in the past) have the property of possibly becoming 100 years old and older, i.e. we still know the old varieties from earlier centuries, can reproduce them and observe them.

Many other cultivated plants are lost as soon as they are no longer actively cultivated.
12 years old tree of the variety 'Discovery' - without spraying fungicides!

Thank you for your attention!

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Epilogue about genetic engineering for apple cultivation:

If companies or scientists want to "push" genetic engineering in the political arena (because genetic engineering in food in Europe is predominantly rejected by consumers), they prefer to argue that genetic engineering can secure the world's food supply, that genetic engineering can help reduce the consumption of pesticides or can produce food with better health properties and so on.

And what happens if genetic engineering - as in the USA - is actually allowed? The so-called 'arctic apples' have been in cultivation in the USA since 2017. Genetic engineering prevents the fruits from turning brown so that they look fresh for longer after pruning. In this way, consumers are deceived about the actual freshness of the apple - in extreme cases also about possible contamination.

Health? Reducing of spraying agents? World nutrition? All the promised noble goals are forgotten!