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Importance of diversification in the variety assortment of apple, pear, cherry and plum orchards

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*In the orchards and mother tree collections of the "Nationale Boomgaardenstichting" biodiversity is kept on a very high level due to a good diversity in the ecosystems in and around the orchards, the zero input of pesticides, a minimum input of herbicides and the use of a huge number of traditional varieties with a wide range of genes. In these ecosystems the infection pressure of most diseases and pests and the losses in fruit quality are very low. With traditional varieties we observed less than 1 % infected leaves or fruit with reference to all pests and diseases, except for: cherry fruit fly (*Rhagoletis cerasi*) and cherry little cherry virus in the cherry orchards; the pear rust* Gymnosporangium fuscum *in the pear orchards; and the plum rust* Tranzschelia pruni-spinosae *and plum moth* Grapholita funebrana *in the plum orchards. In the apple orchards the use of the pheromone confusion technique keeps the infection with apple moth* Cydia pomonella *under the level of 1 %. A good mix of different varieties and the use of robust varieties with a wide range of different genes is the best guarantee to keep the production sound in orchards with a minimum of pesticide input.*
Keywords: biodiversity, fruit varieties, zero input of pesticides, genetic resources, apple, fruit variety collections

Bedeutung der Diversifikation im Sortenspiegel von Apfel-, Birnen-, Kirsch- und Pflaumenanlagen. *In den Obstanlagen und Mutterbaum-Sammlungen der "Nationale Boomgaardenstichting" hat Biodiversität einen sehr hohen Stellenwert auf Grund der großen Vielfalt der Ökosysteme in und um die Obstanlagen, der pestizidfreien Anlagenführung, des minimalen Herbizideinsatzes und der Verwendung einer Vielzahl von traditionellen Sorten mit einer großen genetischen Bandbreite. Daraus resultieren ein geringer Infektionsdruck der meisten Krankheiten und Schädlinge und nur geringfügige Beeinträchtigungen der Fruchtqualität. Bei traditionellen Sorten beobachteten wir weniger als 1 % infizierte Blätter oder Früchte in Bezug auf die meisten Schädlinge und Krankheiten, mit Ausnahme von: Kirschfruchtfliege (*Rhagoletis cerasi*) und Cherry-Little-Cherry-Virus in den Kirschanlagen; Birnenrost (*Gymnosporangium fuscum*) in den Birnenanlagen; Pflaumenrost (Tranzschelia pruni-spinosae) und Pflaumenwickler (*Grapholita funebrana*) in den Pflaumenanlagen. In den Apfelplantagen hält die Anwendung der Pheromonverwirrungstechnik die Infektion mit Apfelwickler (*Cydia pomonella*) unter 1 %. Eine gute Mischung verschiedener und robuster Sorten mit einer großen genetischen Bandbreite ist die beste Garantie für eine gesunde Obstproduktion mit minimalem Pestizideinsatz.*
Schlagwörter: Biodiversität, Obstsorten, pestizidfreier Obstbau, genetische Ressourcen, Apfel, Obstsortensammlung

Goals and tasks of the N.B.S.

Since 1975 some interested people, stimulated by the driving force of Ludo Royen were prospecting the traditional orchards in the Flemish Region in order to collect and conserve the traditional fruit varieties and the local niche varieties. In 1984 they established an official foundation, the Nationale Boomgaarden Stichting vzw. The main targets for the foundation are

- the preservation of the traditional fruit heritage,
- the preservation of the traditional landscape with standard trees, mostly surrounded by hedges (hawthorn) as they were omnipresent in the regions Haspengouw and Hageland in the south-eastern

part of Flanders and
- the conservation of more than 3000 accessions (varieties and clones of our native fruit species). These varieties are preserved in traditional orchards with standard trees (100 ha in 16 allotments) or in mother tree collections on dwarfing rootstocks (5 ha in 5 allotments). Originally about 50 % of the varieties of the collection were collected during the prospect of more than 1000 orchard sites, 25 % came from collections purchased from horticultural schools or institutes in Flanders. The rest is derived from members or sympathizers of the foundation.

Table 1: Collection of fruit varieties at N.B.S

Fruit species	Number of varieties and clones in the N.B.S. collection
apple	1762
pear	1097
cherry	279
plum	288
peach	37
walnut	32
quince	23
medlar	10
grapevine	485

A further target of the foundation is a continuous control and evaluation of the variety characteristics in the collection. The collection is focussing on varieties obtained in Belgium or with a long tradition in the fruit culture of our country, or on varieties with some important ecological or genetic characteristics. A lot of these ancient varieties were endangered to disappear in Belgium, some of them being solely preserved in our collections.

The foundation has also a social task. It is our purpose to inform, to educate and to promote a sustainable agriculture and especially fruit production, respectively. The N.B.S. team investigates and determines about 500 samples of fruit yearly. We organize several expositions with hundreds or sometimes more than 1000 fruit varieties. As the founding member of Europom®, we are involved in the Europom Fruit Exposition, annually organized by our sister organizations in the different EU countries. Our publication Pomologia and other booklets contain descriptions of several varieties and other subjects concerning orchards and the orchard biosystem, with a special attention to elements of a high cultural or historical value. For the interested public the N.B.S. regularly organizes courses of orchard management, fruit determination or the grafting of fruit trees.

N.B.S. has engaged in reintroducing the regional traditional varieties. For the last 6 years we have been supported in this goal by the Flemish government, which subsidises the plant material for the installation of new orchards with standard trees.

Establishing a 'high level' biodiversity in the N.B.S. orchards and collections

We consider biodiversity to be an important factor in our orchards and collections on three different levels:
1. the diversity of the ecosystems of the orchard and its surroundings; orchards are important ecological elements of the natural landscape.
2. the diversity between the different species in an orchard, which make the orchard a very valuable habitat.
3. the genetic diversity in the fruit species or varieties grown in the orchard.

It is essential to take into consideration the interaction between all the living organisms in a certain environment (plants, animals, micro-organisms and human beings). They live together in a certain balance, sometimes a very precarious balance. All the species in an ecosystem influence each other, they are *inter-dependant*. Human action can manipulate this balance and favour some species in a certain 'protected' environment.

Our fruit species and apples in particularly are hiding a very big universe of genes expressed in a wide range of different characteristics as: taste, colour, size, shape, growth habit, productivity, flowering intensity and period, tolerance against pests and diseases etc., although our commercial apple varieties today represent only a fraction of the *Malus* gene pool, and this gene diversity is still decreasing. A century ago the orchards contained hundreds of different apple varieties, collections of local or more regional varieties and clones. Today, most of the 'modern' varieties, grown in the commercial orchards have the same 5 or 6 parents; and this worldwide.

Genetic uniformity makes the apple (and also other fruit species of course) "a sitting duck for its enemies". In the wild a plant and its pests are continuously coevolving, in a dance of resistance and conquest that has no ultimate victor. But co-evolving freezes in an intensive orchard with grafted trees of the same (or related) varieties, since they are genetically identical. Sexual multiplication is nature's way to test out fresh combinations. Viruses, bacteria, fungi, pests are keeping their sexual multiplication with a continuous diversification as

Table 2: Parentage of our modern apple varieties (examples)

Modern apple variety	Parentage
Jonagold	Golden Delicious x Jonathan
Elstar	Golden Delicious x Ingrid Marie
Gala	Kidd's Orange Red x Golden Delicious
Idared	Jonathan x Wagener
Fuji	Rall's Janet x Red Delicious
Pinova	Clivia x Golden Delicious
Diwa(R), Junami(R)	(Idared x Maigold) x Elstar
Kanzi(R) , Jazz(R)	Gala x Braeburn
Sunrise	(Mac Intosh x Golden Delicious) x PCF 3.120

Table 3: N.B.S orchards under observation for biodiversity, pests and diseases

N.B.S.orchard	fruit species	number of trees observed	planting distance
Gulmer mother tree collection on M.9	apples planted 2006	250 (250 different varieties)	3 m x 1 m
Kolmont Cherry orchard on Standard trees	cherries planted 1998	116 (15 different varieties)	10 m x 10 m (seedling rootstocks)
Konijn	pears planted 1993	73 (62 different var.)	8 m x 8 m (seedling rootstocks)
	plums	42 (40 different var.)	

a logical consequence until they have overcome whatever resistance the apple may have once possessed. Suddenly, total victory is in the pest's sight, unless farmers come to save the trees with the heavy hand of modern chemistry. A high input level of chemicals (fertilizers, pesticides) will lead to a tremendous loss of biodiversity in agrosystems, favouring other pests to dominate (examples: red spider (*Panonychus ulmi*) and rust mites (*Aculus Schlechtendali*), woolly aphids (*Eriosoma lanigerum*)).

In our study we are observing the elements of biodiversity, which are important to make a program for sustainable fruit growing, producing healthy and good quality fruit.

Materials and methods

The observations were made in three different orchards of the N.B.S collections (Table 3). We focussed on key pests, which are the main reason for the application of pesticides in commercial orchards.

The interventions in these orchards are minimum, which can be described as extensive farming. (Table 4).

A lot of attention is put on realising a maximum biodiversity in the orchards. A very low level (to level zero) of chemical input is applied in order to respect the ecological balance in an orchard. The borders of the orchards Kolmont and Konijn are planted with a hawthorn hedge. Gulmer is planted in the middle of commercial apple orchards.

For the observations we used a scale for the quantitative assessment of the disease infection or pest infestation and their influence on fruit quality.

Results and discussion

The Gulmer Apple Collection Orchard

In the Gulmer collection the production of apples in 2010 was good (average some 10 kg/tree). The fruit are very sound and of high quality and good skin finish for most of the varieties, although the chemical pest management was zero. (Table 6)

Table 4: Orchard management in the observed N.B.S. orchards

N.B.S. orchard	grassland management	pesticide input	pheromone confusion	tree management
Gulmer mother tree collection on M9	1 x glyphosate (under the trees, 80 cm wide, April), 3 x/year, mulching the grass	zero	pheromones to confuse the *Cydia pomonella* with the Isomate CLR system	medium intensive pruning to maximize productivity
Kolmont Cherry orchard	3 x/year mulching the grass.	zero	no	extensive pruning to keep the canopy vital and open
Konijn (Pears and Plums)	extensive grazing with sheep	zero	pheromones to confuse *Cydia pomonella* with Exomone system	extensive pruning to keep the canopy vital and open

Table 5: Observation scale for the description of the infection degree

scale	description of the degree of infection/infestation
0	no infection observed on the controlled trees
1	less than 1 % infected fruit or leaves observed, no quality reduction
2	less than 1 % infected fruit or leaves observed with some quality reduction
3	1 to 10 % infected fruit or leaves with only limited quality reduction
4	1 to 10 % infected fruit or leaves with severe quality reduction
5	more than 10 % infected fruit or leaves with quality reduction

The Kolmont Cherry Orchard

The Konijn Pear and Plum Orchard

Table 6: Pest and disease observations in the Gulmer Apple Collection Orchard

Observed pest or disease	infection scale	remarks
Scab on leaves, *Venturia inaequalis*	1	only on 2 varieties
Scab on fruit, *Venturia inaequalis*	1 or 2 for one variety	only on 4 varieties
Powdery Mildew, *Podosphaera leucotricha*	1	only on 1 varieties
Fruit tree canker on shoots and branches *Nectria galligena*	1	only on 2 varieties
Rainblotch disease on fruit, *Schizothyrium pomi*	2	
Red Spider Mites, *Panonychus ulmi*	0	
Rust mites, *Aculus schlechtendali*	0	
Rose Apple Aphid, *Dysaphis plantaginea*	0	
Woolly Apple Aphid, *Eriosoma lanigerum*	0	
Apple Moths *Cydia pomonella*	1	
Leaf or fruit damages caused by other caterpillars	1	
Leaf or fruit damages caused by beetles or bugs	1	
Fruit rots	2	

The numbers of observed predators for insects and mites were fabulous. During the apple harvest we calculated an average of about 1 ladybug *Coccinella septempunctata* per 10 picked fruit and 1 earwig *Dermaptera* per 20 fruit. The balance between predators and pests is so optimal that most of the pests do not have any chance to induce damages. This balance can be reached

Table 7: Pest and disease observations in the Kolmont Cherry Orchard

Observed pest or disease	infection scale	remarks
Fruit rots *Monilia spp*	2	Very little amount of fruit was infected, also due to dry weather conditions in 2010
Monilia infection on shoots *Monilia laxa*	1	
Gomose *Pseudomonas mors-prunorum*	1	The variety 'Hedelfinger Riesenkirsche' has some infected branches or shoots per tree
Black Cherry Aphid *Myzus cerasi*	0	
Cherry Fruit Fly *Rhagoletis cerasi*	5	The later ripening varieties had 10 to 15 % infected fruit
Cherry Little Cherry Virus	4	The symptoms are visible only with the variety 'Regina'

Table 8: Pest and disease observations in the Konijn Pear and Plum Orchard

Observed pest or disease	infection scale	remarks
Scab on leaves, *Venturia inaequalis*	1	
Scab on fruit, *Venturia inaequalis*	2	Small spots on 'B.C. Williams'
Red spider mites *Panonychus ulmi*	0	
Rust mites *Aculus schlechtendali*	0	
Pear moths *Cydia pomonella*	1	
Leaf or fruit damages caused by other caterpillars	1	
Leaf or fruit damages caused by beetles or bugs	1	
Pear fireblight, *Erwinea amylovora*	0	
Fruit rots	2	
Pear rust *Gymnosporangium fuscum*	3	
Pear sucker *Psylla pyri*	0	
Plum rust *Tranzschelia pruni-spinosae*	3	
Rose Plum Aphid *Hyalopterus pruni*	0	
Fruit rot *Monilia spp.*	2	
Plum moths *Grapholita funebrana*	4	

easily if there is no pesticide use in the orchard and if the borders and the undergrowth consist of a huge amount of plant species. The high plant diversity, especially with a perennial multi-strata design provide a favourable situation to maintain foodwebs. These are wealthy resources and habitats for living communities, such as beneficial organisms. Against some problematic pests or diseases the ecosystem has not reached a balance yet. For instance, in the cherry orchard, the Cherry fruit fly (*Rhagoletis cerasi*) and the spread of the virus infection Little Cherry are still critical problems.

It is difficult to measure, but it is our conviction that the mix of a huge amount of varieties is the best barrier to avoid diseases reaching an infection level, causing severe symptoms and quality loss in production. The assortment of varieties in our orchards consists of a huge amount of older, traditional varieties, containing a big number of genes, which we donot discover anymore in most of our modern varieties. A classic example is for instance the gene for late flowering. Varieties which contain this characteristic have a late bud burst, which causes their young sensitive leaves to occur after the most infective period for apple scab. 'Rall's Janet' grown by Thomas Jefferson and used by Japanese breeders, looking for such a characteristic ('Rall's Janet' x 'Red Delicious' = 'Fuji'). is such an apple variety.

In the modern breeding programs we can introduce the genes of the traditional varieties to bring in fresh genes into the modern varieties, in order to create new, more robust varieties. These are much less susceptible for the diseases, which are adapted to the common grown varieties in the region.

From 2003 until 2006 the N.B.S. was cooperating in a project titled "Studying apple biodiversity: opportunities for conservation and sustainable use of genetics resources (*Malus*)" (KEULEMANS et al., 2007). This study refers to the genetic diversity present in wild apple populations and old regional varieties at different levels. One of the objectives is to develop an efficient management plan to conserve the biodiversity present in existing collections of old regional varieties.

Literature:

KEULEMANS, W., ROLDAN-RUIZ, I., LATEUR, M. 2007: Studying apple biodiversity: opportunities for conservation and sustainable use of genetics resources (Malus), Belgian Science Policy, Brussels 2007, 121p.