The role of plant breeders in organic fruit production

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THE ROLE OF PLANT BREEDERS IN ORGANIC FRUIT PRODUCTION

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The plant breeders have a key-role to play in organic fruit production. They usually have under their responsability large genetic resources ; inside, they select genitors for their different breeding lines. Among them, material suitable for organic farming could be obtained and proposed for experimentation under the organic farming specifications. A strategy has to be defined to be really efficient and satisfy the organic farming demand within a short term. The example of the apple breeding programme developed at INRA Angers is presented to illustrate what the plant breeders can offer to the growers.

1. Genetic resources

Large genetic resources exist for fruit trees. An effort to organize, describe, distribute is really done at least at a national level, particularly in Europe. Ten thousand or more named apple cultivars are documented (6000 by SMITH, 1971). Although some are synonyms, a large variability exists inside this assortment ; more efforts have to be done to explore their potentiality for resistance or tolerance, tree habit and of course, quality of the fruit. The apple collection at INRA Angers registers about 1500 accessions divided in old varieties and landraces, selections not named but useful for some attributes, scab resistant varieties and selections released all over the world or used as genitors in the current breeding programme. These 3 sets have to be screened to detect the material suitable for organic farming.

What is the demand of the growers for apples ? They want varieties with a good taste according to their consumers, tolerant to the main diseases and pests, with a regular bearing. The first aim will be to detect inside these varieties or selections, the material resistant or tolerant to the main diseases (scab, mildew, fire blight, canker) and pests (rosy apple aphid, codling moth). For some of these diseases and pests, lists of cultivars resistant or tolerant were published during the 60's by researchers from East Malling studying the Brogdale National Fruit Collections (ALSTON, 1967, 1970 ; ALSTON and BRIGGS, 1968, 1977 ; BRIGGS and ALSTON, 1969). Ideally, this material selected after field observations has to be replicated for further accurate testing with absolutely no spray against the disease or pest studied (ALDWINCKLE et al., 1976 ; LE LEZEC et al., 1977).

Today, the breeders can extend this work to the resistant material not grown and sometimes removed from national lists. A systematic study can reveal quite interesting resistance not found during the selection procedure because of a standard chemical protection. The scab resistant variety 'Florina' is an interesting case : resistant to the common scab races, 'Florina' has been found 10 years after its release, tolerant to fire blight and rosy apple aphid ; in fact, 'Florina' originates from *Malus floribunda* 821 which is scab resistant (gene Vf) but also fire blight and rosy apple aphid resistant.

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This study from genetic resources, new varieties bred for resistance or tolerance but also material of value not released because of not suited for standard apple growing, is really the first contribution of the plant breeders to fulfil the organic farming demand.

2. Breeding programmes

The breeding programme developed at INRA Angers is now to strengthen durability of the resistance, continue to improve quality of the fruit and explore tree architecture in order to get well equilibrated trees with regular bearing. These objectives are a good contribution to better answer the organic farming demand.

About the studies developed around "tree architecture", the present results discard the spur types and are in favour of standard habits, guarantee of regular bearing. One trait is particularly emphasized : the ability to retain just one fruit per cluster. This trait selected among seedling populations is actively studied and incorporated in the new selections. This could be a solution to avoid chemical thinning and to reduce manual thinning.

The programme developed for fruit quality is concentrated around fruit texture. It is clear that a crisp texture is a prerequisite for a good fruit quality ; the progenies are selected for late maturing fruit with a long storage ability.

Resistance durability is a major programme which is essential to maintain fruit varieties for years in an orchard.. This is so important and so difficult to achieve that this programme developed for scab and mildew is an european programme : Durable Apple Resistance in Europe (DARE) – LESPINASSE et al., 1998.

Numerous breeding programmes have been initiated in the world over the last 60 years to create new apple varieties. Specific breeding strategies, based on the introgression of monogenic resistance from wild related species, have been developed to create new resistant varieties. Recently, many newly - created resistant varieties have been attacked by 2 new races of *Venturia inaequalis*, showing the vulnerability of such monogenic resistance when confronted by pathogen dynamics. New breeding strategies need to be developed to strengthen the previously obtained resistance and to achieve durable resistance in apple : polygenic resistance should give a much more durable resistance, especially if combined with monogenic resistance by using new molecular biology tools for selection. At the same time, the risk of appearance of new fungal virulences has to be assessed.

Within this framework, the DARE project aims to develop plant material, a pathogen observation network, knowledge and methodologies necessary for the creation and marketing of new apple varieties carrying durable resistance against the causal agents of *scab (Venturia inaequalis)* and mildew (*Podosphaera leucotricha*). The project is based on a close collaboration between geneticists, pathologists, breeders, pomologists and nurserymen, from France, The Netherlands, Switzerland, Germany, Great Britain, Italy, Greece and Belgium. It involves several major objectives :

- characterization of the resistance status of a large range of apple cultivars.
- assessment of the risks of resistance breakdown related to the appearance of new virulences.
- genetic dissection of polygenic resistance taking into account pathogen variability.
- development and use of new breeding strategies.

- market study and consumer preferences regarding new resistant varieties.

The shared cost european project DARE involving 8 countries is the way to boost research programmes and to propose in a short term new varieties with not only durable resistance but also the other attributes as fruit quality to release with nurserymen and growers the right material with the appropriate marketing strategies.

Discussion and Conclusion

The contribution of the breeders is just part of the work to achieve the objectives assigned by the organic farming demand. Breeders, plant pathologists, entomologists, physiologists have to work very closely along different complementary proposals. Some of them are listed below as quite relevant :

- Conventional resistance breeding combined with Marker-Assisted Selection (MAS) contributes to enhance resistance durability and therefore sustainable growing systems. MAS permits to achieve gene pyramiding and early screening of traits.

- Induced resistance could be, in some cases, a promising method ; chemical induction of Sytemic Acquised Resistance (SAR) has been successful against apple fire blight by spraying with Bion® (NOVARTIS). BRISSET et al. (2000) demonstrate that the apple tree has the capability to active natural defense mechanisms (defense-related enzymes). It is a priority to look for biological substances, triggering such an induced resistance.

- Variety-mixtures could be a good proposal to reduce epidemics and to delay breakdown of resistances. DIDELOT et al. (2000) show that 2 different varieties displayed in the orchard according to the design "row by row" or "withing the row" have a reduced scab severity compared to the monoculture.

These concepts and results have to be studied through experiments under organic conditions with appropriate rootstocks and planting distances. In France such experiments will be prepared in 2001 with old european varieties, scab resistant varieties and selections. These experiments with be established in North, South-West and South-East in order to select the best material suited for each pedo-climatic situations. Applying the organic farming specifications, the growers and extension service could make the right choice. This type of experiments could be extended to the other european countries in order to build an european network for trialling varieties suited for organic farming in Europe.

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SUMMARY

The large fruit genetic resources have to be screened for resistance or tolerance to the main diseases and pests, quality of the fruit, tree habit. The breeder has also the possibility to combine by hybridization different cultivars or selections to get the new varieties satisfying the organic farming demand. In the case of apple, the targets are scab, mildew, fire blight, rosy apple aphid resistance or tolerance. To achieve such objectives and to propose durable resistance for scab and mildew, european teams are working within the DARE project (Durable Apple Resistance in Europe). Conventional resistance breeding combined with marker assisted selection contributes to enhance resistance durability and therefore sustainable growing systems. Other traits as the natural ability to retain just one fruit per cluster can be a solution to avoid chemical thinning. The material selected from the genetic resources and obtained after breeding has to be studied in orchard with appropriate rootstocks and planting distances, within the organic farming specifications. This type of experiments could be extended to Europe in order to build progressively an european network for trialling varieties suited for organic farming in Europe.

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RESUME

Le sélectionneur dispose de ressources génétiques fruitières riches en nombre de cultivars et présentant une grande diversité génétique. Il s'agit tout d'abord de sélectionner, au sein des ressources génétiques, les variétés résistantes ou tolérantes aux principaux bio-agresseurs, d'excellente qualité gustative, dont le mode de fructification garantit une production régulière. Le sélectionneur conduit aussi des programmes d'amélioration génétique par hybridation qui doivent permettre de satisfaire la demande de l'Agriculture Biologique. Dans le cas du pommier, les objectifs portent sur la résistance ou la tolérance à la tavelure, à l'oïdium, au feu bactérien, au puceron cendré. Pour sélectionner des résistances durables, un projet européen liant 8 équipes a été mis en oeuvre et concerne la tavelure et l'oïdium (Projet DARE : Durable Apple Resistance in Europe). Les méthodes d'amélioration traditionnelles associées à la sélection assistée par marqueurs doivent conduire aux résultats escomptés et promouvoir une arboriculture durable. D'autres caractères agronomiques sont étudiés – en particulier l'aptitude naturelle à ne conserver qu'un fruit par corymbe ; ce pourrait être une solution pour éviter l'éclaircissage chimique. Les sélections retenues d'une part au sein des ressources génétiques et d'autre part après hybridation seront mises en expérimentation en choisissant les porte-greffes et les distances de plantation adaptés ; l'expérimentation sera conduite suivant le cahier des charges de l'Agriculture Biologique. Ce type d'expérimentation devrait être progressivement généralisé à toute l'Europe afin de disposer d'un réseau d'essais permettant de sélectionner le matériel fruitier adapté aux différentes conditions pédo-climatiques européennes et satisfaisant la demande de l'Agriculture Biologique.