Organic Plant Breeding: a challenge for practice and science

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Abstract **– This paper gives a short overview of the current practical and scientific challenges of plant breeding programmes for organic agriculture in Europe. Research is challenged to prove that organic plant breeding is more than just conventional plant breeding for another market, and to develop appropriate concepts and strategies for improving varieties adapted to the principles and needs of organic farming systems. Emphasis is on defining crop ideotypes and selection criteria, and on developing selection strategies, and on socio-economic and legal obstacles.[1]**

INTRODUCTION

Organic farmers still largely depend on varieties produced for conventional farming systems with high inputs of artificial, mineral fertilisers and chemical crop protectants. But with the EU Regulation 1452/2003 in force, the organic sector is not only striving for organically produced seeds from conventional varieties, but is also urging for breeding programmes for better adapted varieties. However, the fact that the organic sector is still a small market does not stimulate many conventional breeders to start special organic breeding programmes. For them it is also questionable whether organic plant breeding (OPB) is more than merely conventional plant breeding for another market, and whether there is a need for specific concepts and strategies for improving varieties adapted to the principles of organic farming systems. This paper will give a short overview of the challenges for OPB research in Europe from an organic point of view.

CONCEPT OF NATURALNESS

In the perception of conventional plant breeders and seed suppliers organic agriculture is simply characterised by refraining from chemical crop protectants. For them, varieties with many disease resistances seem most appropriate to combat disease problems in organic farming systems. However, not for all diseases sufficient resistances are available; moreover, there are only few organic pesticides and fungicides. Although refraining from chemical inputs and replacing them by natural and organic compounds is the first step in the conversion from conventional to organic farming, an additional, second approach is indispensable: the agro-ecological approach. An organic farmer needs to realise crop health from ecosystem health, and therefore needs to develop sufficient resilience through supporting the selfregulatory capacity. Biodiversity is one of the instruments to enhance this capacity of his farm-ecosystem. A third approach is more and more recognised in organic agriculture: the integrity of life approach. Organic farmers do not only use the instrumental values of farm animals and crops, but also respect their intrinsic values based on their autonomy, wholeness or completeness, their species-specific characteristics and their being in balance with their species-specific environment. These three approaches together are the basis for the concept of naturalness as applied in organic agriculture (Verhoog et al., 2003). These approaches show that organic agriculture departs from a different way of (system) thinking, which also has practical consequences for organic seed production and plant breeding (Lammerts van Bueren & Struik, 2004).

ORGANIC CROP IDEOTYPES

Allthough the organic sector profits from the breeding efforts of the conventional breeding sector, variety trials under organic farming conditions show that the modern varieties are not in all cases the best for organic agriculture, see figure 1. The organic systems approach requires varieties that match a different crop ideotype in which it is more important to adapt the variety to the (given) organic environment rather than the environment to the variety. This includes adaptation to organic soil fertility management (implying low(er) and organic inputs, a better root system and ability to interact with beneficial soil micro-organisms), ability to suppress weeds, contributing to soil and crop health, good product quality, high yield level and high yield stability and the ability to produce healthy seed under organic conditions (Lammerts van Bueren et al., 2002). A sufficient level of disease resistance is not only a matter of absolute, monogenic or polygenic resistant genes. Organic farmers strive for multifaceted solutions to spread risks, by including additional morphological and physiological traits that can contribute to an acceptable level of field tolerance against stress conditions. As the environmental component in organic agriculture is more variable than in conventional agriculture, the former requires flexible and robust varieties. Therefore yield stability is more important than yield as such.

PLANT BREEDING TECHNIQUES

To arrive at such robust varieties is not merely a matter of adding some neglected traits to the list of selection criteria of a breeder. In organic agriculture not only the traits of an end product, but also the

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production (breeding) method should comply with organic principles. The non-chemical approach raised questions on the application of certain inputs during the breeding process, such as colchine. The agro-ecological approach raises the question of the necessity of selecting under organic farm conditions. The most frequently discussed questions concern the ethical criteria related to the concept of integrity of plants (Lammerts van Bueren et al., 2003). The respect for integrity of life is one of the reasons why the organic sector rejects the use of genetic engineering, and other techniques like protoplast fusion, see IFOAM draft standards for OPB.

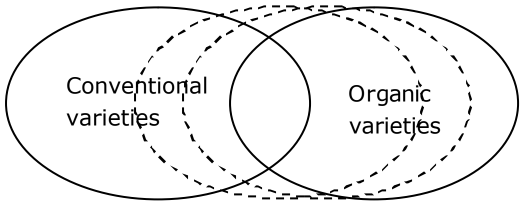

Figure 1. The degree of overlap of conventional varieties with varieties suited for organic agriculture depends on the crop requirements and applied breeding techniques.

Pathway

In the short run, defining organic crop ideotypes per crop and conducting variety trials under organic farming conditions can help to select the best varieties available in the pool of existing (conventional) varieties to be propagated organically. However, organic seed production is the first step towards OPB as many of the desired traits have not received enough priority in conventional breeding programmes. In the middle run adaptation of VCU-protocols for variety testing for organic farming conditions can enlarge the chance that new varieties that better match the requirements of low-input farming systems, can be released from conventional breeding programmes. In the long run the organic sector will head for a true and certified OPB chain, including selection, maintenance and seed production of varieties under organic conditions. Currently, only a small number of breeding programmes are specifically focused on organic production (Legzdina & Skrabule, 2005). Some are conducted by (cooperations of) farmer breeders and some by commercial breeding companies, or in combination with formal and informal breeders, as is the case with potato breeding in the Netherlands.

Plant breeding research

To support the development of innovative OPB programmes three areas of research can be distinguished: 1) selection criteria, 2) selection strategies, and 3) socio-economic and legal conditions.

1. For many crops, such as cereals it is important to develop crop ideotypes for a clear communication between farmers and breeders. For some traits selection criteria and methods still need to be developed, such as for weed competitiveness, and nutrient uptake and use efficiency (Baresel et al., 2005). To prove the relevance of certain concepts like plant health, yield stability, adaptability, and robustness, it is necessary to provide a scientific basis for such concepts in the context of organic farming systems.
2. As organic farmers have few tools to interfere during crop growth, a central question for organic varieties is how yield stability can be improved most effectively. Therefore it is important to explore the role of genetic diversity in the variety concept (variety mixtures, composite crosses). But also the question on the role of the appropriate selection environment (organic versus conventional; high versus low-input), and the role of a participatory breeding approach in enhancing regional diversity need to be addressed. The potential role of molecular markers in OPB should be elaborated.
3. Development of OPB is not only a matter of breeding research, including genetic, agronomic and physiological aspects; also the consequences for socio-economic (financing) and legal aspects (registration, farmer's and breeder's rights) should be on the research agenda.

Conclusions

OPB is more than classical plant breeding refraining from the use of GMOs. To arrive at improved varieties adapted to the values and needs of organic farmers, processors and consumers, the organic sector challenges science to support the development of alternative, plant-worthy concepts and strategies within the framework of an organic systems approach.

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