Organic plant breeding

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ABSTRACT

To a major extent, organic farming depends currently on plant and animal varieties that have been bred for non-organic farming and that are often not suited to organic production. This position is inconsistent with a holistic approach to organic agriculture. Organically-bred plant varieties are needed to develop both the potential of organic agriculture and its integrity. A first attempt at developing a concept for organic plant breeding methodology has been proposed. A novel approach to breeding for organic production has also been started. Further development needs a parallel approach to animal breeding for organic systems.

INTRODUCTION

Organic/biodynamic farming differs from non-organic in that it aims to maximise dependence on naturally occurring biological systems. Such systems are less important in non-organic agriculture, which is highly dependent on synthetic, external inputs and exploitation of biological material at all levels, even from the sub-gene. A major consequence of this difference is that the varieties of plants and animals best suited to the two approaches are significantly different. An obvious example is in relation to weeds, which, in organic farming are regarded as non-crop plants with some positive contributions; such plants are controlled by crop competition or by mechanical means. In non-organic farming, the positive contributions are considered less important and weeds are usually controlled rigorously by herbicides.

Variety trials carried out under organic conditions can be used to try to highlight those varieties better suited to the needs of organic farming. This approach is helpful in the short-term, but cannot allow a full expression of the potential of organic production systems because of the specific constraints of non-organic breeding programmes.

In the longer term, therefore, it is essential to develop varieties and populations that are bred and selected under organic/biodynamic conditions, partly for practical reasons, to ensure good performance and quality for organic production, but also in terms of organic principles. Currently, organic production cannot be regarded as wholly organic while the major tools in use, plant and animal varieties, are varieties that have been developed under non-organic conditions, often using technologies that do not fit well with organic principles.

GUIDELINES FOR ORGANIC PLANT BREEDING METHODOLOGY

Given the need for organic plant breeding, an agreed set of guidelines for breeding methodology is needed that is consistent with organic principles.

An appropriate set of basic principles has been developed by a group in the Netherlands, led by Edith Lammerts van Bueren (Lammerts van Bueren et al., 1999). In October 2001, under a request from the Dutch Government, Louis BoIk Institute, Platform Biologica and ECO-PB (European Consortium for Organic Plant Breeding), organised a workshop involving interested parties, mostly European, to try to form a concensus about the methodologies and the future development of organic plant breeding. The objective was to present an outline set of recommendations to IFOAM at their next International Congress in August 2002 in Canada.

The agreed concept was that the aim of organic plant breeding should be to develop plants that enhance the potential of organic farming and biodiversity. Organic plant breeding should be a holistic approach that respects natural crossing barriers and be based on fertile plants that can establish a viable relationship with the living soil. Organic varieties would therefore be obtained by breeding methods that comply with this concept and that derive from certified organic plant breeding programmes.

Methods not permitted would be those that do not respect the integrity of plants and particularly those that operate below the level of the cell. These include GM, CMS hybridisation without restorer genes and protoplast fusion.

F1-hybrid production would be permitted provided that the F1-offspring are fertile and that the parent lines can be propagated under organic conditions. Within the biodynamic movement, it is likely that production of open-pollinated varieties would be stimulated rather than hybrids. DNA marker-assisted selection would be permitted provided that neither GMOs nor radiation are involved in marker production. Meristem culture would be permitted particularly because of its key role in virus elimination.

Patenting of breeding material would not be allowed because of the restrictions that this places on free exchange of material among farmers and breeders.

Organic varieties would be different from organic seeds and planting material. Organic seeds and planting material originate from breeding programmes, organic or non-organic, and that have been multiplied or propagated for at least one generation under organic management. Some in vitro techniques would be allowed (but not, for example, GM).

The separation of organic varieties and organic seeds should allow for a smooth long-term transition from the current position, where few organic varieties are available but organic seed is relatively common, to a point where organic varieties form the main basis of organic production.

BREEDING OBJECTIVES

Despite obvious overlaps (yield, disease resistance etc.), breeding objectives for organic production differ in range, level and priority from those in non-organic agriculture. For example, competitiveness with weeds is important for organic varieties but not considered in non-organic breeding. Height is important overall, but varieties for organic use tend to be taller than those developed for non-organic production. Yield usually has an over-riding priority in non-organic programmes but will often have a lower priority in organic breeding, relative to quality, for example.

Development of organic breeding programmes should also provide new opportunities. In breeding for quality, one aspect that might be included is breeding plants for human health. In addition to nutritional value (high protein, for example), some secondary metabolites may be valuable in resistance to human diseases.

Because of the current structure of variety legislation, non-organic breeding programmes are directed rigorously towards genetic uniformity among the individual plants in a selected variety. This removes any opportunity for the variety to adapt to local circumstances. For organic breeding programmes, there is much greater interest in maintaining variation within varieties to allow for a buffered response to variation in the local environment.

It seems most likely that the development of organic breeding programmes would lead to increasing differentiation of organic from non-organic crop varieties. It is also clear that a parallel development is needed in breeding animals for organic production.

AN EXAMPLE: COMPOSITE CROSS POPULATIONS IN WHEAT

One approach that we have now started is to produce composite cross populations in wheat. Some 20 outstanding wheat varieties from the last half-century in Europe are being crossed in all possible combinations. Population samples from the F2 generation will be grown at a range of organic and non-organic sites to determine the degree and rate at which the populations adapt to the local environment over several generations. If successful, the material produced could be used either directly or as a rich genetic resource for further selection and breeding. The genetic variation should allow the mechanisms of niche spread, complementarity and compensation to make the populations highly, and rapidly, adaptable in terms of disease, pest and weed restriction together with buffering against variation in the physical environment.

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