Improved quality and disease management in diverse populations

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Abstract
Improved biodiversity is one of the key principles in organic farming and therefore organic plant breeding seeks alternatives to the currently dominant pureline monocultures. Evolutionary plant breeding of composite cross populations (CCPs) has been proposed as a breeding tool for organic plant breeding, where a highly heterogeneous population of offspring is made by mixing a large number of segregating lines from different parents (Döring et al. 2011).
Natural selection will, to some extent, reduce traits conferring major disadvantages in a population if these have a high heritability and a significant impact on seed reproduction. It will not, however, necessarily improve baking quality, negative traits with a strong interaction with the environment or minor negative traits. There may be a need, therefore, for improved maintenance breeding and selection to increase yield, disease resistance and quality in populations. Protein content, as a measure of quality, can be improved in a population by seed sorting. Traditional sorting equipment achieved this based on physical characteristics, e.g. seed gravity; novel technologies for high throughput sorting of seed for hardiness and protein content are now available based on image analysis and Near Infrared Spectroscopy (NIRS).
Regarding disease resistance in plants, if two parents carry two different resistance genes to a disease, one quarter of the offspring may end up being susceptible due to simple Mendelian distribution. In this way, even after crossing multiple resistant parents, a CCP may end up having higher susceptibility to some diseases than the parental lines. Each cross should therefore be grown, assessed and selected for resistance to relevant diseases individually before eventually combining them to form a CCP. Some diseases, e.g. *Fusarium* and smut, can produce mycotoxins which have deleterious effects on seed quality even at low levels without a significant impact on grain yield. Hence, resistance to such diseases will not be sufficiently increased by natural selection under common field conditions. In such cases, selection pressure can be augmented artificially by inoculation with fungi to increase infection incidence under controlled conditions. In this way, inoculation can be considered as a breeding tool to improve quality parameters in CCPs. In the CORE2 funded COBRA project, starting in March 2013, these strategies will be tested and further developed.
Agrologica have grown CCPs of wheat (jointly developed by the Organic Research Centre and the John Innes Centre UK) since 2007. In parallel, 250 new crosses from 30 parents were made to develop a new population improved resistance to common bunt (*Tilletia caries*). Research on this material is now under way in the BIOBREED project (Steffan et al. in press). Based on the practical experience from growing CCPs at Agrologica, some considerations for future development of this breeding strategy can be drawn.

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