

Breeding Techniques for Organic Agriculture

Honnappa M.¹, Padmashree R.² and Umesh Babu B. S.³

¹Assistant Professor, AHRS, Ponnampet, Kodagu, Karnataka

²Junior Research Fellow, ICAR-IIRR, Rajendranagar, Hyderabad, Telangana

³Ph.D. Research Scholar, Department of Genetics & Plant Breeding, Raichur, Karnataka

SUMMARY

Organic agriculture (OA) is one of the several approaches found to meet the objectives of sustainable agriculture. The OA which emphasizes using organic inputs is growing rapidly as an alternative strategy to modern agriculture. Many techniques are being used in organic farming like inter-cropping, mulching and integration of crops and livestock systems including the traditional agriculture practice. Today, many agricultural breeding programs are conducting studies on the nitrogen and phosphorous use efficiency (NUE, PUE) of plants and populations in natural ecosystems helps in designing selection regimes and identifying specific traits that are useful low-input and organic systems along with a selection of characters such as weed competition, nutrient uptake and disease and pest resistance.

INTRODUCTION

Organic farming is an age-old agricultural system used and practiced to raise animals and grow plants. Currently, the consumption of expensive organic food is increasing due to rising awareness of toxic chemicals used in modern agriculture and their hazardous effects on human health and the environment. Organic farming uses agricultural production systems reliant on biological pest control, green manure or compost and crop rotation to produce crops, poultry and livestock. Organic farming forbids the use of chemicals like fertilizers, pesticides, antibiotics and growth hormones in crops, meat and other food production. The main objectives of organic agricultural production are farming grains, vegetables, fruits, flowers, fibres and animal products like eggs, milk and meat in the best natural way without using synthetic chemical fertilizers, herbicides, pesticides or antibiotics.

The primary aspects of organic farming are, to use of green manure or compost, animal manure, crop rotation to improve soil fertility, restoration of soil biological activity, and interrupting pest habitation and diseases. Organic farming is an agricultural system that aims to mimic processes in natural ecosystems for the provision of nutrients and pest control, instead of relying on inorganic chemical inputs. Basically, organic agriculture is based on the underlying principles of health, fairness, ecology and care. Organic farming is based on the concept of working 'with nature'. A very well-known characteristic of organic farming is that it produces food without the use of any synthetic fertilizer or pesticide, and neither with the use of genetically modified organisms (GMOs).

Organic farming is a strategy used in the agricultural sector to avoid the overuse of chemical fertilizers, pesticides, insecticides and herbicides so as to reduce public health issues and environmental risks. Use of chemical fertilizer destroys the natural habitat of wasps, beetles, bugs, flies, birds or frogs. The use of organic manures instead of chemical/conventional fertilizers and adaptation to crop rotation practice preserve soil health and provide the necessary nutrients for crop growth and development. Many agricultural products like meat, dairy products and eggs are produced in a natural and organic way of feeding and maintaining animals. Every agricultural system has pros and cons including organic farming. Organic agriculture (OA) is defined by the worldwide umbrella organization, the International Federation of Organic Agriculture Movements (IFOAM).

As it is given definition in 2005, "Organic Agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic Agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and good quality of life for all involved." Plant Breeding impacts people and societies because it determines the course of our agricultural future, without appropriate varieties that are relevant to their particular farming systems, farmers cannot be successful and consumers suffer from either price increases or lack of food availability, or both, so plant breeding plays a major role in the success of any farming system by breeding cultivars specific for the particular farming system.

Definition of organic Plant Breeding (OPB):

Organic plant breeding is sustainable, enhances genetic diversity and works according to the ecosystem. Organic breeding is always creative, cooperative and open to science, intuition, and new findings. Organic plant breeding is a holistic approach that will concentrate not only on the final product of the crop but also on the complete procedure of plant growth and development. Organic varieties are obtained by an organic plant breeding program.

Requirements for organic plant breeding:

- Plant breeders shall select their varieties under organic conditions that comply with the requirements of this standard. All multiplication practices except meristem culture shall be under certified organic management.
- Organic plant breeders should not use genetic engineering as the use of any genetically modified organisms is complexly prohibited in organic agriculture, so the use of genetic engineering in the development of cultivars in organic plant breeding is prohibited.
- Organic plant breeders shall disclose the applied breeding techniques and this will allow farmers to select the varieties based on the techniques and tools used in the plant breeding program.
- Organic farming looks at the breeding of new varieties in a holistic way. holistic view the organic sector embraces the partner attitude towards nature which includes that not only humans and animals but all living entities, including plants, are considered ethically relevant out of respect for the integrity of life, referring not only to an extrinsic value (usefulness for mankind) but also to a perceived intrinsic value of living organisms (worth as a living entity as such based on respect for their “otherness”, dignity, wholeness and autonomy).

Different Breeding Techniques for OPB:

- 1. Inter-specific hybrids:** Critical issues from the perspective of organic farming: Crossing barriers between species are not clearly defined boundaries, but become stronger with increasing differentiation of the species, *i.e.* the chance of successful fertilization and seed formation decreases correspondingly. Technical interventions, like, in vitro fertilization of the egg cell and pollen or in vitro cultivation of the embryo shortly after fertilization.
- 2. Embryo Rescue in Plants:** In order to improve the frequency of progeny of wide crosses, the embryo is transferred to artificial media in rare cases. The embryo must be derived from a natural fusion of egg and pollen cells, so the embryo obtained should be natural and completely free from any artificial hormones.
- 3. Bridge crossing:** Critical issues from the perspective of organic farming: None When two species are not cross compatible we can go with a bridge crossing to cross-compatible species so that be useful traits can be transferred.
- 4. Shuttle breeding:** Critical issues from the perspective of organic farming: None We can have cultivars that are suitable for two different locations simultaneously thus making breeding effective and speeding up the process of breeding.
- 5. Proteomics / Metabolomics:** Critical issues from the perspective of organic farming: none unless chemical or genetically engineered plants are not involved in cultivar development. Mere selection of the best cultivars based on the results of genomics, transcriptomics, proteomics, metabolomics and phenomics will benefit for early and efficient selection of cultivars.
- 6. Clonal varieties:** Critical issues from the perspective of organic farming: None Application of synthetic rooting hormones for increasing the rooting, effective roots and use of pesticides are completely prohibited in organic plant breeding.
- 7. Apomixes:** Critical issues from the perspective of organic farming: No apomixes can be used in plant breeding programs for improvement in organic conditions but the apomixes should be natural and they can't be induced through any chemicals.
- 8. Synthetic varieties:** Critical issues from the perspective of organic farming: None While open pollination care should be taken to prevent outcrossing with conventionally grown varieties and GMOs, so by maintaining the proper isolation with GMOs and conventional varieties.
- 9. Polyploidisation:** Critical issues from the perspective of organic farming: None If natural colchicine and if applied on intact seed or plants NO issues. Tetraploid plants occur in nature but can also be induced by anti-mitotic drugs, e. g. colchicine or *oryzalin*. Tetraploid plants often show higher vigor. The antimitotic drug can be obtained from plants. Application can take place on the whole seed or on seedlings and no in vitro step is necessary.

10. Marker-assisted selection: Critical issues from the perspective of organic farming: None Plants are evaluated merely based on their DNA Sequence no interventions into cell or genome so markers can be used in an organic breeding programme.

We can go with other breeding techniques:

- Early generation marker-assisted selection
- Marker-assisted Backcrossing

11. Marker-assisted gene pyramiding (MAGP): Pyramiding is a breeding strategy for taking genes from different parents and stacking them in one progeny. MAGP is one of the effective methods for accumulating multiple resistance genes; it is one of the most important applications of molecular markers to organic plant breeding

12. Participatory organic plant breeding: In this participatory organic plant breeding, the development of new cultivars in collaboration with farmers, breeders, stakeholders, consumers etc. This method is very effective especially for organic conditions as the one who grows in the field will select the best for them and the adoption rate will also be high in this method.

13. Speed breeding: The principle behind speed breeding is to use optimum light intensity, temperature, and daytime length control. Speed breeding had been reported to shorten generation time by extending photoperiods, while certain crop species, such as radish (*Raphanus sativus*), pepper (*Capsicum annum*), and leafy vegetables such as Amaranth (*Amaranthus spp.*) and sunflower (*Helianthus annuus*) responded positively to increased day length. But it is not allowed to use phytohormones. In the image we can see that reduced time for the life cycle so that we can reduce the generation time by almost significant time, here in a single year we have 4 generations, and this will gradually reduce the time for variety release. Importantly in organic conditions more frequently we require cultivars against prevailing diseases, pests and nutrient conditions in the field. So we require this kind of method where we can breed more cultivars in less time for organic conditions.

14. Fast track breeding by single seed descent: In order to speed up the breeding process causing fast onset seeds allowing several generations per year, e.g. wheat, ground nut. To enhance the speed of breeding, increase seed quantity and increase selection efficiency this method can be used that results in elite cultivars with more quantity of seed and in less time.

15. Spontaneous Haploid Genome Duplication (SHGD): Double Haploids obtained by pollination with inductor line and spontaneous duplication (in vivo). Egg cells can be induced by cross-pollination with an inductor line into developed haploid embryos without fusion of the egg cell and pollen and, thus, no recombination of genes. The haploid embryos can spontaneously double their chromosomes to become homozygous double haploid plants. This was a standard practice in maize breeding.

CONCLUSIONS

Organic agriculture is very much necessary in the present situation in the context of nutritional security, human health and a safer environment, so when we think of organic farming there are few varieties specifically bred for organic conditions thus making organic farmers go with conventional varieties. As there is a raise in demand for organic products, so the mere selection of the best ones among conventional varieties is not enough to sustain nutritional demand keeping natural biodiversity intact. Thus new breeding techniques and tools are required for the development of crop varieties specifically for organic conditions.

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