Advantages and Disadvantages of Breeding Open-pollinated Varieties or Hybrids in Developing Countries

by **Florin STOENESCU**

Interstate Seed Co., Member of Advanta
Box 338, West Fargo, ND 58078, USA

After a brief review of sunflower genetic studies and breeding history, which looks as interesting as that of most important crops, this paper tries to make a comparison between breeding open-pollinated varieties (OPV's) and open-pollinated synthetics and line synthetics versus hybrids, with special recommendations for developing countries.

Advantages of open-pollinated varieties or synthetics over hybrids are as follows:

- **Larger ecological plasticity.** Economical yields are achieved with OPV's or synthetics under less favorable growing conditions and with lower crop inputs. Because sunflower is a typical allogamous species, most OPV's are mixtures of multitude heterozygous genotypes. Genes for self-incompatibility assure a continued inter-mating and gene rearrangement each generation of breeding and seed production, maintaining in this way a certain percentage of adapted individuals for different environments .
- **Simpler and less expensive breeding procedures and a shorter development cycle.** From initial breeding material to the commercial product, five more generations on average are needed for hybrids than for OPV's or synthetics. The breeding cycle depends very much on the target traits.
- **Larger disease resistance spectrum.** OPV's and particularly synthetics can be built by inter-mating populations or lines carrying genes of resistance to different pathogens or parasites. So called multi-linear varieties can be also developed incorporating resistance genes of different races of the same pathogen or parasite. In comparison with hybrids, total resistance can not be achieved because of less than 100% frequency of each allele involved in resistance.
- **Better economic efficiency of seed production.** OPV's are characterized by higher yield per elite plant and per hectare in each stage of seed production, from Breeder to Certified seed, especially when compared to single cross hybrids, which have as female an inbred line.
- **Cheaper seed for planting.** Due to less expensive breeding and the seed increase process, seed of OPV's and synthetics may be 3-5 times less costly than F1 hybrid seed.

Advantages of hybrids over open-pollinated varieties or synthetics are as follows:

- **More intense heterosis for yield and other important traits.** Inter-population heterosis is considered for most crops more important than intra-population heterosis, which generally characterizes OPV's and synthetics. High level of inter-population heterosis can be achieved when hybrid parental lines are originated from different populations, particularly from different heterotic groups. A full impact of biotechnology is expected to identify more reliably heterotic groups in sunflowers and to establish genetic distances among them. Single-cross hybrids are generally higher yielding than three-way hybrids.
- **Uniformity.** Because all individuals are of similar genotype, hybrids, especially single-crosses, show better plant and seed uniformity for all traits in comparison with OPV's and synthetics.

  For growers uniformity is particularly important for:
  - ***disease resistance.*** OPV's with good resistance to broomrape, Verticillium wilt, downy-mildew and charcoal rot were developed in Russia in the 60's, but they usually comprised high percentage of susceptible plants for each pathogen and parasite, due to the permanent segregation of the resistance genes. Entirely resistant hybrids can be easily developed, mainly when oligo-genic resistance is available.
  - ***insect resistance.*** Uniformity in blooming helps the control of damaging insects because of fewer or more timely applications of insecticides.
  - ***agronomic traits.*** Uniformity in maturity, height and head inclination has advantage for harvest.
  - ***herbicide tolerance.*** Total herbicide tolerant hybrids can be developed, even when tolerance is partial dominant or recessive. In these cases, the responsible genes need to be incorporated in all parental lines and to be in homozygous stage. This conversion is much more difficult for OPV's and synthetics due to heterogeneity problems.

  For processors uniformity is important for:
  - ***seed features.*** Uniformity of seed size, shape and color for non-oilseed sunflowers, for both "in-shell" and dehulling markets is essential.
  - ***specialty oil products.*** The industry needs to meet constant standards, for example over 80% oleic in high-oleic oils. It can be achieved easier with hybrids due to their uniformity.
- **More modern and efficient breeding:**
  - ***trait incorporation.*** Classical as well as molecular marker assisted back-cross projects are performed easier and with more consistent results when using inbred lines than heterogeneous populations as recurrent parents. Homozygosity of the gene(s) of interest is difficult to be accomplished in OPV's, keeping in the same time its initial large genetic background for maintaining a strong intra-population heterosis.
  - ***Use of special breeding techniques.*** Microspore and/or anther culture for doubled-haploid line production has been used recently on a larger extent to develop highly homozygous inbred lines. Embryo and immature seed culture has become a routine method for many breeding

programs to reduce substantially the plant vegetative life, getting more generations per year in the growth-room and greenhouse.

- **More efficient biotech transformation.** Very important genes from another genus, such as Ox-Ox for Sclerotinia sclerotiorum resistance, anti-fungal proteins, Bt or similar genes for insect resistance, herbicide resistance genes, biochemical C4 pathway genes, etc., are preferred also to be transferred in inbred lines than populations.
- **Sunflower product diversification.** Breeding programs for value-added sunflower product development consider inbreeding and hybrids a better option than working with OPV's and synthetics.
- **Hybrid seed production efficiency can be increased.** Seed cost for inbred seed may be more expensive, however savings can be achieved by selecting higher yielding inbreds as female parental lines. Three-way hybrids, having a single-cross sterile hybrid as female, are a good option to increase substantially production efficiency over single-cross hybrids.

Recommendations for sunflower breeding in developing countries.

Breeding objectives vary with the cropping conditions and industry demands in each country, but generally emphasize high seed yield and high oil content. They depend on many factors, including suitable agronomic type, resistance to disease, insects and other pests, as well as tolerance to stress environments. For special markets certain breeding objectives are different, as in the case of confection sunflower, changes in fatty acid composition and in protein content and quality to enhance the value of the meal.

To achieve these objectives, inbreeding and hybrid development are presently the choice of most breeding programs. Faster and more important genetic gains can be obtained with hybrids. Improved open-pollinated and synthetic cultivars may also have value, especially in countries where hybrid seed production and marketing are not feasible for technical or economic reasons.