Doubled haploids as a material for biotechnological manipulation and a tool for rapid breeding of winter oilseed rape (*Brassica napus* L.)

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Oilseed rape (*Brassica napus* L.) is the third, after palm and soybean, most important source of vegetable oil in the world and a significant contributor to the economy of many countries. Due to its high performance in *in vitro* culture, oilseed rape is also considered one of the most suitable species for improvement through biotechnology. Cultured microspores of oilseed rape can be induced to develop into fully functional haploid embryos, instead of mature pollen grains. The ability of these cells to change their development in response to environmental stimuli is an exceptional example of totipotency in plants.

Doubled haploids (DHs) are produced by chromosome doubling of haploid plants, whereas conventional inbred lines are developed by selfing in successive generation. Haploids and DHs in *Brassica* ssp. have been produced using anther culture or isolated microspores. Since the method of isolated microspore culture became available (Lichter, 1982), this technique has continuously being improved and modified, and a number of androgenic plants from different species of the *Brassica* genus were obtained. The key to higher regeneration efficiency during androgenesis lies in the control of two crucial developmental points: the induction of microspore cell division and their commencement to embryogenic pathway. Haploids and doubled haploids of *Brassica napus* have been extensively used in genetic studies such as gene mapping, location of QTLs, marker/trait associations, genomics, and as targets for transformation. Nowadays, oilseed rape haploid induction can be efficiently combined with several other biotechnological techniques, enabling novel breeding achievements like hybrid breeding, mutation, genetic transformation and resynthesis of *Brassica napus*.

Advancements in *in vitro* androgenesis of oilseed rape permit to obtain DH populations on a larger scale, facilitating application of DH lines in genetic analysis of quantitative traits and research on environmental impact on yield and seed quality. Thanks to its homozygosity, a single DH line produces only one type of gametes which in controlled conditions can duplicate their own genotype. This allows to carry out multiple experiments with the same genotype, in various locations and years, which is not possible with a generation of segregated hybrid populations in classical breeding. Moreover, for traits controlled by polygenic inheritance, DH technology requires fewer genotypes, since there are no heterozygotes, thus no dominance effects, and no interactions of nonallelic heterozygous loci can be observed. A microspore culture is a useful tool in breeding, as homozygous lines exhibiting desired agronomic traits can be rapidly selected, creating opportunity for faster production of commercial cultivars. Cultivar Monolit (Plant Breeding Strzelce Ltd., Co.), is the first Polish winter oilseed rape variety obtained using doubled haploid technology. The breeding cycle of this variety was about four years shorter than a classical breeding program. The other Polish cultivar Brendy (Plant Breeding Smolice Ltd., Co.) was developed in a similarly short time. Currently, homozygous restorer lines are exploited in most breeding programs pursuing new hybrid varieties of oilseed rape.

Utilization of oilseed rape doubled the haploid technology in basic research and its application to improve qualitative and quantitative traits of oilseed rape will be presented in view of results obtained in the Institute of Plant Breeding and Acclimatization NRI in Poznań as well as ongoing research in the world.

References

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