Fact sheet

12/2013

Brussels, Belgium

ESA_13.0834.3

ESA is the voice of the European seed industry, representing those active in research, breeding, production and marketing of seeds of agricultural and ornamental plant species. It represents more than 30 national seed associations and more than 60 direct company members.

ESA's mission is to work for fair and proportionate regulation of the European seed industry, freedom of choice for customers in supplying seeds as a result of innovative, diverse technologies and produc - tion methods and for effective protection of intellectual property rights relating to plants and seed.

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Hybridization and Male Sterility (MS) in plant breeding - history, current use and legal status

Exploiting heterosis: the success of hybrids in plant breeding and farming

Plant breeding is based on both, the breeders' knowledge of the biology of crops and his expertise in making use of this knowledge by applying a large number of different breeding techniques and approaches to achieve the desired result: the development of better varieties in comparison to the existing ones.

Hybridization is one very common technique in the respect. It is a process which is at the very base of biodiversity and evolution of living organisms and in particular a starting point for the development of new varieties in quite many crop species.
The first hybrids in plant breeding were produced as early as 1908 in maize. In the following decades, sunflower, tomato, pepper, eggplant, melon, brassicas, carrots and other crops followed.

Hybrid varieties express specific agronomic traits, resulting from the addition and/or overexpression of the characteristics of the two combined parental lines. This effect is commonly known as heterosis effect or hybrid vigour. With that, hybrid breeding enables breeders to react quickly and in a targeted manner to new challenges by combining complementary characteristics originating from the two parents, e.g. in case of the need for new resistances to diseases. Hybrids therefore bring benefits to the grower, the supply chain and the consumer by better products and qualities.

Hybrid seed production requires systems somewhat different from the production of seed from self-pollinating crops, since in this case, the selfing of the plants (in the parental line chosen as the female) is undesired and shall be prevented. For that, manual emasculation is necessary to prevent the pollen production (in crops such as maize, tomato, pepper, eggplant, etc.) or pollen competition (e.g. in brassicas, chicory). Also treatments for feminization of flowers in wheat or cucurbits are used. However, in some species, with these types of hybridization, it is not possible to fully manage and avoid the self-pollination of the female line which may thus cause subsequent seed quality problems in view of the required high purity standards (with occurrence of inbreds) and lack of homogeneity.

Breeders therefore continuously have tried to find and make use of further, more adapted and reliable systems for hybrid development and seed production. One of these systems is based on male sterility.


Male sterility – a natural ally for breeders in developing hybrids

Male sterility is a biological characteristic commonly present in nature. It prevents the production of viable, i.e. fertile male pollen (more specific: gametes).
To identify or to create a male sterile line that is genetically unable to produce viable pollen is not only a simple way to establish a female line for hybrid seed production; such plants also offer breeders an option to produce and develop seeds of hybrid varieties with much greater homogeneity of the resulting crop. This has significant importance and benefit for farmers and growers as well as consumers.

Male sterility has meanwhile been identified in over 150 plant species. Today, two natural sources of male sterility present in the genetic diversity are mainly used by breeders in their breeding programs:
Either male sterility is controlled by genes of the nucleus (Genic Male Sterility) or by genes of the cytoplasm (Cytoplasmic Male Sterility) in the organism, sometimes in interaction with the environment for the stability of its expression. Numerous examples exist across crops: male sterility can thus be found in maize, wheat, oilseed rape, sunflower, sorghum, sugar beet, rye, barley, rice, cotton, flax, onion, spinach, carrot, asparagus, celery, cucurbits, tomato, pepper, eggplant, leek, fennel, radish, cabbage, cauliflower, broccoli, turnip, chicory, etc..

Cytoplasmic Male Sterility (CMS) was commonly identified within the genetic diversity of sexually compatible species. It is introduced in the crop either by crossing or with the help of protoplast fusion. For example, in brassicas, CMS was discovered in 1968 in a Japanese radish and introduced in cabbage by crossing in 1974. In this specific case, protoplast fusion was later used to correct the chlorophyll deficiency of cytoplasmic male-sterile brassica plants (cabbage and oilseed rape) by fusing a cabbage male-sterile cell without functional chloroplasts with a cabbage cell that had functional chloroplasts.

The EU's legal classification of male sterility breeding

According to the EU Directive 2001/18, organisms deriving from cell fusion (including protoplast fusion) of plant cells from organisms which can exchange genetic material through traditional breeding methods, are not to be considered as Genetically Modified Organisms. Such long standing breeding methods are also recognized by EU Regulation 258/97 concerning Novel Food, as falling out of the scope of that Regulation. Also the EU Organic Farming Regulation 834/2007 does consider CMS varieties as fully compliant with organic farming rules.

Consequently, there are neither specific legal authorisation obligations nor production nor labelling requirements as regards varieties produced by such male sterility breeding methods. The development and use of CMS varieties is therefore fully compliant with all relevant EU legislation and is not restricted in any way by EU or Member States.
However, some private standards have been developed where varieties produced by e.g. CMS are considered incompatible with these individual production rules. It should be noted that these are private standards that do not affect the legal status of CMS varieties but are an expression of individual choice.