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# SPT System in Maize

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SPT, which stands for Seed Production Technology is a transgenic construct-driven non-transgenic seed system. This process incorporates a transgenic SPT maintainer line capable of propagating non transgenic nuclear male-sterile lines for use as female parents in hybrid production.

Commercially, hybrid seeds are the $F_1$ (first filial) seeds produced by crossing two distantly related inbred lines. Among them, one is a male inbred line or pollen donor and the other one is a female inbred line or pollen recipient. To prevent self-pollination during hybrid seed production, manual detasseling (removal of the pollen-producing tassel) from a female parent is required, which is a time-sensitive and labor-intensive process. If not done on time, it can lead to contamination and lower yield of hybrid seeds. Thus, to eliminate the need for detasseling SPT utilizes a naturally occurring dominant maize sterility gene "*Ms44*". The female inbred line utilized in the *Ms44* SPT system does not yield pollen and does not require detasseling to produce a single cross-hybrid seed. Lastly, up to 10% of the potential female seed output may be lost since manual detasseling frequently removes one or more leaves in addition to the tassel. The complete seed yield potential of the female line can be achieved with the *Ms44* SPT system.

*Ms44*" is a dominant male sterile mutant Identified by Marc Albertsen in 1978 from EMS mutanized population (Albertsen and Trimnell, 1992). This gene is anther-specific, located on chromosome number 4 which, affects anther development at early nucleate stage. *Ms44* male-sterile plants reduced tassel growth and improved ear growth by partitioning more nitrogen to the ear, resulting in a 9.6% increase in kernel number. Hybrids carrying the *Ms44* allele demonstrated a 4%–8.5% yield advantage when N is limiting, 1.7% yield advantage under drought and 0.9% yield advantage under optimal growth conditions relative to the yield of wild type.

Hybrids produced using Ms44 segregate 1:1 for pollen producing and non-pollen producing plants and are thus referred to as 50% non-pollen producing (FNP). This technology

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*i.e.*, Ms44-SPT system is well suited for three-way hybrid production and offers three key benefits: (1) increased female seed yield because detasseling is unnecessary, (2) improved quality assurance during seed production, and (3) increased yield of FNP hybrids due to reduced tassel growth and greater partitioning of nitrogen to the ear, increasing nitrogen use efficiency (Fox, 2017).

During hybrid seed production, the plants that carry Ms44 gene are male sterile but still have female reproductive organs capable of receiving pollen. A separate line (maintainer line) is developed to maintain the male sterile line. The maintainer line when cross which male fertile plant produces fully male sterile plant of the same genetic background. When non-pollen producing (NPP) female inbred line A is crossed with male inbred line B produces an NPP single cross hybrid. And, when NPP single cross hybrid is crossed with male inbred line C, it gives a 3-way hybrid. This 3-way hybrid segregates into a 1:1 ratio of pollen-producing (PP) plants and NPP plants (Figure 1).

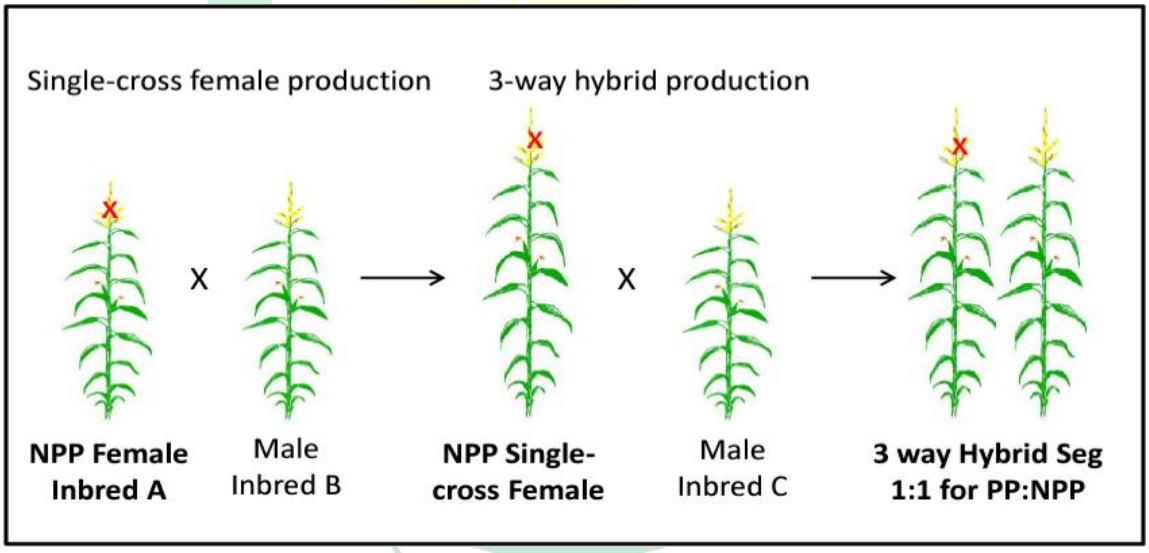


**Figure 1 Hybrid seed production using *Ms44* SPT system, Olsen, 2018**

Another SPT system is maize utilizes *ms45* gene. GMS mutant *ms45* utilized by DuPont Pioneer in hybrid production platform named SPT (Wu *et al.*, 2015). The maize ms45 SPT maintainer line is a homozygous recessive male sterile transformed with a SPT construct containing (i) a complementary wild-type male fertility gene to restore fertility, (ii) an α-amylase gene to disrupt pollination and (iii) a seed colour marker gene. Of the pollen grains produced by the SPT maintainer line all have the ms45 genotype, 50% are non-transgenic and 50% have the SPT transgenic elements. The latter grains are unable to germinate due to

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expression of the ZmAA gene. Thus, self-pollination of the SPT maintainer line produces both seeds with the same genotype of the SPT maintainer line (ms45/ms45+SPT-T-DNA) and seeds with the male-sterile genotype (ms45/ms45). The two types of seeds can be efficiently separated by mechanical color sorting, since the 50% of seeds that contain the SPT elements show a red color under green excitation light. When the male-sterile line (ms45/ms45) is pollinated with the SPT maintainer line, almost 100% of the resulting seeds have the ms45/ms45 genotype and can be used as male-sterile female lines for cross-breeding and hybrid seed production.

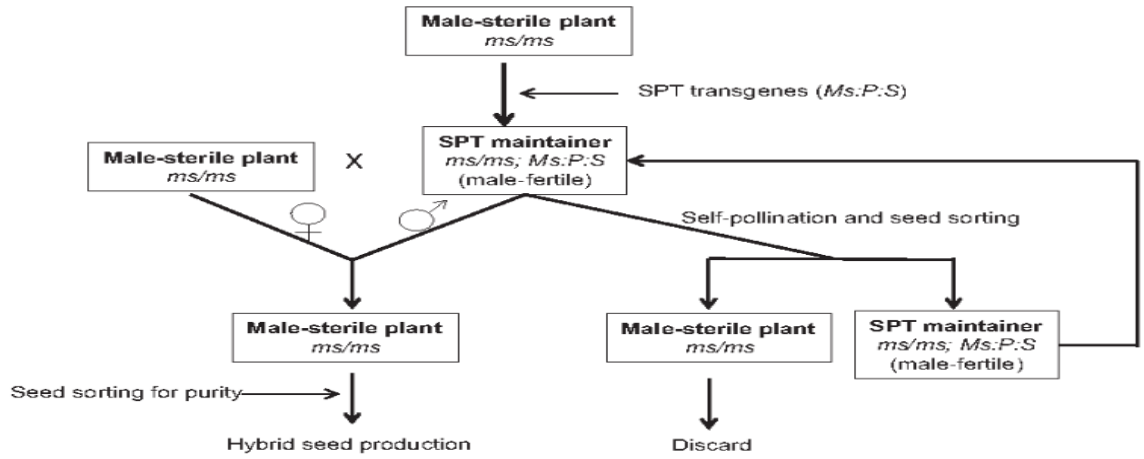


**Figure 2 Hybrid seed production using *ms45* SPT system (Wu *et al.*, 2015)**

**References:**

Albertsen, M.C. and Trimnell, M. (1992). Linkage between *Ms44* and C2. *Maize Genet. Coop. Newslett.* 66, 49.

Fox, T., DeBruin, J., Haug Collet, K., Trimnell, M., Clapp, J., Leonard, A., (2017). A single point mutation in Ms44 results in dominant male sterility and improves nitrogen use efficiency in maize. *Plant Biotechnol. J.* 15, 942–952. doi: 10.1111/pbi.12689

Wu, Y., Fox, T.W., Trimnell, M.R., Wang, L., Xu, R., Cigan, A.M., Huffman, G.A., Garnaat, C., Hershey, H.P., & Albertsen, M.C. (2015). Development of a novel recessive genetic male sterility system for hybrid seed production in maize and other cross-pollinating crops. *Plant Biotechnology Journal, 14*, 1046 - 1054.

Mike Olsen, 2018. CIMMYT GMP Upstream Research Collaborations: Seed Production Technology (SPT), gene editing, and seed chip genotyping. www. https://repository.cimmyt.org