ecobreed
IMPROVING CROPS

Increasing the efficiency and competitiveness of organic crop breeding

PRACTICE ABSTRACT No. 4

Soybean genotyping for food safety and organic traits

PROBLEMS:

- No synthetic pesticides or fertilisers are used in organic soybean production. Therefore, varieties suitable for organic production particularly require high disease resistance and efficient nutrient uptake.
- The maximum level of cadmium in soybeans was recently reduced to 0.2 mg/kg fresh weight by Commission Regulation (EU) 2021/1323 (**https://eur-lex.europa.eu/eli/reg/2021/1323/oj**).
- Conventional plant breeding based on phenotypic selection for the above traits is time-consuming and expensive, thus limiting yield progress in the smaller organic and low-input sectors.

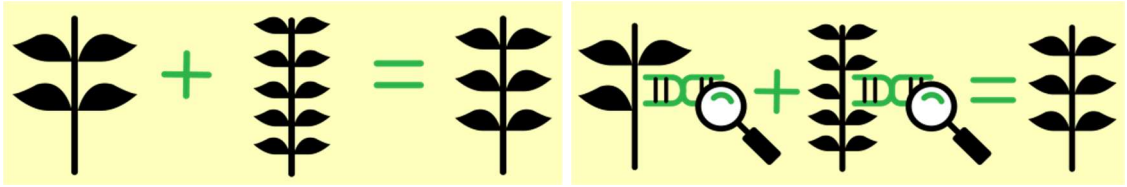

*Fig. 1: Schematic representation of phenotypic (left) and marker-assisted (right) selection (MAS): in traditional breeding, the desired traits are identified in the field and combined by crossing; selection for trait combination in the segregating progeny is again performed in the field. Identifying the genes responsible for a trait and a DNA marker near that gene can make breeding more efficient by identifying plants with the desired trait at early stages of development. MAS can also be used to identify (a) genetic diversity in breeding material, (b) varieties with complementary traits for crossing, and (c) plants with a combination of valuable traits (genes) in segregating progeny. (Source: modified after Munday O. & Jung J. (Int. Rice Res. Inst.); see Folger T. (2014), The next Green Revolution, National Geographic Magazine, October 2014 issue; **https://www.nationalgeographic.com/foodfeatures/green-revolution/**)*

SOLUTIONS:

- The use of soybean varieties suitable for organic farming provides more efficient and sustainable strategies for organic production systems. Genotypes with low cadmium accumulation should be used in organic food production to improve food safety. Selection for supernodulation in soybean could be an important trait showing potential for increased nitrogen fixation. In addition, breeding for disease resistance offers an efficient and sustainable strategy for organic production.

- The use of improved and more efficient breeding approaches such as marker-assisted selection (MAS) reduces costs and can be used directly in breeding for organic and low-input production (Fig. 1). This has the potential to shorten the breeding cycle and increase the precision of selection. With better varieties, farmers are likely to achieve greater yield stability and more sustainable production, which means lower risks in the organic production process.

PRACTICAL RECOMMENDATIONS:

Molecular markers were used to screen ECOBREED breeding material harbouring traits relevant to organic farming:

- *Cadmium accumulation*: by using two different marker strategies 11 soybean cultivars (Kamianetz, Novosadska Rana, NS Albus, NS Kraljica, Tajfun, Xonia, Columna, Larisa, NS Maximus, Ovidiu F and Steara) were identified containing an allele for low Cd accumulation, which is particularly suitable for soybean food production. The first six genotypes also showed high grain yields in ECOBREED field trials.
- *Supernodulation*: a molecular marker linked to the gene controlling the autoregulation of nodulation allows rapid screening at early developmental stages without inoculation. However, no supernodulating genotypes were identified in the ECOBREED soybean nursery.
- *Disease resistance*: using multiple molecular markers, soybean cultivars were identified that carry a high number of loci that confer tolerance to: (i) *Sclerotinia sclerotiorum* (i.e., Astafor, Favorit, Fortuna, Gracia, NS Kaca, NS Maximus, Pando, Rubin, Tajfun, Venera and Zita,), (ii) resistance to northern stem canker caused by *Diaporthe caulivora* (i.e. Favorit and Jelica') and (iii) against southern stem canker caused by *Diaporthe aspalathi* (i.e. Astafor, Becejka, Belka, Isidor, Jelica, NS Kraljica, NS Sirius, Pando, Zita and Zlata).

FURTHER INFORMATION

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Kim MY, Van K, Lestari P, Moon JK, Lee SH (2005). SNP identification and SNAP marker development for a *GmNARK* gene controlling supernodulation in soybean. Theoretical and Applied Genetics 110: 1003-1010. **doi: 10.1007/s00122-004-1887-2**

Vollmann J, Lošák T, Pachner M, Watanabe D, Musilová L, Hlušek J (2015). Soybean cadmium concentration: validation of a QTL affecting seed cadmium accumulation for improved food safety. Euphytica 203: 177-184. **doi: 10.1007/s10681-014-1297-8**

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ECOBREED CONSORTIUM

ABOUT ECOBREED:
ECOBREED is a 5-year (2018-2023) project funded by European Union's Horizon 2020 research and innovation programme that will improve the availability of varieties and seed suitable for organic and low-input production. Activities will focus on four crop species i.e. wheat, potato, soybean and common buckwheat, selected for their potential contribution to increasing the competitiveness of the organic sector.

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