BRE1714: Development of Adapted High-Yielding Faba Bean for Saskatchewan

The population development and early stages of appropriate future germplasm development are completed for all objectives. We have screened and selected faba bean genetic materials for drought adaptation, vicine-convicine, micronutrient profile, chocolate spot resistance, and crop architecture. We expect this activity to maintain momentum within the breeding program in future, especially for chocolate spot disease resistance, reduction of seed size, reduction of maturity, improvement of drought tolerance, reduction of phytate, increase of plant protein, and other measurable economic benefits.

Objective 1 (develop adapted faba bean germplasm and breeding lines with improved drought tolerance for use in the Southern and Western regions of Saskatchewan): we investigated the nature and size of genetic control of morpho-physiological traits related to drought adaptation in faba bean. Field experiments and seed increases were conducted at appropriate locations in Southern and Western Saskatchewan used to shape and select within segregating faba bean germplasm, recombinant inbred lines, and pre-breeder lines.

Objective 2 (develop commercially acceptable faba bean germplasm and breeding lines with low anti-nutritional properties): a rapid mass spectroscopy method and an inexpensive molecular SNP marker-based (single nucleotide polymorphism) method were developed to create an in-the-gene marker for selecting seeds with high or low (99% reduction) vicine-convicine content. These markers were tested across a wide range of germplasm and were found to be robust and accurate. We are now able to accurately and quickly identify faba bean plants, greatly assisting the effort to breed faba bean varieties with LVC content. This aided our NORFAB collaborating team to elucidate the vicine-convicine biosynthetic pathway.

Objective 3 (develop low phytate faba bean/improve the micronutrient bioavailability): a reliable KASP marker was developed and validated for the zt2 (white flower/low tannin) gene based on available EST sequences and a genetic map. Tannin reduction results in improvement of bioavailability of some micronutrients. The quality and repeatability of the marker was validated. We then started research on a modified translational genomic approach that will allow us, eventually, to develop molecular markers for low phytate genes in faba bean. We now have access to new genomic and marker tools developed by collaborators in Europe.

Objective 4 (improving resistance to chocolate spot): we initially developed an irrigated field screening system for chocolate spot. Results indicated that we have reliable and rich sources for resistance. These sources tended to have late maturity. This can be overcome through breeding for earliness. We have developed a system for screening F2 plants for chocolate spot resistance that is now integrated with the crossing program as a way to accelerate genetic gain potential. We are able to use a Southern hemisphere contra season to accelerate generation advancement.

Objective 5 (develop ideotype faba bean germplasm for use in the Northern and Eastern regions of Saskatchewan): we have developed a solid understanding of the genetics of branching pattern, determinate growth habit, maturity, dwarfing, reduction of seed size, and improvement of seed shape from angular to completely round. This will allow us to develop genotypes for specific cropping systems, for example, production in Southern brown soil regions, Northern short season areas, and intercropping compatibility in organic systems. Overall benefits of these outcomes include (1) reduction of seeding costs and (2) improved reliability of seed distribution and handling systems.

Faba bean integration into pea and lentil based crop rotations are a desirable outcome and future goal of this project as a strategy for: (1) combating the negative effects of Aphanomyces in pea and lentil crop rotations - both crops are highly susceptible to this devastating root rot, while faba bean is tolerant; (2) providing more plant protein for extraction and development of plant based food systems, and; (3) integrating faba bean as an important rotational crop that has the highest potential for providing nitrogen fixation benefits as part of improving environmental sustainability of crop agriculture systems in Saskatchewan (see Klippenstein et al., https://doi.org/10.1002/agj2.20945).

The next phase of faba bean germplasm development and breeding will logically become focused on (1) a deeper understanding of the quality characteristics of new round-shaped, small seeded germplasm based on a phenotypic and genotypic analysis of protein content and quality, carbohydrate content and quality, vitamins and minerals, and fibre; (2) a deeper understanding of flowering and maturity in relation to the range of Saskatchewan environments; (3) further understanding of genomic tools as a way to accelerate chocolate spot resistance breeding; (4) deeper understanding of faba bean root systems in relation to drought tolerance; and, (5) a re-evaluation of herbicide tolerance of recently developed germplasm.