Transforming Genetic Gain in Pulses

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Legumes have proven to be useful and, in favourable market conditions, high value components of sustainable cropping rotations. However, the well-known risk of profit margin losses due to market instability, disease, climatic variables, herbicide damage, subsoil constraints coupled with a relatively small research community has moderated their uptake. In the Western Region, the low market price of lupin and competition with oilseeds has decimated the production area of the only widely adapted grain legume option. Producer surveys continue to recognise the development of further legume options as a high priority for weed, pest and disease control and reducing nitrogen inputs. In answer to the need for tools to facilitate the necessary rapid genetic gain in legumes, we began a broad-ranging fundamental and applied ‘seed-to-seed’ physiology research effort in chickpea, field pea, lupin, lentil and faba bean.

Our findings have enabled the regulation of key components in legume phenology to achieve rapid plant turnover. They include elucidation of biochemistry of seed development for precocious germination (Abstract: Ribalta et al.), understanding the role of light quality when combined with saturation photoperiod and conducive temperatures in the synchronisation and compression of time to flower (Abstract: Bennett et al.) and plant height manipulation for multi-tier, high-density plant growth in controlled environments (Abstract: Munday et al.). The resulting accelerated single seed descent (aSSD) approach enables the turnover of 5-8 generations per year in all the major pulses. In collaboration with breeders and research colleagues, we have successfully integrated marker assisted selection and screening for key production constraints under controlled conditions as part of the aSSD platform. The platform is continuously deployed to accelerate genetic gain within phenotypically diverse segregating breeding populations for our own research and for pulse breeding and research groups nationwide with processing of > 30,000 breeding lines to date.

The knowledge acquired in the domesticated grain legume species provided the basis for fundamental studies into physiology and genetics of phenology in wild *Cicer* species. The resulting Rapid Gene Introgression (RGI) platform speeds and eases geneflow between the wild relatives *C. reticulatum* and *C. echinospermum* and domestic chickpea enabling seed-cross-RIL interspecific production within two years (Abstract: Pazos-Navarro et al.). The RGI platform has enabled prompt access to inbred wild, cultivated and hybrid accessions and facilitated the evaluation of interspecific geneflow and evolution of wild and cultivated *Cicer* (Abstract: Lichtenzveig et al.). With the aim of expanding the crop’s adaptation potential, we are currently elucidating the genetic basis of recalcitrant traits, such as response to low temperature (e.g. chilling at reproductive stage). We expect our fundamental studies into genetics and physiology coupled with the aSSD and RGI platforms will have a transformational impact at the farmgate, through both novel gene combinations and rapid delivery of key traits. We acknowledge the continuous support of this research by GRDC investment in partnership with The University of Western Australia.