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The development of commercial crop options from the safflower oil research undertaken under the CSIRO–GRDC Crop Biofactories Initiative is now underway in Victoria

David Hudson and Dr Surya Kant in the Plant Phenomics Victoria Horsham facility, where phenotyping of safflower for water stress tolerance is taking place. Photo: Brad Collis

Agriculture Victoria researchers based at Bundoora and Horsham, Victoria, are looking to 'reinvent' safflower as a profitable break crop producing super-high oleic oil for use in industrial applications such as lubricants and plastics. This biodegradable and renewable safflower oil has the potential to replace fossil fuel oils and palm oil in the oleochemical industry.

An 'accelerated precision breeding program' is underway to develop new elite varieties of safflower that produce super-high oleic oil.

About 500 lines, most sourced from the Australian Grains Genebank at Horsham, are undergoing the first round of phenotyping (trait assessment) at Agriculture Victoria's state-of-the-art Plant Phenomics Victoria Horsham (PPVH) facility and in field trials, and genotyping (genetic profiling) at the AgriBio Centre in Bundoora. This work will identify the most prospective parent lines for breeding new elite varieties with particular agronomic traits for different growing conditions.

The research by Agriculture Victoria, being undertaken in collaboration with the Victorian-based GO Resources Pty Ltd (which holds the worldwide licence to commercialise super-high oleic safflower oil), is a follow-on from the initial CSIRO–GRDC development of transgenic lines capable of producing 91 to 93 per cent oleic oil content – far exceeding the previous benchmark of 70 to 75 per cent in conventionally bred safflower and sunflower varieties.

The CSIRO technology was developed through the Crop Biofactories Initiative, a joint initiative with the GRDC.

The research and development manager at GO Resources, David Hudson, says two main objectives are to establish a high-value safflower industry for Australia and to produce super-high oleic safflower oil for domestic and export markets. The potential to achieve these outcomes led to a $3 million grant in 2017 under the Federal Government Cooperative Research Centre Projects (CRC) grant program.

The CRC program supports industry-led collaborations between industry, researchers and the community.

The estimated value of the worldwide industrial oils and oleochemical market is said to exceed $30 billion a year.

Industry interest

Lead researcher at Agriculture Victoria Dr Surya Kant says the CSIRO development, on which this next research phase is based, has demonstrated the potential for safflower crops to produce sufficient levels of super-high oleic oil to be of serious interest to industry as a sustainable, non-fossil fuel oil source.

“The immediate objective is the introgression of the transgenic lines that produce the super-high oleic oil into commercial varieties of safflower sourced from safflower breeding programs in the US. These varieties have proven to be readily adapted to dryland and irrigated grain-growing regions in south-eastern Australia,” he says.

“This work will set the basis for the world’s first reference population for safflower, having been intensively phenotyped for key agronomic traits, along with mapped genetic signatures, and its subsequent use for genomic selection and precision breeding.”

The Horsham team already has 434 accessions from the adjacent Australian Grains Genebank (part of the Victorian Government's Grains Innovation Park at Horsham) in field trials, with plans to screen a further 60 or so lines from overseas.

The phenotype observations include agronomic performance in areas such as emergence, biomass accumulation rate, water use efficiency, salt tolerance, disease resistance, flowering time, crop duration and oil content.

This work is now able to be automated through the new PPVH facility and using unmanned aerial vehicles (UAVs) equipped with high-resolution digital cameras and multispectral sensors, combined with application of the latest software to analyse big data with resolution from whole field trial to plot to single plant level.

Using the latest phenomics capabilities, plants can be observed non-destructively and periodically for their entire life cycle with higher efficiency, reliability and precision.

"We are particularly targeting the plant's already useful drought and salt tolerance to come up with a variety that would provide options for growers in drier areas, although generally safflowers suit the same agro-ecological zones as canola, but with a few additional advantages," Dr Kant says.

"Safflower can tolerate dry conditions, has a high salt tolerance and can be sown as early as June for a December harvest and as late as August for a February harvest, so it can also be a back-up option if traditional crops miss their optimum sowing window."
He adds that the crop's canopy also provides a competitive edge against weeds and its deep roots can contribute to improved soil structure and water use efficiency, especially in poor finishing seasons.