Novel weed control technologies from the USA – new possibilities for Australian growers

Michael Walsh, Gulbali Institute, Charles Sturt University, Wagga Wagga

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Take home message

- New weed control technologies are under development for US cropping systems
- Widespread occurrence of herbicide resistance in US cropping systems is driving the development of alternative weed control techniques
- Opportunities to evaluate the potential of these systems in Australian grain production systems.

Background

Globally, the current rate of research and development on weed control technologies for large scale cropping systems is the greatest that we have ever seen. These efforts are being driven by necessity as well as innovation. Worldwide herbicide availability continues to decline, within creased regulatory restrictions and a lack of new molecules being released. To a lesser extent, there has also been progress on alternative, non-chemical weed control techniques. This has been aided by technological developments in machine learning that have created the potential for accurate in-crop weed detection and recognition. Although these innovative activities are occurring overseas, mostly in the US as well as Europe, some of the technologies under development could be highly suited for use by Australian grain growers. The more exciting of these developments are summarised here.

WeedErase and Weed Seed Destroyer

Global Neighbor, Inc. (https://g-neighbor.com/) is a startup based in Ohio who have developed a weed and weed seed control approach based on heat from the combination of 440 nm wavelength blue light and mid-wave infra-red (MWIR) wavelengths. The blue light at high intensity, 30 times sunlight, damages photosynthetic systems (chloroplasts), as evidenced by blackened leaves. MWIR which is not present in sunlight, penetrates the soil to damage weed roots. This technology is currently only commercially available as the handheld WeedErase® system for home garden use.

Further research has found that the combination of high intensity blue light and MWIR can be effective at killing weed seeds. Global Neighbor, Inc. is now pursuing the use of this approach for targeting weed seeds during harvest. Preliminary studies have shown that complete control of weed seeds in chaff can be achieved within a few seconds exposure. Global Neighbor, Inc. are pursuing this opportunity with a development labelled the Weed Seed Destroyer (WSD). This technology is still very much under development, with prototype systems being produced for benchtop as well as field testing.

Preliminary testing with a benchtop system at the University of Western Australia has identified high efficacy (>90%) of the WSD on annual ryegrass seed present in wheat chaff. Although initial results are encouraging, gaps remain in the efficacy of this approach in the field, across a range of weed species and crop chaff combinations in varying harvest conditions.

Electrical weeding

There are now commercially available electrical weeding systems suited to use in large scale crop production systems. Companies including Zasso (https://zasso.com/), a Swiss based company, RootWave (https://rootwave.com/) from the UK and Weed Zapper (https://theweedzapper.com/)

from the US, have all developed high voltage electrical weeding systems. In the US, this type of system is being used to target weeds in organic crops where selectivity is based on height differences between crops and weeds. Weeds taller than the crop can be effectively targeted by the high voltage (>10,000V) electrical weeding systems (Schreier et al. 2022). The GRDC has a current investment with DPIRD investigating the potential use of the Zasso system in Australian agriculture systems (DAW2303-002OPX).

An Australian company, Azaneo (https://azaneo.au), is pursuing a more novel and precise approach to electrical weeding. Preliminary studies with their low powered, pulsed electrical weeding system have demonstrated high efficacy at very low power output (<3.0W) on broadleaf and grass weed seedlings in pot and field studies. This technology is being progressed towards achieving in-crop control through selective targeting of weed plants.

Weed recognition technologies

The opportunity to specifically target weeds with control treatments is driving considerable research activities and commercial developments. There is a substantial USDA-funded effort lead by Texas A&M University, on the development of an open-source database of annotated and classified images of major cropping weeds. They have focussed efforts on the major weeds of corn and soybeans, Palmer amaranth and water hemp. Weed image data is being collected from both in-field and pot-grown scenarios, enabling the combined use of real world and synthetic data for training dataset development. The general goal for this research is to provide high quality image data for the entire weed control industry. This image data is being used for refined software development, such as weed growing point detection which enables accurate plant recognition despite high occlusion levels (for example, 50%). Hardware-based research includes the evaluation of 3D camera systems for the collection of whole of plant data.

Evaluation of gametocides to prevent weed seed production

Gametocides are frequently used to control crossing in the hybrid seed production industry where gametocides act to prevent pollination from treated plants. A range of chemicals, including some herbicides, are routinely used as gametocides and several of these are now being considered for use in preventing the seed production in weed species. Targeting the pollen production of herbicide resistant plants could be important in preventing the seed production of these plants, as well as the spread of resistance genes to susceptible populations.

Allelopathic weed control and biological nitrification inhibition

The role of crop-produced chemical growth inhibitors (allelochemicals) on weeds has been documented for many crop:weed combinations (Dayan *et al.*, 2010; Kong *et al*., 2011). There has been a considerable research effort aimed at developing an understanding of the weed control potential of crop root exudates (Duke, 2015). Recently, research has identified that allelochemicals produced by some crops also inhibit biological nitrification, leading to the more efficient use of soil available nitrogen. Root exudates of these crops have been shown to inhibit nitrification, the conversion of nitrite to nitrate, which contributes to nitrogen loses through NO3- leaching and N2O emissions. The production of secondary metabolites in crop root exudates have the potential to negatively impact weed growth, as well as reduce soil nitrogen losses.

Conclusion

There are several exciting new areas of weed research and weed control being developed in the US. These new approaches are in various stages of development and commercialization. These new technologies present the Australia grains industry opportunities to test and advance weed control in Australian cropping system.

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Contact details

Michael Walsh
Gulbali Institute for Agriculture, Water and Environment
Charles Sturt University
Wagga Wagga
Ph: 0448 847 272

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