"Finding alternative solutions to fungicides, such as the use of stubble to elevate the canopy and limit disease spread, could be invaluable to pea production," Sarita said.

"It's a simple and cost-effective method for growers to adopt by using equipment and resources that most would already have at their disposal."

CCDM pulse researcher Rob Lee, who assisted in the study, said the solution would potentially allow growers to fully realise the yield benefits of an earlier sowing date while reducing disease by keeping the plants off the ground.

"Although early-sown trellised crops would be heavier and prone to some lodging late in the season, adoption of stubble trellising could still improve harvestability over non-trellised crops that have reduced biomass due to disease," Rob said. "We look forward to testing this on a broader scale."

In an earlier trial in 2016, the research team looked into the impact of nine different fungicide treatments at two times of sowing to determine the best timing and mode of action for controlling Ascochyta blight in field peas.

They found that time of sowing had a greater impact on reducing disease levels (that were lower in the later time of sowing) than the use of fungicide treatments, but the shorter season brought about by late sowing limited the yield potential for the crop.

Field pea losses to disease are estimated to cost around $23.7 million annually, which equates to $73.35 per hectare.

Growers who adopt the stubble method are encouraged to share their experiences, whether positive or negative, by emailing ccdm@curtin.edu.au.

Sarita presented the field pea research at the 19th Australian Agronomy Conference 2019 in Wagga Wagga in August . ■

Recent field pea research has been led by CCDM researchers Dr Sarita Bennett and Dr Rob Lee. (PHOTO: CCDM)

Crop assessment project proves drone accuracy

By Andrew Spence

DRONES have proven to be just as accurate at taking plant measurements as more hands-on traditional methods, paving the way for a range of agricultural applications.

A two-year University of Adelaide project funded by the South Australian Grain Industry Trust used drone imagery to measure biomass, growth rate and greenness at trial sites in the wheat belt of South Australia.

Not only did the measurements correlate with physically collected results but data was able to be gathered more regularly because the drones are more efficient than manual techniques.

The ability for drones to potentially replace labour-intensive farming tasks has been known for some time. But the previous high cost of drone technology and doubts about the accuracy of the data they captured, have held them back from widespread use in agriculture.

University of Adelaide Agricultural Scientist and Researcher Dr Rhiannon Schilling and Dr Ramesh Raja Segaran from the university's Unmanned Research Aircraft Facility worked together on the project, which began in 2017 and finished in July this year.

The project used drones to capture aerial images of the GRDC-NVT wheat trial sites every few weeks during the five growth stages from early tillering through to late grain ripening.

Rhiannon said the more efficient use of drones not only allowed for data to be gathered more regularly but also avoided the destructive practice of physically taking biomass samples.

"At the moment when you try and measure biomass throughout the season, every biomass cut we take is reducing the grain yield from the plot so we want to minimise that," she said.

"It's really fast to go out and image our sites using a drone – within half an hour we can have our site imaged and the data processed in a few hours back at the university – so it's going to speed up the process.

"Because biomass cuts are so time intensive they were only being done at one or two time points in the growing season. Now we can watch the plant growth rate through time in the field throughout the whole season so it's a lot more informative."

Rhiannon said the technology could improve crop research capabilities and offer more efficient methods for plant breeders and pre-breeding researchers and growers.

Drones and new opportunities

She said that while the project focused only on the biomass, growth rate and greenness of trial wheat crops, the confirmation of drone accuracy opened up many opportunities in other areas.

"What we've done here is we've been able to show that we can measure crop growth through time," Rhiannon said.

"In terms of this project, farmers should be able to use this method to assess the amount of biomass for something like hay production but also assess responses through time.

"So looking at grazing pressure or assessing the effect fertiliser had on the growth rate of your crop or pasture – this is where this sort of technology is going."

To take the bulk of the images, the project used a standard DJI Phantom 4 drone, which is available to farmers and comes fitted with a good quality RGB camera for about $2000.

Rhiannon said the quality and affordability of sensing equipment that could be added to drones was also constantly improving.

She said more fine-tuning was needed to maximise the value extracted from drone images including overlapping them with data collected from soil and satellite imagery.

"We should be able to put all the layers together now and we've been starting to work with some machine-learning experts to do that," Rhiannon said.

"Drones have been around for a long time but I don't think they've been used to their full potential yet. One of the limitations has been that until now we didn't know if what they measure is actually accurate and that's what this project has achieved." ■

The project found that drone measurements are accurate.

A widely available DJ Phantom 4 drone was used to capture the majority of imagery during the trial.

The drone images were analysed at the University of Adelaide to produce the crop growth data.

Turning Australia's arid land into green pasture

MILLIONS of hectares of sandy, low fertility Australian farmland could benefit from the commercialisation of a South African shrub, allowing farmers and graziers to better carry sheep over the summer-autumn period.

Researchers at Murdoch University's Centre for Rhizobium Studies have undertaken a decade-long global search for legume plants capable of surviving harsh, dry summers and sandy soils.

They discovered lebeckia, a perennial legume, in the Western Cape of South Africa and commenced trials on the poorest sandplain soils of the Western Australian wheatbelt.

Lead researcher Professor John Howieson said lebeckia was designed to be used by farmers on soils that may otherwise be completely unproductive.

"Lebeckia has real potential to turn as much as three million hectares of Australia's marginal farming lands into much more productive country, where its presence in pasture over summer could allow farmers to carry more sheep, grow more wool and provide better animal husbandry," said John.

"We have recorded very promising results in agronomy, soil fertility and feed quality trials.

"It is a long sought after outcome of legume science given its ability to grow during summer on infertile sandy soils."

Worth up to $400 per hectare each year

John said the plant had the potential to create substantial savings for farmers, reducing the need to purchase supplementary feed, and support higher animal stocking rates.

"Economic analysis has shown that using lebeckia on sandy soils could be worth up to $400 per hectare per year to the farmer," he said.

"We think it will be incredibly valuable for farmers who can lamb or wean into it, and provide high-quality feed and shelter."

Murdoch has been working with the South African government to secure full commercialisation rights.

South African Agricultural Research Council President and CEO Dr Shadrack Moephuli said the growing of lebeckia had economic benefits to farmers, especially those with sandy and acid soils.

"Lebeckia is an acid tolerant legume that has been developed by the Agricultural Research Council and Murdoch University from genetic material collected on the acidic soils derived from sandstone in the Western Cape," Shadrack said.

"As cultivation and alien invasion reduces the soil pH, this species can be grown in soils affected by acidification.

"This is another milestone and innovation by the two institutions to assist farmers to produce food for the growing population."

WA Agriculture Minister Alannah MacTiernan recently witnessed the signing of a commercialisation agreement for the new cultivar of lebeckia called Isanti (Chosa for sand) by Murdoch University Deputy Vice Chancellor, Research and Innovation, Professor David Morrison and Shadrack.

Under the agreement, a royalty on seed sales will be paid to the Agricultural Research Council. The new crop will be also made available to South African farmers, meaning farmers in both Australia and Africa will have access to the benefits of this research.

A group of South African scientists and administrators recently visited one of the trial sites at Harrismith in the Wheatbelt region of Western Australia where the first five hectare crops are in the ground.

Lebeckia is a promising legume for sandy soils.

John thanked David Quartermaine and Ted Astbury for their strong support for the lebeckia program by allowing intensive field research on their farms for the past six years.

The research project was funded by Murdoch University, with support from the Australian Centre for International Agricultural Research. The first seed will be available for sale next year.

The South African scientists and administrators visited WA to attend the 9th Annual Africa Australia Research Forum Annual Africa-Australia Research Forum which forms part of the Africa Down Under conference.

The forum is part of the Third Murdoch Commission, a research investigation bringing together international experts and thought leaders to work on pressing problems and issues of public concern to Africa. ■

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Workshops optimising summer weed management

THE breadth of summer weed species present in the Australian grainbelt can make management decisions difficult, yet it is important to identify species early and correctly. This maximises the effectiveness of summer weed control by allowing growers to select appropriate techniques that can be used on small, actively growing weeds.

Andrew Storrie from Agronomo said summer rain often occurred in cropping areas and growers needed to not only identify weed species early, but to 'speak the same language' when referring to them, as common names varied.

"While it is relatively simple to identify weeds when they are flowering, correct identification of seedlings is more challenging," he said.

"Every grower understands that large weeds are harder to control and that in summer, weeds grow faster and can set seed in weeks.

"Large weeds also use more soil water and can cause problems at seeding. Therefore, waiting until identification is easier is not the best option.

"Growers attending the workshops will have the opportunity to identify weeds that are at an early stage of development, using live specimens, and will be shown identification short cuts and handy tools to use."

Andrew will also address how to get good control of summer weeds using 2,4–D, under the regulations relating to this herbicide that were introduced late in 2018.

"Using very coarse or coarser spray quality may require changes to application set-up to maintain efficacy. We will run through how to select the best nozzles for the task and discuss tank mixes for dominant local weed species," he said. "Local innovative weed management practices will be workshopped at each event."

DPIRD representatives will cover results from WA weed surveys in recent years and present specific management programs for common locally-found weeds.

Andrew said that, in addition to information about plant identification, the workshops would cover:

- Best management practices for summer weeds, including presentation of local trial results;
- Maximising spray application coverage when conditions are not ideal;
- The regulations on the use of 2,4–D and how this affects summer spraying;
- How to get the best control and stay within the regulations;
- Understanding how to maintain efficacy using a very coarse or coarser spray quality with 2,4–D tank mix partners; and,
- New technologies for weed management.

Timing of the workshops varies so to register and for more information, go to *https://www.agronomo.com.au/training/*, or contact Andrew on 0428 423 577 or andrew@agronomo.com.au.

For information about how to comply with Australian Pesticides and Veterinary Medicines Authority (APVMA) 2,4–D application requirements, download the GRDC Fact Sheet Maintaining efficacy with larger droplets – new 2,4–D application requirements at *http://bit.ly/2GpWz4h*

SUMMER WEED WORKSHOPS...

Summer weed workshops will be held in various locations including Wagin on October 11, Moora on October 14, Dalwallinu on October 15, and Lake Grace and Narrogin on October 17 – the second in a series of hands-on events in the WA grainbelt.

These workshops have GRDC investment and are the result of GRDC Regional Cropping Solutions Network (RCSN) groups highlighting summer weed control as a high priority issue for grain growers.

Andrew Storrie, of Agronomo, is organising the events, with assistance from Department of Primary Industries and Regional Development (DPIRD) weeds researchers Catherine Borger and Alex Douglas, as well as local grower groups.

Summer weeds such as melon can deplete stored soil water and create problems at seeding time. (PHOTO: Agronomo)

New oaten variety stacks up

KINGBALE, the world's first imiadazolinone (IMI) tolerant hay oat, was launched by InterGrain at South Australia's premier agronomic field day site at Hart on Tuesday, September 17.

Bred by Michael Materne, the IMI hay oat, formerly known by its breeding code GIA1701, was developed by Grains Innovations Australia (GIA) and will be commercialised by InterGrain following a recent agreement with GIA.

According to Michael, Kingbale offered growers a new herbicide option for their oaten hay rotations, while significantly improving weed control.

'Looking over the fence' towards a new variety

"While looking over the fence from our pulse trials, we saw weedy oat crops and quickly learnt that herbicide options were very limited. This presented us with an opportunity to develop IMI herbicide tolerant oats to improve weed control within this crop and the broader rotation.

"Kingbale's imiadazolinone tolerance supports the variety as an excellent option where there are residue concerns from imidazolinone use in previous crops," Michael said.

While yield information is currently limited, 2019 independent industry trials across southern Australia will provide an excellent opportunity for further hay and grain yield testing, while preliminary data at hand is very pleasing.

InterGrain CEO Tress Walmsley said InterGrain and GIA were proud to join with Nufarm to bring innovative herbicide technology systems to market to help Australian farmers overcome challenges in controlling weeds in their oaten hay.

"The Nufarm partnership means InterGrain and GIA can introduce expertise in weed control and further sharpen our focus on innovative solutions that will help solve identified challenges for grain growers.

"InterGrain always prioritises maximising grower returns from the varieties we introduce to them and strategic partnerships can value add that proposition," Tress said.

A tall oat variety, Kingbale has good early vigour and preliminary data shows it has a similar disease profile to Wintaroo.

The perfect fit

Tress said launching Kingbale at the Hart field day was the perfect fit, with South Australia's mid-north a large export oaten hay producer.

"Our new partnership with GIA and the Kingbale launch complements the current wheat and barley varieties we have available to growers and supports our Australia wide market leading cereal breeding programs.

"Kingbale is the first of what we like to call the new oat dynasty, with other lines in the GIA pipeline also set to deliver agronomic and yield benefits that will boost Australian oat and oaten hay production and subsequent profitability for growers," Tress said. ■

Kingbale's breeder Dr Michael Materne and GIA Commercialisation Manager Janine Sounness inspect the new variety at Landmark Manangatang's Victorian trial site.

Manganese deficiency in lupins makes an unwelcome return

LUPIN growers are encouraged to assess their crops for manganese deficiency – a problem which has resurfaced in recent years – particularly in the northern grainbelt of Western Australia.

Narrow-leafed lupins have a poor ability to translocate manganese from the leaves to the grain, resulting in split seed and in some instances substantially reduced yields.

Grains Research and Development Corporation (GRDC) Grower Relations Manager – West, Jo Wheeler, says manganese deficiency has been a 'sleeping issue' since the 1970s when it impacted significantly on yields.

"It has re-emerged as a problem in recent seasons, so growers need to keep an eye on their crops and consider treatment if symptoms of manganese deficiency symptoms are presenting," Jo says.

According to the GRDC's Western Lupin GrowNotes publication (*https://grdc.com.au/GN-Lupin-West*), yield penalties of up to 70 per cent can be incurred as a result of manganese deficiency causing split seed disorder.

The publication states that the incidence and severity of split seed disorder in WA lupin crops will vary according to the maturity of the variety, sowing date, amount of rainfall received during the growing season and soil type.

More prevalent on lighter pH soils

High pH soils (above pH 7) tend to have lower manganese availability to lupin crops than soils with lower pH, and therefore manganese deficiency is more likely to occur in those soils.

Lime application to raise soil pH has been found to induce split seed disorder on some soils in some years in Western Australia.

Common symptoms of manganese deficiency in narrow-leafed lupin crops include:

- Plants with straggly growth and delayed maturity with 're-greening';
- Dropped leaves;
- Re-shoot leaves with a 'tufty-type' growth on branches;
- Seeds split through the seed coat;
- Discoloured seed around the margins;
- Small, shrivelled seed; and,
- Dirty brown patches on leaves.

Jo suggests growers consult with their advisers about testing and treatment if they suspect manganese deficiency.

Main stem analysis of lupin can be used to diagnose any manganese deficiency at flowering.

The Western Lupin GrowNotes publication states that split seed disorder can be treated by applying manganese fertiliser to soil (with rates based on soil type) and/or using sprays on lupin foliage (typically with manganese sulphate or a range of other manganese products).

Foliar applications of about one kg of manganese per hectare in 75–100 litres of water usually corrects the deficiency – if sprayed when pods on the main stem are about 2–2.5 cm in length.

Soil-applied fertiliser has good residual value and can last for several years. Foliar sprays supply manganese only to the target crop in the season of application.

Management of manganese deficiency in WA lupin crops starts with early sowing of early maturing varieties to reduce the risk of split seed developing when seed fills and matures before soil moisture is exhausted in spring.

Jo says testing lupin seed for manganese concentrations can be important when retaining grain for subsequent sowing, as low levels can affect germination and crop establishment.

It is recommended growers use seed for sowing from lupin crop areas that have had an application of manganese or from better soil types that have a history of producing lupin seed with good manganese levels.

More information about manganese deficiency in narrow-leafed lupins, and how to monitor and manage the issue, can also be found on the Department of Primary Industries and Regional Development website at *http://bit.ly/2XNcu4b*

Symptoms of manganese deficiency in narrow-leafed lupin pods. (PHOTO: Nigel Wilhelm)

NORTHERN FOCUS
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IMI-tolerant sorghum and concerns related to shattercane

By Gulshan Mahajan[1] and Bhagirath Chauhan[1]

AT A GLANCE...

- Introduction of imidazolinone (IMI)-tolerant sorghum technology in Australia has provided an opportunity for a wide spectrum of weed control in this valuable summer crop.
- But it could increase the risk of gene flow for herbicide-resistant traits from sorghum to closely-related weed species such as shattercane, if not carefully managed.
- To reduce the risk of outcrossing and survival of weed-crop hybrids, IMI-tolerant sorghum systems must be integrated with stewardship guidelines.
- Research is needed to address issues concerning outcrossing for herbicide-resistant traits and fine-tuning of IMI-tolerant sorghum technology, including stewardship guidelines.

SHATTERCANE (*Sorghum bicolor*) is a troublesome annual weed in sorghum and can significantly reduce crop yield. It is de-domesticated sorghum with similarities to grain sorghum. Shattercane competes greatly for sorghum's growth resources (light, nutrients and water) and it is difficult to identify this weed plant in a sorghum crop at an early stage. It resembles forage sorghum, having waxy leaves, and reaches to a height of 1.5–2.5 metres at maturity.

Shattercane seeds are egg-shaped, a little bit smaller than sorghum seeds, shiny and of black to deep reddish-purple colour. The seed head of shattercane is loose and seeds tend to shatter easily. The shattercane plant can produce more than 2000 seeds per panicle, indicating its high reproduction potential. In addition, seeds have variable dormancy, allowing them to germinate over a long time period.

Chemical control of shattercane in conventional sorghum is very difficult as sorghum and shattercane are the same species.

Introduction of IMI-tolerant sorghum

Recently, imidazolinone (IMI)-tolerant sorghum was introduced in Australia. No doubt, it provides a great opportunity for a broad spectrum of weed control – including shattercane – in sorghum with the use of IMI herbicides such as Intervix. But widespread use of IMI-tolerant sorghum technology in the future could cause serious concerns due to high selection pressure on shattercane and other weed species.

IMI-tolerant sorghum could also result in uncontrolled movement of pollen containing herbicide-resistant genes, also known as gene flow/escape. Evidence of gene flow has already been reported in the US, where herbicide-resistant genes from IMI-tolerant wheat was naturally transferred to goatgrass (*Aegilops cylindrica*) and now herbicide-resistant biotypes of goatgrass is a serious problem. The probability of gene flow or escape is greater when the plant species are closely related because of the high possibility for cross-pollination.

This US experience underlines the risk of gene flow for herbicide-resistant traits from sorghum to shattercane while using IMI-tolerant sorghum technology in Australia.

Proper use of herbicide-tolerant technology – that is, the right dose at the right time – as a part of integrated weed management, is essential if we are to extract the maximum benefit of this technology. This research was conducted to optimise the dose and application timing of Intevix for weed control of shattercane while achieving a high yield of IMI-tolerant sorghum.

An Intervix-applied plot of IMI-tolerant sorghum.

Shattercane-infested plot (unsprayed) of sorghum.

FIGURE 1: Effect of Intervix application time (2 and 6-leaf sorghum growth stage) and dose (0, 0.5, 1.0 and 2.0 L per hectare) on shattercane biomass (g/m^2)

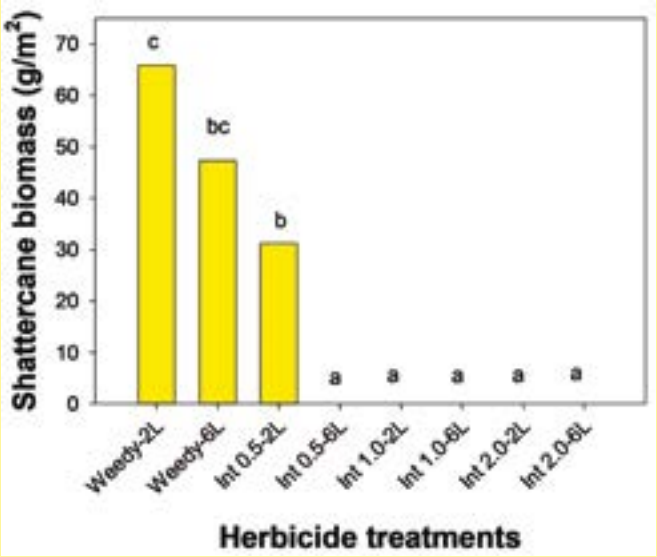
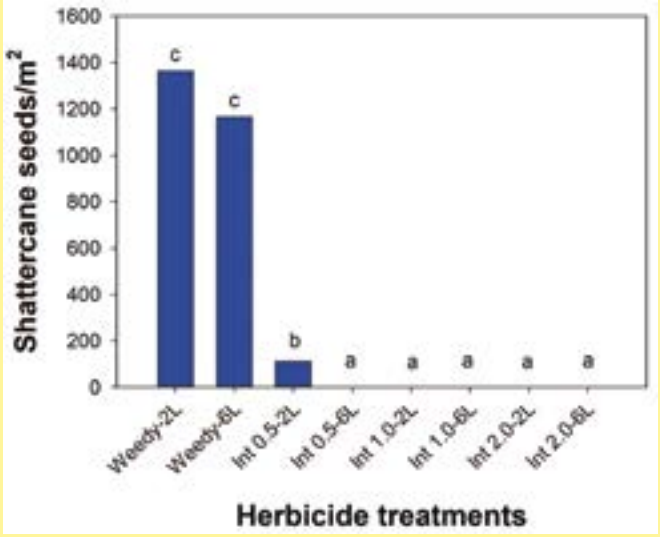


FIGURE 2: Effect of Intervix application time (2 and 6-leaf sorghum growth stage) and dose (0, 0.5, 1.0 and 2.0 L per hectare) on shattercane seed production (seeds/m^2)



How the research was done

A trial was conducted in 2018–19 at the Gatton research farm of the University of Queensland to evaluate the dose and time of application of Intervix (33 g/L imazamox plus 15 g/L imazapyr) in IMI-tolerant sorghum.

The experiment was conducted in a randomised block design (in a factorial arrangement) comprised of eight treatments: Two application timings (2 and 6-leaf stage of sorghum) and four herbicide treatments (non-treated weedy, Intervix at 0.5 L per hectare, Intervix at 1.0 L per hectare and Intervix at 2.0 L per hectare). There were three replications of each treatment. Hasten at one per cent was used with Intervix.

The crop was planted with a tractor-mounted planter on December 4, 2018 using an IMI-tolerant sorghum cultivar 'Elite Sentinel IG' at a row spacing of 70 cm and a density of 10 plants per square metre. Intervix was applied using a CO_2-pressurised backpack sprayer equipped with flat-fan nozzles delivering a water volume of 160 litres per hectare at the 2 and 6-leaf stages of the crop in the respective plots.

Shattercane in the non-treated (weedy) plot at maturity.

Shattercane biomass and seed production were determined before desiccation of the crop using a quadrat (50 cm by 50 cm) placed randomly at two locations in each plot. Samples were collected by cutting weeds at the ground level and dried in an oven at 70°C for 72 hours.

The harvested area for grain yield was 9.8 m^2 and the grain yield from the harvested area was converted to kg per hectare at 12 per cent moisture content.

What we found

Results revealed that the plots treated with Intervix at 1.0 and 2.0 L per hectare provided complete control of shattercane (Figure 1). Shattercane plants survived in only those plots that were treated with Intervix at 0.5 L per hectare at the 2-leaf stage.

This treatment had 47 per cent shattercane biomass of the non-treated control treatment. This treatment also produced 110 shattercane seeds per square metre (Figure 2).

The season-long weedy plots produced the lowest yield (0.4 tonnes per hectare) among all weed control treatments (Figure 3). Averaged over the leaf stage treatment, plots treated with Intervix at 0.5, 1.0 and 2.0 L per hectare gave 3.9, 6.5 and 7.8 times higher yield, respectively, as compared with the weedy plot.

Plots treated with Intervix at 1.0 and 2.0 L per hectare had similar yields, but yield in these plots was higher than the plots treated with Intervix at 0.5 L per hectare.

Stink grass (*Eragrostis cilianensis*) and black pigweed (*Trianthema portulacastrum*) were also present in the weedy plots (data not shown). Intervix provided good control of these weeds at 2.0 L per hectare but proved inferior at lower doses (0.5–1.0 L per hectare). Therefore, the yield loss of sorghum grains was not only due to shattercane but also due to other weed species.

To sum up

This trial suggests that the infestation of shattercane (and other weeds) significantly reduced sorghum grain yield. The post-emergence application of Intervix at 1.0 and 2.0 L per hectare provided complete control of shattercane and resulted in seven to eight times higher yield as compared with the weedy plots.

The results also suggest that shattercane plants could survive