Monitoring barley grass in broad acre paddocks

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Location
Minnipa and Heddle's
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2018 Total: 268 mm
2018 GSR: 208 mm
Soil Type
Red loam
Plot Size
Paddock monitoring
Location
Yaninee
2018 Total: 181 mm
2018 GSR: 156 mm
Soil Type
Red loam
Plot Size
Paddock monitoring

Key messages

- **UAV imagery with skilled specialist analysis and programs has the potential to identify and map weed issues in paddocks.**
- **Grass weed patches are easier to identify in legume and pasture crops than cereal crops.**
- **Variability in germination and crop growth makes it harder to identify grass weed areas.**
- **Data capture and analysis for analytical purposes such as grass weed mapping in individual paddocks will be beyond the skills of most farm businesses unless farmers have a special interest in this area.**
- **Group A resistant barley grass has once again been detected at the Minnipa Agricultural Centre. Barley grass resistance to Group A herbicides has been detected three times in three years, so be aware it is present in current farming systems.**

Why do the trial?

Barley grass continues to be a major grass weed in cereal cropping regions on upper Eyre Peninsula (EP). The use of unmanned aerial vehicle (UAV) technology to identify and assess barley grass populations in paddocks and monitor potential resistant populations may be a useful tool for farmers. Barley grass weed density was monitored in three paddocks on upper EP (Minnipa Agricultural Centre (MAC), Heddle's at Minnipa and Wilkins' at Yaninee using an UAV during the 2017 (EPFS Summary 2017, p 83) and 2018 growing seasons at three different timings, with paddock transects conducted to verify grass weed density in paddocks.

How was it done?

In-crop paddock monitoring for grass weed populations

Grass weeds were assessed in crop or pasture at eight paddock-marked GPS points, and in 2018 also marked in the paddock with a large corflute sign visible in the imagery, with six or more counts taken at each sample point and each timing during the season. This was used to verify the UAV data captured at three times during the cropping season. Extra sampling points in the paddock were targeted if more information was needed to verify the imagery. The paddock photos were captured on an iPad with 'Avenza Maps' linked to the location in the paddock.

In 2018, grass weed assessments were undertaken on:

- Heddle's (sown early with barley and wheat) 13 July, 21 August, 14 September.
- MAC (vetch) 9 August, 14 September, 18 October.
- Yaninee (late sown wheat to allow grass control) 9 August, 17 September, 18 October.

UAV imagery

UAV data were captured three times in each paddock during the 2018 cropping season. The UAVs used were either a DJI Matrice 100 with both NIR and RGB sensors or a Mavic Pro with RGB sensors. In 2018 the UAVs were flown at a height of 120 metres and a smaller 10 ha area at 50 metres to increase the detail of the information captured.

Training features were created which highlighted areas of high weed infestation within the image. These areas are identified by matching photos from the ground with the aerial imagery. Originally, training features also aimed to identify other features such as clean crop areas, but the training process was found to be more accurate when a single type of weed pixel was the focus of analysis. This currently needs to be done separately for each image flown, which is a labour intensive process.

Data analysis of UAV imagery

To analyse weed locations at a whole paddock level using the UAV imagery, geospatial analysis tools were used to automate the selection of likely weed infestation areas. A map of the paddock with the UAV coverage was generated from ArcGIS Desktop as a geo-pdf to enable collection and analysis of field data.

This is a map file which can be used in a range of devices. With this file loaded to the 'Avenza Maps' app on a tablet, photos and comments with GPS locations were collected. This data was then added to ArcGIS and used to interpret the UAV mapping.

The Spatial Analyst extension within ESRI's ArcGIS Desktop software was used to carry out a 'Maximum Likelihood' spatial classification. This classification uses small parts of the image selected by the user as 'training features' for deciding which category each pixel of the image most likely fits into. This classification method is based entirely on the spectral (colours through different bands of light) characteristics of the imagery. Training features were created which highlighted areas of high weeds, low weeds/crop features and bare ground.

What happened?

In 2018 the paddocks monitored were two cereal crops and one vetch. Heddle's at Minnipa Hill was sown on 7 May with Scope barley at 50 kg/ha with 60 kg/ha of 18:20:0:0 (DAP) on the outside with six seeder widths to increase grass weed competition with weeds captured in the chaff dumps, which are dropped in the outer areas of the paddock. The remainder of the paddock, and the larger area, was sown with Mace wheat at 60 kg/ha with 60 kg/ha of 18:20:0:0.

Wilkins' paddock at Yaninee was sown on 16 June after a cultivation and grass weed germination with Mace wheat and 18:20:0:0, both at 60 kg/ha, and pre-emergent herbicides of 1 L/ha Treflan and 800 ml/ha Ultramax. Post emergent herbicides Ester 680 @ 400 ml/ha and ZMC @ 3 L/ha were applied on 18 August.

MAC paddock S4 was sown with Volga vetch @ 40 kg/ha on 4 May with 40 kg/ha Granulock Z and Metribuzin @ 100 g/ha and Diuron @ 400 g/ha. The paddock was sprayed with 150 ml/ha of Targa Bolt and Uptake @ 500 ml/ha on 10 August for grass weeds. Circular barley grass patches were still present in the paddock so the western corner of the paddock was cut for hay on 27 September. The vetch averaged 81 plants/m^2, with 132 barley grass weeds/m^2 and 11 ryegrass weeds/m^2 on 9 August, before grass weed control. In the general paddock there were 21 barley grass weeds/m^2 on 14 September after spraying, with visual circular patches of barley grass with an average of 212 barley grass weeds/m^2.

At Minnipa the 2018 growing season rainfall was 208 mm, decile 3 (below average), with small rain events in April and May, 30 mm in June and July, with August finally having good rains totalling 89 mm. There was variable germination in early sown paddocks and minimal growth and dry matter in paddocks until mid-August. Very little rainfall occurred in September, but 33 mm in October and mild grain filling conditions were followed by rain events during harvest.

UAV flights were conducted on the dates shown in Table 1. Wilkins' paddock was sown and established late and had very few grass weeds to monitor, so only two flights were undertaken in this paddock, three flights at MAC and four flights at Heddle's during the 2018 season.

Early season growth in paddocks was low, especially in later sown crops and dry matter (DM) only increased in mid-August. In Heddle's paddock (Images 1, 2 and 3), differences in early moisture stress and plant establishment resulted in large differences in dry matter by 21 August (average of 0.24 t/ha DM, with a maximum of 1.06 t/ha DM). Differences in crop growth may be an important factor in the changing of crop coloration (Image 3).

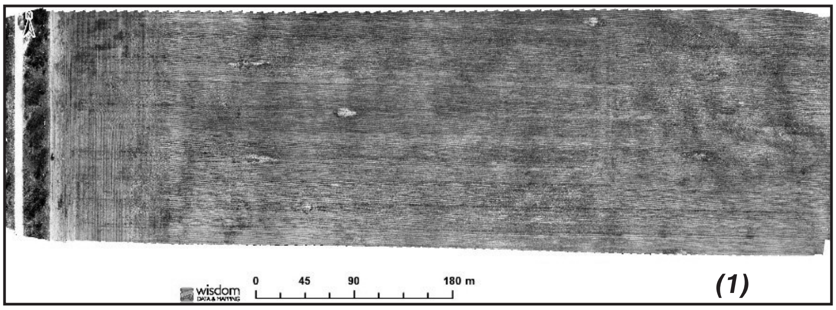
In 2018 higher and lower UAV flights were trialled so a smaller area at higher resolution with more detail was captured to use as a training data source for the image flown at higher altitude. The training data created from the lower flight didn't seem to detect grass weeds any better when used in an analysis process run against the larger image. It is possible the camera slightly changed the exposure due to different light levels, even though they were flown on the same day. The image is also at lower resolution so the pixels would be different. Flying at different heights to add more detail to the analysis will be tested again in 2019. Satellite imagery may be another way to extend the area of the analysis, however no satellite imagery with a resolution below 10 m could be cost effectively sourced and this option was not pursued in 2018.

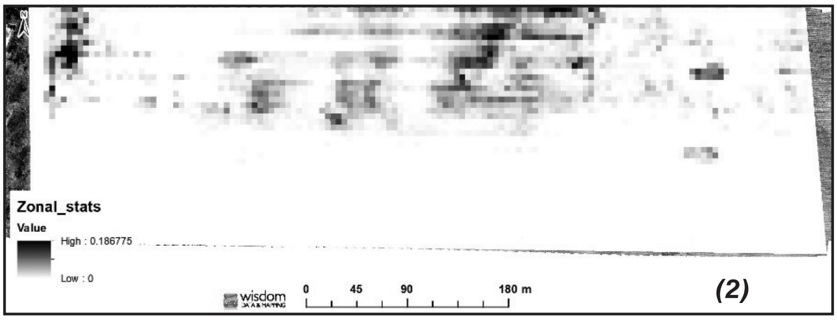
The MAC S4 paddock in vetch, which has previously shown resistance to Group A herbicides, had large areas of barley grass weed patches survive chemical applications, and some smaller circular patches in the southern end (Image 6). This paddock is again being tested for herbicide resistance to confirm Group A resistance in barley grass.

A comparison of the 2017 and 2018 weed map area in MAC S4 for the western half of the paddock was made (Image 4 and 5). Some similarities in occurrence patterns were observed, but differences in crops sown (barley in 2017 and vetch in 2018) may also have had an impact. The vetch crop in 2018 may have been less competitive with weeds, or it is much easier to detect grass weeds in legume and pasture crops than cereal crops. The area of heaviest weed growth in the 2017 imagery was cut for vetch hay in the 2018 image, indicating the area is likely to have been higher in weeds in both seasons.

Table 1 UAV image capture flights conducted in 2018

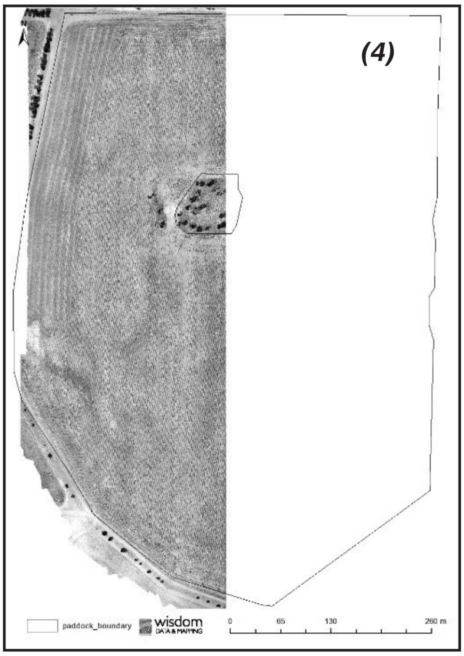
Heddle's	20 July	21 August	12 September	18 October
MAC S4		13 August	12 September	18 October
Wilkins			12 September	18 October





(3)

Image 1 and 2 Heddle's crop image flown on 12 July 2018 and weed areas detected from the analysis. Image 3 Photo of differences in crop growth at Heddle's in July 2018 due to germination and moisture stress.



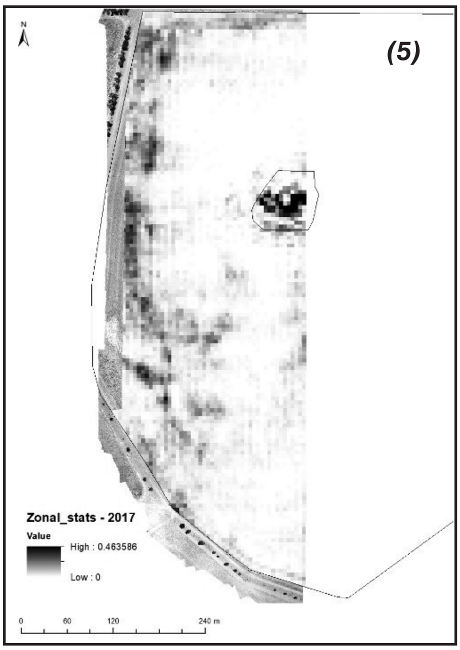


Image 4 and 5 MAC S4 paddock in 2018 and the barley grass weed density map. Image 6 Photo of Group A resistant barley grass patches, September 2018

Wilkins' paddock was sown late to enable effective grass weed control with cultivation prior to sowing, and the flight analysis found this to be a 'clean' (almost grass free) paddock, which was reflected by in-paddock grass weed counts. At this site the changing light conditions (cloud cover) as the flight was in progress in September resulted in variability in exposure on the image which made the analysis less accurate.

What does this mean?

UAV imagery may provide an opportunity to assist in targeted grass weed management. Current UAV technology is cheap to purchase and has high resolution. However the time and effort of collecting data over large paddock areas, and the expertise required for analysing the data, and variable image quality, may limit the adoption by farmers unless they personally have the time or the interest to acquire these skills, are willing to pay to acquire the data capture and analysis (approximately $6,000 per paddock), or if a cheap and easy to use analysis method or program becomes available.

In 2018 the UAV flights captured data over a smaller area at half the usual height to provide a higher resolution strip, which was used for more accurate analysis within this smaller area of the paddock. Higher resolution imagery allows 'cleaner' weed pixels (those which include less dirt, stubble or crop) to be selected when training the image classification process. With a higher resolution image the classification process will also encounter a higher percentage of 'cleaner' weed pixels, which improves the classification output. It is also possible to check the analysis results and see what is being identified because the inter-row areas can be selected from the crop. This process of analysis is looking to identify weed infestation trends to guide variable rate application and identify areas of the paddock needing ongoing grass weed monitoring.

Acquiring a full paddock analysis but using the information from the smaller area to predict the whole paddock and other paddocks on the same farm is required before the technology will be adopted by farmers on a broad scale. This research is ongoing for the 2019 season so more information and knowledge will be generated about the use of imagery and data collection for weed management in current farming systems.

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