Weed mapping using drones for targeted weed spraying

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Key words

weed mapping, drones, spot spraying, weed management, chemical saving

Take home messages

- Weed maps are a significant tool in the fight against herbicide resistance, reducing the requirements for cultivation hence reducing farming carbon footprint
- Weed mapping using drones is now commercially available at significantly lower costs than conventional sprayer mounted optical spot sprayers
- Weed maps can be produced at rates of up to 250 ha/hr that can then be loaded into conventional sprayers to be used as spot sprayers
- Weed maps from drones allow for selecting weeds based on size as well as calculating the spray area prior to spraying which is the next step forward in selective spot spraying – know what to spray before you spray
- **Knowing what to spray before you spray allows for informed decisions maximising chemical efficacy and minimising spray costs resulting in cheaper, more effective weed control.**

Background

Drone-based weed mapping involves using a drone equipped with cameras or sensors to fly over a field and collect data on the location and size of weeds. The drone can be programmed to fly a predetermined flight pattern over the field, taking images at high frequency time intervals to ensure complete coverage and adequate resolution. The images and data are then processed to identify the location and size of the weeds in the mapped area, which is then converted, typically, into a prescription map. The map is then loaded into a spray rig display which turns on the individual spray sections to only spray the weeds in a spot spraying pattern across the field.

In this approach the mapping is completed prior to the critical spray timing windows and is not constrained by dust while stubble interference is minimal. The spray rigs can use standard spray nozzles (i.e. AI nozzles) to meet label requirements, can spray at full recommended speed and the capital outlay is lower than many fixed camera boom based spraying technologies. Drone-based weed mapping allows the location and size of the weeds to be identified and this enables the area to be sprayed to be calculated prior to spraying as well as options to filter based on weed size and spray area (radius) around the weeds. This is a very powerful tool and how this can be leveraged to optimise cost savings and maximise chemical efficacy will be explored in the rest of this paper. The technology described here does not distinguish weeds species from crop species unless there is a clear size difference where the weed is much larger than the crop, consequently the technology described here is mostly applied to fallow scenarios with some exceptions. The scenarios below are examples of completed weed maps and the advantages they offer in weed control.

Fallow situation with dual line spraying with one blanket spray line and one spot spray line

Situation

A winter fallow spray event in July 2022, near Coonamble NSW, with fresh weed germination (small weeds) after a rain event and advanced milk thistle (*Sonchus oleraceus*) that were randomly distributed across the paddock. Conventional spray application would require a blanket spray of glyphosate @ 2.2L/ha and mixing partner costing $42.40/ha which would be enough to target milk thistle as well as eliminate the smaller weeds, however if only the small germinating weeds were targeted, the chemical rates required to treat the weeds in the paddock would be significantly less. In this situation, this paddock would not be economically viable for conventional spot spraying (i.e., broom spray mounted camera with live weed recognition) due to the high density of small weeds that the conventional spot spraying systems would spray.

Drone weed mapping

The field was mapped using the Single Shot® drone weed mapping system with a coverage rate of 200ha/hr at a cost of $1.30/ha. The data was analysed using the inbuilt tools at various weed diameters to determine spot spray areas as per Figure 1.

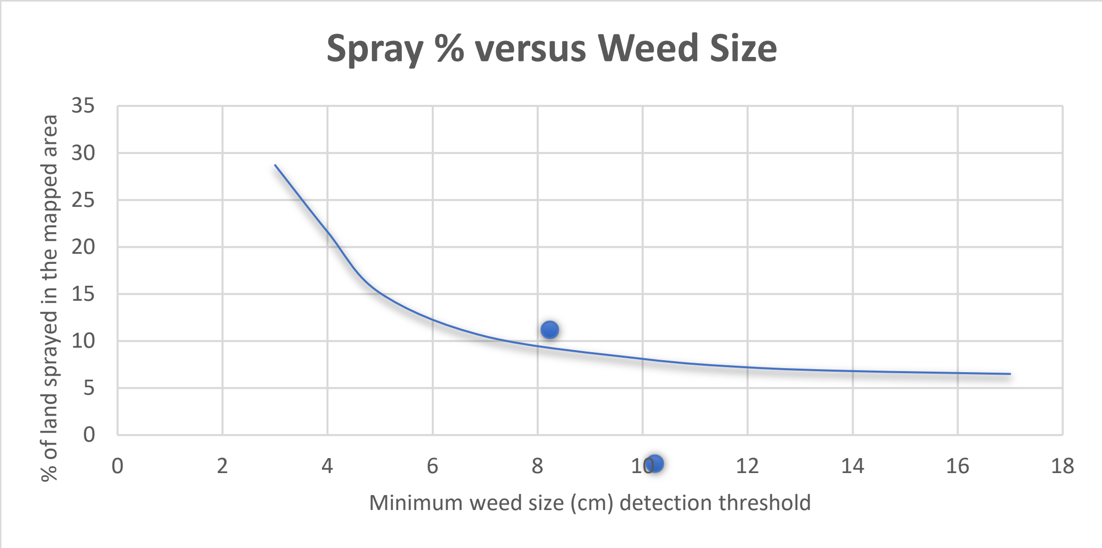

Figure 1. The estimated percent of land sprayed (y axis) in the mapped area as impacted by weed size (x axis). The smaller the weed size detection limit - the larger the land area that requires spraying.

The key observations from the graph are:

- Spot spraying milk thistle which had a diameter of 15cm or larger results in ~7% of the land area (done mapped area) being spot spray however;
- Reducing the minimum weed size threshold from 15 to 7cm results in the % of land sprayed in the mapped area increasing from 7 to 11%, meaning a greater number of weeds could be targeted with higher chemical usage without a dramatic cost increase,
- The drone mapping system has a minimum weed detection size of 3-4cm and size detection can be used to inform when it's most appropriate to move to a blanket application. For example, where the weed size detection limit is change by 1 cm (e.g. from 4 down to 3 cm detection) and the % of land sprayed in the mapped area increases significantly (e.g. >5% per cm of weed), ground truthing with paddock inspection would be necessary to identify if blanket application was the best approach.

Solution

A blanket spray at 1.4L/ha glyphosate and mixing partner in spray line one, plus an additional spot spray in spray line 2 at 1.4L/ha glyphosate, and mixing partner as a spot spray rate on the weeds 7cm and greater. It should be noted that a higher chemical rate used on milk thistle did not significantly increase the overall cost, but the efficacy on milk thistle was significantly increased. This approach resulted in a saving of $13.40/ha as well as a much more successful control of milk thistle. This analysis and decision making was all made prior to any spraying and would not be possible without the ability to both calculate spray areas, spray volume as well as selectively targeting different sized weeds.

Green-on-green using size differences mapped by drone

Situation

Feathertop Rhodes grass (*Chloris virgata*) was growing in a wheat crop (Figure 2) after being unsuccessfully controlled prior to planting. There is no current in crop treatment available, with the typical treatment being an application of appropriate pre-emergent herbicides post-harvest as well as higher cost knock down herbicides applied during fallow periods.

Figure 2. feathertop Rhodes grass in wheat

Drone weed mapping

The field was mapped using the Single Shot® drone weed mapping system with a coverage rate of 200ha/hr at a cost of $1.30/ha. By using a minimum weed size detection diameter of 7cm, the wheat was removed from the weed map leaving just the feathertop Rhodes grass (FTR) displayed on the map. By itself, this isn't particularly useful as the FTR will have matured and seeded by the time of mapping. The advantage in this situation is that the software also includes the ability to set a radius around each plant as a target zone which is part of a necessary solution.

Solution

A radius around each FTR plant was estimated to cover the likely seed rain area around FTR plants. This assisted the targeting of a pre-emergent herbicide applied post-harvest to control seed banks in these limited areas, killing FTR seedlings as they emerged and significantly reducing chemical usage. This strategy also reduces the risk level associated with herbicide residue impacts on future crops. Maps can be kept and used in later years for additional targeted pre-emergent applications as well as a useful forensic tool to determine the effectiveness of the control methods used. Additionally, a knock down can be used to target the existing plants if a registered option is available.

Of note in this example, is that there was an ideal time for weed detection (early crop development) and an ideal time for weed treatment (post-harvest) and they were vastly different. This process can also be applied to weeds that do have selective herbicides available, for instance marshmallow in wheat. Detection can be at an early stage of the wheat development, (e.g. similar to Figure 2), and then treatment can be at a later date to comply with the label and minimise crop damage.

Combine drone weed maps with other spatial data

Situation

A field with areas of black and red soil was due to be sprayed in November prior to sorghum planting which contained low levels of windmill grass and fleabane amongst other more easily controlled weeds. When inspecting the paddock, it was noted that the windmill grass was almost exclusively present in the red soil areas of the field while fleabane and other weeds were distributed across the paddock (both soil colours). Typical application would be to either blanket or spot spray to control both the windmill grass, fleabane and other weeds throughout the whole paddock, with products and rates determined by the harder to control weeds.

Drone weed mapping

The field was mapped using the Single Shot® drone weed mapping system and processed using a minimum weed diameter of 7cm and the weed map was then loaded into Google Earth® (Figure 3). The different soil types can clearly be seen. The processing software was used to draw polygons to only output weed maps in the red soil area and calculate the spray area for the selected polygon. This feature is normally used to define fields (field boundaries) but can also be used to define other areas (see Figure 3 example).

Figure 3. Google Earth® overlaid with weed locations (small yellow atches) and red soil area enclosed in the polygon. Windmill grass was confined to the red soil area. Other weeds were distributed across both soil types in the paddock.

Solution

The field was segmented as per Figure 3 with the polygon enclosed area (red soil) only sprayed with the herbicides needed to target the windmill grass. Then the entire field was spot sprayed in a second application with a broad-spectrum knockdown herbicide. Segmenting the field allowed for targeted chemistry to control the windmill grass which substantially reduced cost, as these higher cost herbicides were only applied to that portion of the field where windmill grass was a problem (polygon area).

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