Factsheet 22/13 Projects FV 307 and FV 307a

Field Vegetables

Spot spraying weeds in horticultural crops

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A new system has been developed where weeds within a crop are detected using image analysis and specialised nozzles are then used to apply herbicides directly to the detected weeds (Figure 1). Commercial versions of such machines are now being developed and are likely to be available from the spring of 2014. This factsheet gives an overview of the technology and helps growers understand how to use it.

Action points

- Use the recently developed automated spot herbicide application technology to control large weeds in horticultural row crops where selective herbicide options are limited, will give poor control or there is a risk of damaging the crop.
- The technology can be used to apply a range of herbicide formulations, though best results have been obtained with glyphosate.
- An Extension of Authorisation for Minor Uses (EAMU) is available for the spot application of two commercial formulations of glyphosate to control large weeds in a wide range of vegetable crops and must be referred to when using glyphosate based spot treatment strategies.
- The utilisation of spot application equipment can be increased by using it for other applications, such as those based on guided precision band spraying.

1. The new herbicide spot sprayer system developed in HDC HortLink project FV 307a

Background

Changes to the approvals of herbicides have reduced the availability of products, such that in many vegetable crops, the options for controlling weeds by overall application of selective herbicides are now very limited. Control of such weeds is important because of the implications for crop yield, uniformity and quality and also because, in the case of volunteer potatoes, a lack of control can represent a rotational bridge for diseases such as blight. A horticulture LINK project (FV 307a) has successfully developed the technology to detect and spray individual or patches of weeds within the crop.

Machine features

In principle, a spot spray bar could be added to any tool frame. However, in practice, it is cost effective to combine spot spraying with a band sprayer as the requirements for a frame are similar and the guidance system can be shared. Figure 2 shows a typical spot/band sprayer configuration featuring a disc steered frame with automatic levelling to stabilise both camera and nozzle positions. This example spans three beds and so three cameras are required to view the full width. These cameras are connected to an implement mounted computer module that detects weeds and controls both nozzles and implement functions. A console is mounted in the cab to display live video images and graphical representations of machine performance. The same software can be used for band or spot spraying and will be familiar to users of Garfords Robocrop as it shares many features.

Nozzle technology

Accurate spot targeting requires the generation of relatively large spray droplets from a nozzle that can be turned on and off very rapidly so as to facilitate precise application to the target and the minimum contamination of surrounding crop plants. Special nozzles (eg “Alternator” by Hypro EU Ltd) have been developed for spot application, producing sprays that are much coarser than other agricultural nozzles, including those used for liquid fertiliser application. Fortunately, such sprays provide sufficient coverage to give good control with large broadleaf weed targets. Nozzles are run at a low pressure (0.5 - 1.0 bar) so as to reduce droplet velocities and the risk of splash. A narrow footprint, typically 12cm, from these nozzles, coupled with a modest forward speed (4 - 5kph) requires low flow rates necessitating relatively small (approximately 0.5mm) orifices. As a consequence, fine filters (eg 200 mesh) are required and special attention should be made to the cleanliness of spray liquid mix.

Spray tank

The low overall application volumes (typically 2.0 L/ha based on spraying 1% of field area) required for spot spraying make it possible to mount a small spot spray tank on the frame thus minimising pipe lengths, contamination risk and washing out operations. Band spraying requires much higher volumes making it more convenient for that tank to be rear mounted.

2. A hooded band sprayer equipped with a spot spray bar and three cameras

Machine set up

Machine settings broadly fall into two categories:

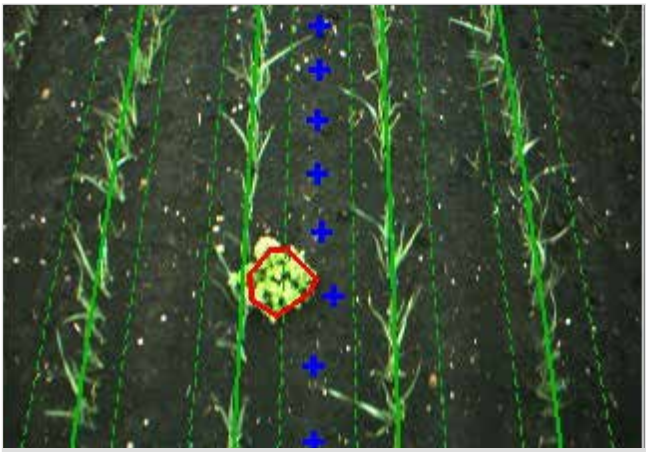
- machine geometry, such as camera height and lens type
- crop and weed parameters, such as row width

The former will have been set by the manufacturer/dealer and should not change on a day-to-day basis. We will only consider settings that change with the crop and will be set by the operator.

Weed detection is based on a combination of factors that include weed size and shape but, most importantly, the position of a potential weed with respect to crop rows. It is, therefore, important to provide the machine with row spacing and approximate width of crop plants in the row. The computer control system creates a template based on this information super-imposed over live video images so it is possible to see at a glance if the machine is configured correctly. Figure 3 shows a typical image in which the solid green template lines show the detected crop rows and the two dotted green lines

either side of the row show nominal width of plants in the rows. The blue crosses are an indication of good row tracking (like Robocrop) and a red polygon has been drawn around a feature that the system has identified as a weed to be treated.

The operator also sets two parameters relating to the weeds. The first is the minimum weed size that the machine will attempt to spray. If set low, the machine will do more spraying and increase the risk of crop damage. If set high, more weeds will go untreated, though it may be possible to catch undersized weeds on a subsequent pass. In practice, between 3cm and 5cm is usually satisfactory. The second parameter determines the percentage of an individual detected weed area that the machine will attempt to cover with herbicide. In many cases it will only be necessary to spray 50% or less of the total area. The machine achieves this by minimising the number of nozzles turned on and by turning nozzles on late and off early. This strategy is an effective way of reducing crop damage when spraying a total herbicide such as glyphosate.



3. Screen shot of the machine console when operating in leeks showing row crop tracking information and a large broadleaf weed that the system has detected and marked with a red outline

Operating the machine

Normal spray operating procedures also apply to a spot sprayer, though special attention should be paid to ensuring that all nozzles switch on and off correctly before starting work. A nozzle test function checks for blocked or stuck open nozzles, but a visual inspection of spray patterns is also needed.

The implement should be placed on the headland aligned with crop rows with the hitch in float. All operation of the implement function is then automatic until the next headland is reached. However, the prudent operator will periodically check that the spray pattern is accurately aligned with the target weeds. This can be done by close inspection of weeds immediately after treatment, but spray volumes are so low this can be difficult to see. It can be easier to visualise if artificial targets are placed in the field. Any small (up to 6.0cm) bias in the spray pattern can be corrected in software using buttons on the console.

System performance

Which herbicides to use

Results from trials work, including an assessment of crop residues, have been submitted to The Chemical Regulations Directorate to support a grant of an Extension of Authorisation for Minor Uses (EAMU) for the spot application of glyphosate formulations (“Roundup Flex” and “Roundup Energy” from Monsanto UK Ltd) in a wide range of vegetable crops. In addition to these glyphosate formulations, any herbicides or mixture of herbicides with the appropriate approvals for overall application can be spot sprayed.

4. Experimental prototype machine operating in a crop of leeks to treat mugwort

A number of common herbicides and tank mixes have been spot sprayed in a range of crops in field trials with an experimental version of the system (Figure 4). Results have been assessed in terms of weed control and crop damage. When using glyphosate at the maximum field rate (4.0 L/ha on the treated area), typically better than 90% weed control was achieved with levels of crop damage that were judged to be commercially acceptable. Weed kill was more rapid and reliable than when using approved selective herbicide mixtures although the use of such mixtures eliminated any observable crop damage.

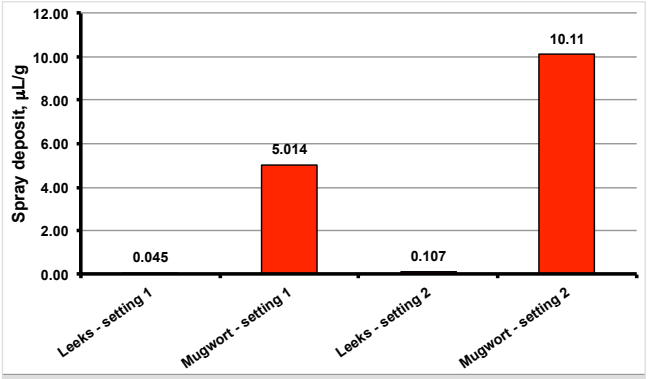
Crop damage

Figure 5 shows the ability of the system to target weeds within the growing crop. While there is some damage to crop plants in the immediate vicinity of a treated weed, this damage is small and severely damaged crop plants do not survive to harvest (Figures 6 and 7). Assessment of residues in crop plants growing close to treated weeds was found to be below the level of detection except in very stunted crop plants and was used to support the grant of an Extension of Authorisation for Minor Uses (EAMU) for the spot application of the defined glyphosate formulations.

5. Volunteer potatoes to be treated with the spot sprayer in a carrot crop

6. The carrot crop after treatment

7. Onions after treatment



8. Measured spray deposits on both weed and crop plants when operating to spot treat mugwort in a leek crop

Tracer dye field studies were used to quantify the amounts of spray being retained on both weeds and crop plants. The results shown graphically in Figure 8 indicate that spray deposits on target weeds were two orders of magnitude greater than on surrounding crop plants. With setting 1, the machine was set to spray 40% of the detected weed area whereas for setting 2, 80% of the detected weed area was sprayed. Increasing the area sprayed increased deposits on the weed as expected but also increased deposits on crop plants.

Conclusions

- EU legislation has been, and is continuing, to reduce herbicide availability to the point where, the remaining products do not adequately cover the weed spectrum encountered in some horticultural crops.
- Spot spraying achieves good control of problem broadleaf weeds such as volunteer potatoes, typically with levels of weed control of more than 90%: a 50 fold reduction in herbicide use when compared with overall application offers financial and environmental benefits.
- Spot spraying builds on widely used commercial vision guided weeding technology and is expected to be cost-effective particularly when combined with band spraying equipment for which the frame and guidance systems can be shared.

£8.75
where sold

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