



SPRAY APPLICATION MANUAL FOR GRAIN GROWERS

Module 20

Target-selectable sprayers

How they work and set-up considerations

Bill Gordon

Key points

- Target-selectable sprayers have the capacity to reduce the amount of chemical used by more than 70 per cent when compared to a 'blanket spray' with a conventional boom
- Where approved on the label or by APVMA permits, these systems can be used at a 'spot-spray' rate (litres of product per 100 litres of water) for a range of products, but may also be able to be applied at a L/ha rate where spot-spraying rates are not yet permitted
- Target-selectable sprayers are increasingly being used to target harder-to-kill weeds in fallow and also under shielded sprayers in some cropping situations
- Target-selectable sprayers may be recognised on labels as a drift-management strategy, providing for reduced downwind buffers or no-spray zones when compared to conventional booms
- As with any decision about which equipment to purchase, the operator should always take into account the support they will receive from the manufacturer and the dealer

1. Introduction

Target-selectable sprayers are designed to detect and spray only the green vegetation (weeds) present in a paddock. Typically they have been used to apply knock-down herbicides as a fallow application, or under shielded sprayers in some cropping situations.

In any given fallow situation the actual weed cover rarely exceeds 20 to 30 per cent of the actual paddock surface, so target-selectable sprayers have the potential to offer large savings in chemical use or the ability to use typically more expensive products, which can provide greater efficacy on harder-to-kill weeds. In situations where weed cover is approximately 30 per cent or more it is recommended to consider using a normal boom sprayer for blanket applications.

Before choosing a product to be applied through a target-selectable sprayer, the operator needs to carefully check the intended product labels or current Australian Pesticides and Veterinary Medicines Authority (APVMA) approved permits to see if the application is allowed. Also check that the formulation type or solvents in the product or tank mix are compatible with the machine being used.

Generally, where the applied rate, calculated on a litres per hectare (L/ha) basis, is within the maximum permitted rate on the label, and the label does not specify or exclude the use of certain nozzle types, spray qualities or application equipment, then an application with a target-selectable sprayer should be able to proceed.

However, in some cases APVMA-approved permits and labels may also permit a spot-spray rate, based on the tank mix concentration of product (litres of product per 100 litres of water). Where a spot-spray rate is included on the label or APVMA-approved permit, the operator must check that the equipment they intend using is permitted to apply the product selected at the spot-spray rates.

2. Commercially available systems in Australia: WeedSeeker[®] and WEEDit[®]

The WeedSeeker[®] has been available in Australia in various forms since the early 2000s, with more-recent models having improved sensors and nozzle set-ups. Over time, owners and operators of the WeedSeeker[®] have become familiar with the system's strengths and limitations.

The WEEDit[®] is the more recently released of the two technologies and has spent several years under field conditions in Australia to demonstrate its reliability. In many instances, operators are still learning about some of the strengths and limitations of this system as it evolves.

2.1 How they detect weeds

Both units rely on sensors that measure the reflectance of particular wavelengths of light, caused by the absorption and fluorescence of red light by the chlorophyll contained in green plants.

WeedSeeker®

The WeedSeeker® uses a combination of two wavelengths of light (invisible infrared light and visible red light), which are projected onto the target weeds, while the sensors assess the ratio difference of red and near-infrared reflectance of the vegetation and background.

WEEDit®

The WEEDit® uses a single source of visible red light and measures reflectance (fluorescence) from the leaf, which occurs in the near-infrared (NIR) spectrum.

The WEEDit® sensor and nozzle configuration



A WeedSeeker® sensor mounted onto a standard boom



The WEEDit® sensor controls five separate nozzles, mounted 20 centimetres apart. ▶

Source: Graham Betts



The WeedSeeker® sensor controls a single nozzle, with each sensor mounted 15 inches or 38cm apart. ▶

Source: Graham Betts

Comment on night spraying

Both units are capable of spraying at night. In fact there may be improved detection of the reflected wavelengths of light when other incidental light levels (e.g. NIR) are reduced. However, as with all spraying operations, the operator must be certain that a surface temperature inversion is NOT present to be able to legally spray at night.



► **Play For an example of a target-selectable sprayer operating at night, go to the following YouTube clip. The red light produced by the sensors is highly visible:**
www.youtube.com/watch?v=kYx2Xoxlxo

2.2 Calibration of the sensors

The WeedSeeker® requires that the operator perform a manual calibration of the sensors against the background (soil and light conditions). Generally this needs to be done a couple of times throughout the day, or when moving from one soil type to another.

While the calibration may take a few minutes, it will improve the performance of the machine.

The WEEDit® has an auto-calibration function, where the sensors continually sample the reflectance to calibrate the sensors against the background reflectance levels. This eliminates the need for the operator to perform the calibration, saving time in the paddock.

While the auto-calibration feature is very useful in paddocks where the weed density is relatively low, in large areas of high weed density the continuous auto-calibration may desensitise the unit, causing less detection of weeds over time. Generally this will not happen if suitable paddocks are selected for spraying using the WEEDit®.

It is important for the operator to assess the weed density in paddocks (or specific areas in a paddock, such as fencelines) where they intend to use a target-selectable sprayer.

2.3 Sensor height

Maintaining a constant sensor height is very important to how target-selectable sprayers perform. It is important that they are mounted on a stable platform such as a tool bar or boom with a rigid centre and excellent height control (preferably manual jockey wheels).

As with any light source, the intensity of the light reduces rapidly with distance from the source, so the ability to detect reflected light reduces if the sensor is lifted above its optimum height. Conversely, if sensors are lowered too far, the field of view may be reduced, and if mounted on a boom the width of the spray pattern may not be suitable (particularly for L/ha rates as opposed to spot-spray rates).

2.3.1 WEEDit® sensor height

The height of the WEEDit® sensors needs to be kept between 100 and 110 centimetres above the ground, while the nozzles are typically mounted closer to the ground, usually at 650 millimetres from the ground.

This means that the mounting of this system onto a standard broadacre boom requires careful consideration of the sensor height and position in relation to boom, particularly for folding the boom. Nozzle height on a conventional boom is also important for maintaining the sprayed width, which dictates the applied rate of product.

In Australia, the WEEDit® is marketed by Croplands in several configurations: as a wider unit (up to 36 metres) sold as a trailing device (with independent wheels to maintain the required sensor height); or as linkage-mounted units on toolbars for narrower widths, typically to match the planter or seeder width.

Maintaining sensor height is critical for target-selectable sprayers



Amazone in Europe has developed an innovative system that folds the sensors down before folding the boom.

A number of the early trailing models have had some issues with fatigue in rough environments, particularly where operators have sprayed at high speeds, while the more recent models appear to have improved many of these issues.



Croplands prefers to use wheels to maintain height for the WEEDit® on the toolbars and trailing rigs the system is mounted onto. ►

Source: Graham Betts



► For more information about how WEEDit® technology has been integrated into the Amazone spraying system, go to: www.go4innovation2016.de/innovations/medaillen-gewinner-en-us/amaspot-sensor-nozzle-system/

A trailing version of the WEEDit® folded for transport



Trailing versions of target-selectable sprayers need to be mounted onto robust frames or tool bars. ▶

Source: Graham Betts

WeedSeeker® sensors normally need to be between 650 and 800mm above the ground, which means that this system can easily be mounted onto a conventional boom (trailing or self-propelled), provided the boom can handle the additional weight of the sensors, or onto linkage units.

With a 650mm sensor height, the broadacre nozzles on the boom can achieve double overlap, which would be 500mm above the stubble or target area for a 50cm nozzle spacing and 110-degree nozzles.

Before considering mounting a WeedSeeker® system onto a conventional boom, it is important to consider the impact the additional weight may have on certain boom types and hydraulic fittings.

Ideally, sensors would be mounted onto robust booms with rigid centres, with suitable hydraulic rams fitted to the boom sections. Auto height control may struggle to function correctly unless more robust hydraulic rams are used. Most systems mounted onto booms generally do not exceed a width of 24 metres.

WeedSeeker® units mounted onto a John Deere boom



Boom design, particularly the centre section and hydraulic rams, needs to be suitable for the additional weight of the sensors and plumbing. ►

Source: Bill Gordon



► **For more information about boom centres and stability, see Module 14: Boom stability and height control**

2.3.3 Using target-selectable sensors under shields

As the sensors produce their own light source, it is possible to mount sensors and nozzles under shields for specific applications, such as inter-row spraying of contact herbicides and some knockdown products.

Due to the height requirement for the sensors above the target, the WeedSeeker® is currently preferred for this purpose.

WeedSeeker® units can be mounted under shields for inter-row spraying



The height of the sensor above the target is an important consideration. Shields need to be 'tall' enough to allow the sensor to function correctly. ►

Source: Southern Precision

2.4 Weight consideration of both systems

A lot is written about the comparative weights of the systems, with the WeedSeeker® having an increased number of sensors and a greater overall weight. While this is an important consideration in terms of the boom type the systems are mounted onto, the height requirement of the sensors generally means that the WEEDit® system is rarely mounted onto a standard boom.

3. Controlling the nozzle output

Fixed pressure or pulse-width modulation

Both the WeedSeeker® and the WEEDit® utilise constant pressure in the spray line, so spray quality remains constant, unless the pressure or the nozzles are changed by the operator.

Both systems generally operate between 2 and 3 bar pressure, but always follow the specific recommendations for each manufacturer and the label requirements for spray quality for the particular nozzles fitted to the machine.

The WeedSeeker® system utilises a solenoid-based system to rapidly turn nozzles on and off, and as a result the applied rate will change if the spraying speed varies from the intended or calibrated speed.

The WeedSeeker® controls the nozzle using Goyen solenoids



Rapid opening and closing of the nozzle by the solenoids limits the choice of nozzles that can be used on target-selectable sprayers. ▶

Source: Bill Gordon

The WEEDit® nozzle body



WEEDit® has the ability to run Pulse Width Modulation, although this function is often turned off. ▶

Source: Graham Betts

The WEEDit® also utilises solenoids to rapidly turn the nozzles ‘on’ and ‘off’. More recent models have pulse-width-frequency modulation (PWF) at 50 hertz (cycles per second) to control the nozzle output, so the application rate and droplet size remain constant even if the spraying speed changes (provided it remains within the limits of the duty cycle of the system). However, the PWF systems are often not utilised to avoid potential misses of very small weeds at slower spraying speeds.

If choosing to use the PWF function it is ideal to run them as close to 100 per cent duty cycle at the upper end of your normal spraying speed as this will provide a buffer as the machine slows down. It is important to note that as the duty cycle decreases, the area covered by coarse spray droplets may be impacted as they do not readily redistribute in the same way as fine or medium spray qualities.

PWF offers the opportunity to apply a blanket rate across the whole paddock (e.g. at 50 per cent duty cycle) for small weeds and to use the sensors to apply a spot rate (100 per cent duty cycle) to larger weeds. Before considering this approach to spraying, careful consideration must be given to the nozzle type fitted to the machine, as even nozzles are less than ideal for blanket applications. The operator also needs to carefully consider the registered or permitted rates of the selected products, as well as the potential for resistance where less-than-robust rates of product are applied.

In almost all situations it is better to have two separate tanks and spraying systems: one for broadacre applications and another for target-selectable sprayer applications.



▶ **For more information, see Module 17: Pulse-width modulation**

4. Nozzle type, position and constraints for effective use

Opening and closing a solenoid (or a pulse width modulation system) in rapid succession (to turn a nozzle on and off) tends to limit the type of nozzles that can be run on target-selectable sprayers to the standard hydraulic-fan-type nozzles or perhaps solid cones. Other nozzle types that utilise a pre-orifice typically do not work effectively due to the relatively short time the volume flows, which does not allow the nozzle to produce an effective spray pattern. Most target selectable sprayers are fitted with flat fan nozzles with a relatively narrow fan angle, such as 40° or 65° nozzles, which allow them to be able to achieve a coarse spray quality, and to match the required sprayed width under each sensor.

It is difficult to run air-induction and many pre-orifice nozzles when using a solenoid that opens and closes rapidly for a number of reasons; primarily this is due to the timing of when the droplets arrive at the target. Narrow-angle fans tend to have higher-speed droplets than wider-angle fans or pre-orifice nozzles.

The droplet speed and the location of the nozzle behind the sensor are carefully matched to the spraying speed range and the height of the nozzles above the target. The droplets reach the target area at the actual location of the weed(s) that are detected.

Both pre-orifice and air-induction nozzles have slower droplet speeds than narrow-angle fan nozzles, so changing nozzle types on a target-selectable sprayer means that the position of the nozzle behind the sensor and the travel speed may both have to be adjusted so that the droplets actually land on the weeds that are detected (otherwise misses will occur).

Apart from the slower droplet speed, most air-induction nozzles will not function correctly when there is a very short duration of the opening and closing of the solenoid. The short duration of flow into the internal chamber of the nozzle may not generate enough pressure within the nozzle to correctly produce the spray pattern and liquid may even flow out of the air intakes.

Many nozzle types are not available in the narrow fan angles required to ensure the correct amount of product lands on the target weeds (for L/ha applications instead of spot-spray rates). This is due to the narrow band or sprayed width required to match the spacing of the sensors. Where wider-angled nozzles are being considered, they should be restricted to spot-spraying rates only (and will require adjustment to the nozzle position or timing).

4.1 WeedSeeker® nozzles

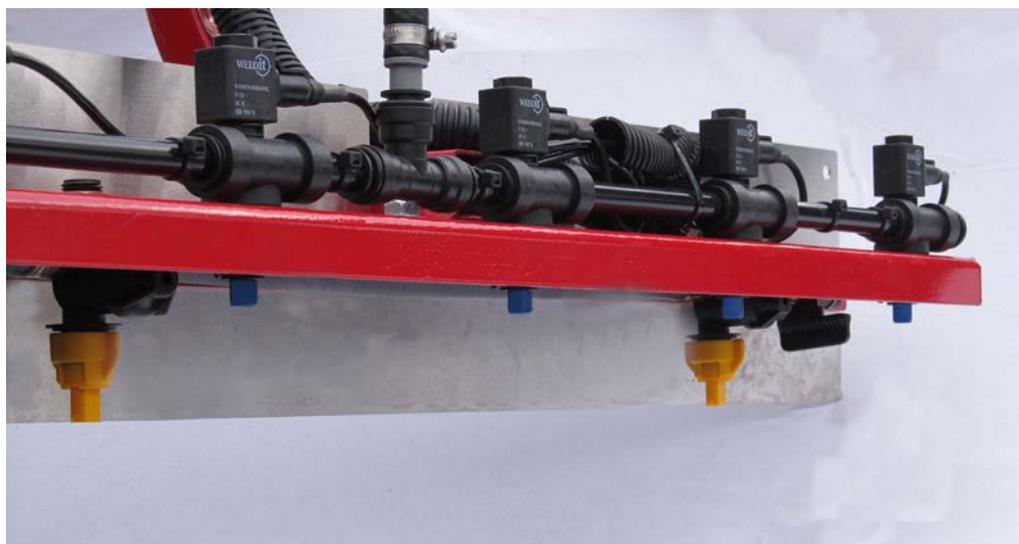
The WeedSeeker® usually runs a 65-degree even fan, in 04 or 05 orifice sizes. These nozzles typically produce a pattern that is approximately 60cm wide on the ground when the sprayer is operating. At a spraying speed of 16km/h this allows an 04 orifice nozzle to deliver an applied rate of 100L/ha to the sprayed band (under a single sensor).

WeedSeeker® currently recommends that nozzles are angled back from the vertical by 13 degrees to provide better coverage on both sides of the target plant at the recommended spraying speed. To achieve this, the nozzles on more-recent models have been brought forward, closer to the sensor, so that the droplets still arrive at the target when required.

4.2 WEEDit® nozzles

The WEEDit® normally runs 40-degree even flat fans, in an 03 orifice. However, Croplands has also worked with solid cone nozzles with either 65-degree or 80-degree fan angles. The solid cone nozzle should only be used for spot-spraying rates. While some literature suggests that this system can be operated at spraying speeds of up to 25km/h, Croplands recommends spray operators do not exceed a spraying speed of 16km/h.

The WEEDit® fitted with 40 degree 03 (blue) even nozzles



In this example the WEEDit® nozzles (blue) are mounted in combination with the broadacre boom nozzles (yellow). ▶

Source: Croplands



TIPS

- **DO NOT** change the nozzle type or position fitted to the sprayer unless you have consulted the distributor or the manufacturer.
- Use water-sensitive paper to look at when the sprays turn on and off in relation to the position of weeds, and to determine the sprayed width for calculating the actual applied rate when using a litres-per-hectare rate rather than a spot-spray rate.

5. Timing and sensitivity

Both systems have the ability to adjust sensitivity to detect smaller or larger weeds. However, increasing the sensitivity too much may lead to an occasional 'misfire'.

Both systems have the ability to manipulate the length of time that the nozzle is 'on' which directly corresponds to how much of the ground and target will be sprayed (before and after the weed).

While reducing the length of time the nozzle is 'on' will save chemical, this will be relatively small in comparison to the overall saving a target-selectable sprayer will provide when compared to a conventional boom 'blanket spraying' a whole paddock. By reducing the duration the nozzle is 'on' too much, the operator risks missing some weeds, particularly in situations of higher wind speeds and higher spraying speeds.

5.1 Assessing spray coverage in relation to the target weed

Water-sensitive paper (WSP) is a valuable tool for setting up the timing and determining the sprayed width for target-selectable sprayers.

Using long strips of water-sensitive paper, or a number of cards clamped to timer strips will help to highlight where the spray is depositing in relation to a target weed

Using water-sensitive paper to assess spray deposits



In this example the sprayer was travelling from the bottom of the image to the top using a pre-orifice nozzle, which delayed the droplets arriving at the target at the correct time. ▶

Source: Bill Gordon

Determining sprayed width for L/ha applications

Measuring the actual sprayed width in the field, under operating conditions, is critical to determining the application rate when a spot-spraying rate is not included on the product label.



► For more information about determining the required sprayed width, speed or nozzle flow for a particular situation, see **Module 8: Calibration of the spray system**

WSP cards are useful for assessing the sprayed width. Once this has been determined the following formula can be used to determine the application rate (L/ha):

$$\text{L/ha} = \text{litres per minute per nozzle} \times 600 \div \text{speed (km/h)} \div \text{width (m)}$$

While WSP is a useful tool for determining where the droplets are landing, it will not indicate how many droplets will actually stay on the target weeds. When using high-speed, coarse droplets there will be a lot of droplet bounce and shatter from the leaf surface, which may not be picked up when using WSP.

To assess actual spray deposits it may be useful to consider using a fluorescent dye and black light blue (UV) torch to assess how much product is actually depositing on the target weed, and where on the weed the droplets are landing.



► For more information about assessing spray deposits, see **Module 21: Assessing spray deposits**

6. Recognition as a drift-management strategy (DMS)

Droplets don't care how they were made: they will still behave in the same way if they become airborne during the application process.

Target-selectable sprayers use hydraulic nozzles. Even a coarse spray quality will produce a small fraction of the spray in droplet sizes that can become airborne, so the target-selectable spray technology itself does not offer special drift-reduction qualities.

The weather conditions required for spraying with a target-selectable sprayer are no different to any other piece of application equipment and are subject to the same spray-drift restraints that are listed on the product label.

Target-selectable sprayers can greatly reduce the amount of active ingredient being released over a specific area. As a result this can potentially diminish the amount of product available to move downwind and away from the target area, resulting in reduced downwind buffer requirements.

7. Set-up considerations: standalone or in combination with a broadacre boom set-up?

Many operators choose to have the target-selectable sprayer as a standalone unit which is only used for 'spot-spraying', while others choose to have the system integrated with a conventional boom so that 'blanket spraying' and 'spot-spraying' can occur at the same time, from one machine.

7.1 Standalone set-ups

There are many benefits to having a standalone target-selectable sprayer, in terms of size, weight and horsepower of the machinery required to get the sprayer across the paddock.

Standalone set-ups also offer the ability to have both the conventional boom and the target-selectable operating at the same time in different paddocks. This also means that the operator is not dragging the target-selectable set-up, particularly the sensors, all over the farm when only the conventional boom is required for spraying.

Smaller target-selectable sprayers are cheaper to establish and generally easier to maintain, while offering the ability to easily increase the width if required at some time in the future.

A standalone set-up of the WEEDit® on a toolbar



Standalone units are preferred by many operators, and are less expensive as an initial purchase. ▶

Source: Graham Betts

7.2 Integrating a target-selectable sprayer with a conventional boom set-up

The best approach, even if the system is to be mounted on one machine, is to have two completely separate plumbing systems, one for the conventional boom system and another for the target-selectable system.

While the sensors may be able to be mounted onto a single boom or toolbar, this means having two tanks, two pumps and two separate plumbing systems.

A WeedSeeker® integrated with a conventional boom sprayer



When mounting a target-selectable onto a sprayer, it is a good idea to have two separate tanks and plumbing set-ups. ▶

Source: Bill Gordon

This is particularly important as target-selectable systems require the use of a pressure accumulator, typically a Ramsay valve, which is difficult to integrate into the conventional boom's plumbing set-up as the pressure may need to be limited to a maximum of about 3 bar for the target-selectable system.

The Ramsay valve pressure accumulator



Pressure accumulators make it difficult to integrate a target-selectable plumbing system with the existing plumbing system of a boom sprayer. ▶

Source: Graham Betts

The benefit of having two separate plumbing systems far outweighs the benefits of trying to use one system.

Some benefits of separate plumbing systems include:

- **being able to have two different products, rates or tank mixes for each application, while still allowing either system to be used independently, or together, when required;**
- **having a smaller tank for the target-selectable sprayer, which is important to ensure adequate agitation and to avoid product potentially 'going off' if it remains in the tank too long (as it may in larger tanks);**
- **ease of decontamination of two separate systems, particularly where one tank may only require a water flush while the other may need a full decontamination; and**
- **ease of troubleshooting or isolating a system if a problem occurs with one of the systems.**

8. Some other points to consider before purchase

Tank size

It is always difficult to predict how much product will be used by a target-selectable sprayer, so it is hard to anticipate how large the spray tank for the system should be. But, as a guide, expect to use less than 20 per cent of the total volume that a conventional boom may use.

Alternatively, it may be more important to consider how long it will take to empty the tank, to avoid tank mixes 'going off'.

Carefully consider the width of the machine and the spraying speed, for example a 9m spraying at 16km/h will cover approximately 15 hectares per hour.

If the application volume is calculated to be about 100L/ha, at a maximum of 30 per cent weed coverage, you may expect to apply about 30L of the tank mix over a hectare of paddock.

So the sprayer output could be about 30L/ha x 15ha/hr = 450L/hr, hence a 1000L tank would allow for at least 2 hours of spraying.

Stand-alone units only require small tanks



To determine an appropriate tank size, it is best to consider how long it will take to empty when spraying.

Source: Graham Betts



► For information about the agitation requirements for a particular tank size, see Module 11: Pumps, plumbing and components

Agitation requirements of the tank mix

It is important to ensure that the tank mix is well, but not excessively, agitated for the tank size to prevent foaming.

Product limitations

Always consult the product label or APVMA-approved permits to determine if a particular product can be applied using a target-selectable sprayer.

Always consult the sprayer's instruction manual to see if there are limits to the types of formulations that can be used, or potential impacts from the solvents that may be contained in certain products on the components used in the target-selectable sprayer.

Operating limitations

The sensors on target-selectable sprayers are not very different to the human eye: if something obstructs our view we are not able to see everything that is in front of us.

Anything that obstructs the field of view of the sensor may impact on the performance of the target-selectable sprayer.

In particular there are two situations in which the sensors may be impacted: high dust levels and tall or thick stubble.

Other factors that impact on performance include high spraying speeds and high wind speeds. High spraying speeds may impact on the droplets' ability to stay on the target or may increase shadowing and deposition onto one side of the target weeds. High wind speeds will tend to displace the spray away from the target weed.

If purchasing a target-selectable sprayer, anticipate that the spraying speed will not be more than 18km/h.

9. Experimental equipment – what's on the horizon?

A range of experimental equipment capable of distinguishing between crop plants and weeds has been developed and trialed in recent years. Some technologies have the ability to differentiate between weeds and particular crop plants in real time at speeds of 12km/h or more, based on plant shapes, sizes and other characteristics.

Such technologies offer not only the ability to greatly reduce the total amount of selective products used in-crop, they may also be able to be coupled with other non-chemical control strategies, such as steam, flames, microwaves, wick-wiping or even spot-cultivation.

10. Summary

Target-selectable sprayers offer large savings in the amount of product required to spray a fallow paddock. There are now a number of products that can be applied at a spot-spray rate (either on the product label or by an APVMA-approved permit), which may assist with controlling difficult-to-kill weeds.

Unfortunately, target-selectable sprayers have too often been used for 'salvage' sprays to control escapes from an application by a regular boom spray; this is not the best way to use this technology. As with any spraying operation, timing is everything. Spraying weeds while they are most susceptible is important for target-selectable sprayers, provided the sensors are able to detect the target at the size when they are most susceptible.

Before considering purchasing a target-selectable sprayer, operators should discuss the options with other owners who have a current model of the machine(s) they are interested in. Operators should also carefully consider the support they are likely to receive from the manufacturer and the dealer or distributor.

[NEXT MODULE](#)

SPRAY APPLICATION MANUAL FOR GRAIN GROWERS

Module 21 Assessing spray deposits A way to improve spray applications
