NATIONAL

# Nozzle selection for boom, band and shielded spraying

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

# THE BACK POCKET GUIDE

## Nozzle selection should be based on flow rate, spray quality, fan angle and nozzle type

**Orifice Size:** Nozzle size, pressure, spray width per nozzle and speed determine application rate (L/ha). ISO nozzles have the following standard colour codes for orifice size:

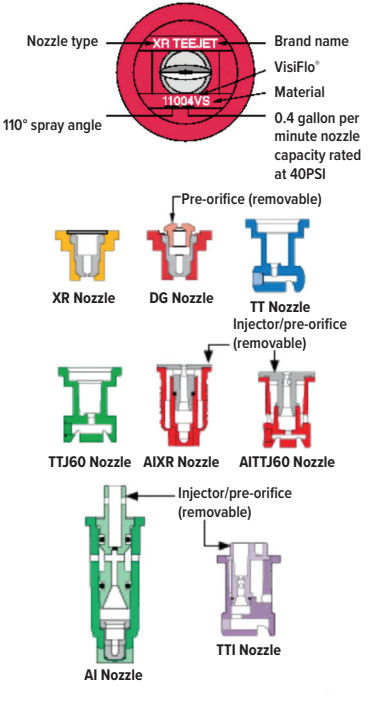
| 01 | 015 | 02 | 025 | 03 | 04 |
|---|---|---|---|---|---|
| 0.39 L/min @ 3.0 bar | 0.59 L/min @ 3.0 bar | 0.79 L/min @ 3.0 bar | 0.99 L/min @ 3.0 bar | 1.18 L/min @ 3.0 bar | 1.58 L/min @ 3.0 bar |
| The flow rate of a nozzle size is a multiple of the flow rate of an 01 at the same pressure, e.g. an 03 has 3 x the flow rate of an 01 at the same pressure. | | | | | |

**Spray Quality:** ASABE standard 572.1 describes the range of droplet sizes produced by a nozzle at a particular pressure. (Colours assigned to spray quality are NOT related to colours assigned to nozzle size.)

| UC | XC | VC | C | M | F | VF |
|---|---|---|---|---|---|---|
| Ultra Coarse | Extra Coarse | Very Coarse | Coarse | Medium | Fine | Very Fine |
| Very good drift control ← | | | | | → Poor drift control | |

**Fan Angle:** Determines the width of the spray pattern, which affects the height that the nozzle should be set above the target.

**Nozzle Type:** Nozzles can be identified by the brand name and the type of nozzle. Types include standard, extended range, pre-orifice and air induction nozzles. Many are available as tapered or even patterns. Some are also available as off-set fans or twin fans (diagrams to the right show examples of nozzle labelling and nozzle styles from the manufacturer TeeJet®).



## Nozzle types commonly used in grain production

| Nozzle Types | Images | Main Uses | Examples & Pressure Ranges | Drift Control |
|---|---|---|---|---|
| **Pre-orifice** |  | Mostly used for in-crop spraying or for products requiring a medium spray quality. Larger orifices may produce coarse spray qualities at lower pressures (for sprayers with limited pressure e.g. < 3 bar maximum) | TeeJet® DG, 2 to 4.0 bar,<br>HARDI ISO LD,<br>1.5 to 5.0 bar<br>TeeJet® TT, 1 to 6.0 bar<br>**best above 2.0 bar** | Poor<br>to<br>Moderate |
| **Low Pressure Air Induction** |  | Mostly used for fallow spraying and some in-crop spraying. Most produce a coarse spray quality, but some can produce a medium spray quality at higher pressures. | HARDI ISO MINIDRIFT<br>agrotop AirMix®<br>TeeJet® AIXR<br>Lechler IDK<br>2.0 to 5.0 or 6.0 bar<br>**best above 3.0 bar** | Moderate<br>to<br>Good |
| **High Pressure Air Induction** |  | Good for fallow spraying with fully translocated products and for pre-emergent applications.<br>Good drift control, mostly coarse to very coarse spray qualities. | TeeJet® AI,<br>HARDI INJET,<br>Lechler ID. 2.0 to 8.0 bar<br>**best above 5.0 bar,**<br>**never below 3.0 bar** | Good<br>to<br>Very Good |
| **Extended Range Flat Fans** |  | Not legal for many herbicide applications. Larger orifices may be suitable for some foliar applications where a medium spray quality is required at higher volumes. | Hardi F,<br>TeeJet® XR<br>1.0 to 1.5 bar to<br>4.0 or 5.0 bar | VERY<br>POOR |

| Nozzle Types | Images | Main Uses | Examples & Pressure Ranges | Drift Control |
|---|---|---|---|---|
| **Twin Jets** |  | Can provide improved coverage, if operated at low travel speeds. Not ideal for speeds above 16-18kmh. Air Inducted Twins also available | TeeJet® TTJ-60, TeeJet® AITTJ-60 HARDI MINIDRIFT DUO most 2.0 to 6.0 bar | Poor to Good |
| **Hybrid Nozzles** |  | Very good for pre-emergent applications and stubble penetration. TTI-015 & 02 @ 4.0 bar or higher are suitable for fully translocated herbicide application on moderate to larger-size weeds. | Turbo TeeJet® Induction (TTI) 1.5 to 7.0 bar **best above 4.0 bar** | Very Good to Excellent |
| **Fence Line Nozzles** |  | Used on the ends of boom sections to avoid impacts. Some have a sprayed width of 5m or more and 10 x the flow rate of standard nozzle of same colour. (Should be plumbed as a separate section in controller.) | TeeJet® XP BoomJet® (L or R) | Very Good to Excellent |
| **Streaming Nozzles** |  | Used for delivery of liquid fertilisers and other products that need to be applied directly to the soil, or to minimise contact with foliage. | HARDI QUINTASTREAM TeeJet® StreamJet® SJ-3 | Very Good to Excellent |

## Spray patterns

Most nozzles are available as tapered-flat fans. Some are also available as even-flat fans.

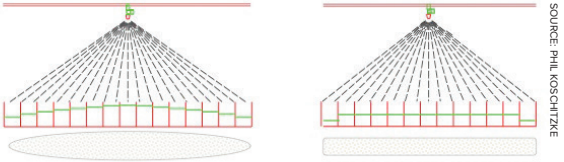
Tapered-flat fans are most commonly used on booms to achieve the required double overlap.

Even-flat fans are normally used for banded spraying, under shielded sprayers and on target selectable sprayers.

## Nozzle angle and height above the target

Boom height should be set to achieve a double overlap.

Narrower spray angles require increased boom heights to maintain the double overlap.

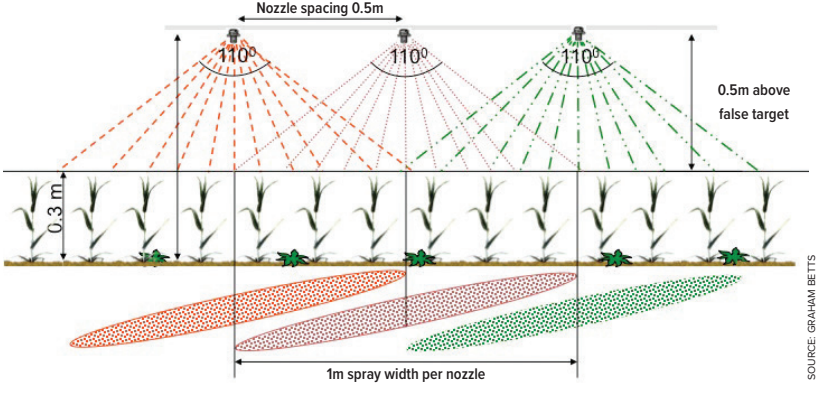


SOURCE: PHIL KOSCHITZKE

Tapered-flat fan nozzle spray pattern

Even-flat fan nozzle spray pattern

**The weeds to be sprayed in this example are 0.02 metres (2 cm) high but the false target, the crop, is 0.3 metres high. If we are using 110° nozzles at 0.5-metre nozzle spacing, the nozzles need to be no lower than 0.8 metres above the ground (0.5 metres above false target).**




SOURCE: GRAHAM BETTS

## Selecting appropriate nozzles using manufacturer's spray charts

**STEP 1:** Determine the application volume (L/ha) and spray quality (check the label)
*e.g. 65-70 L/ha at 16 kmh using a coarse spray quality.*

**STEP 2:** If your nozzle spacing matches the chart (e.g. 50 cm) use the nozzle chart to find nozzle sizes and pressures that give the desired L/Ha at your average speed (kmh)
e.g. *65-70 L/ha at 16 kmh with a 50 cm nozzle spacing* (blue line/circle on chart).

**STEP 3:** Identify suitable nozzle types based on their optimum operating pressure at the average speed, and choose an appropriate minimum operating pressure for each nozzle type. e.g.
**015 @ 7.0 bar** = *High pressure air induction nozzle (minimum pressure = 3.0 - 4.0 bar)*
**02 @ 4.0 bar** = *Low pressure air induction nozzle (minimum pressure = 2.0 - 2.5 bar)*
**025 @ 2.5 bar** = *Pre-orifice nozzle (minimum pressure > 1.5 bar)*

**STEP 4:** Use the preferred minimum operating pressure (red line or circle on chart) for each nozzle type to identify at what speed the desired L/ha is achieved (dropping below this speed, means the nozzles may not work properly if the pressure is too low).

| Choices | Nozzle type | Min. pressure | Min. speed |
|---|---|---|---|
| 015 @ 7.0 bar @ 67.5 L/ha | high pressure air induction | 4.0 bar | = 12 kmh |
| 02 @ 4.0 bar @ 68.3 L/ha | low pressure air induction | 2.0 bar | = 11-12 kmh |
| 025 @ 2.5 bar @ 67.5 L/ha | pre-orifice | 1.5 bar* | = 11-12 kmh |

(*not shown on chart)

**Note:** Regardless of the nozzle type selected in this example, the speed at which the nozzles no longer perform well is approximately the same for all nozzle types (around 11-12 kmh).

## Nozzle flow chart and application rates (L/ha) at various speeds

| Nozzle size | Pressure (bar) | Flowrate (L/min/nozzle) | Application rate L/ha @ km/h (at 50 cm nozzle spacing, water only) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 |
| 01 (orange) | 2 | 0.32 | 48.0 | 38.4 | 32.0 | 27.4 | 24.0 | 21.3 | 19.2 | 17.5 | 16.0 |
| | 3 | 0.39 | 58.5 | 46.8 | 39.0 | 33.4 | 29.3 | 26.0 | 23.4 | 21.3 | 19.5 |
| | 4 | 0.45 | 67.5 | 54.0 | 45.0 | 38.6 | 33.8 | 30.0 | 27.0 | 24.5 | 22.5 |
| | 5 | 0.50 | 75.0 | 60.0 | 50.0 | 42.9 | 37.5 | 33.3 | 30.0 | 27.3 | 25.0 |
| | 6 | 0.55 | 82.5 | 66.0 | 55.0 | 47.1 | 41.3 | 36.7 | 33.0 | 30.0 | 27.5 |
| | 7 | 0.59 | 88.5 | 70.8 | 59.0 | 50.6 | 44.3 | 39.3 | 35.4 | 32.2 | 29.5 |
| 015 (green) | 2 | 0.48 | 72.0 | 57.6 | 48.0 | 41.1 | 36.0 | 32.0 | 28.8 | 26.2 | 24.0 |
| | 3 | 0.59 | 87.8 | 70.2 | 58.5 | 50.1 | 43.9 | 39.0 | 35.1 | 31.9 | 29.3 |
| | 4 | 0.68 | 101.3 | 81.0 | 67.5 | 57.9 | 50.6 | 45.0 | 40.5 | 36.8 | 33.8 |
| | 5 | 0.75 | 112.5 | 90.0 | 75.0 | 64.3 | 56.3 | 50.0 | 45.0 | 40.9 | 37.5 |
| | 6 | 0.83 | 123.8 | 99.0 | 82.5 | 70.7 | 61.9 | 55.0 | 49.5 | 45.0 | 41.3 |
| | 7 | 0.89 | 132.8 | 106.2 | 88.5 | 75.9 | 66.4 | 59.0 | 53.1 | 48.3 | 44.3 |
| 02 (yellow) | 2 | 0.64 | 96.0 | 76.8 | 64.0 | 54.9 | 48.0 | 42.7 | 38.4 | 34.9 | 32.0 |
| | 3 | 0.78 | 117.0 | 93.6 | 78.0 | 66.9 | 58.5 | 52.0 | 46.8 | 42.5 | 39.0 |
| | 4 | 0.90 | 135.0 | 108.0 | 90.0 | 77.1 | 67.5 | 60.0 | 54.0 | 49.1 | 45.0 |
| | 5 | 1.00 | 150.0 | 120.0 | 100.0 | 85.7 | 75.0 | 66.7 | 60.0 | 54.5 | 50.0 |
| | 6 | 1.10 | 165.0 | 132.0 | 110.0 | 94.3 | 82.5 | 73.3 | 66.0 | 60.0 | 55.0 |
| | 7 | 1.18 | 177.0 | 141.6 | 118.0 | 101.1 | 88.5 | 78.7 | 70.8 | 64.4 | 59.0 |
| 025 (lilac) | 2 | 0.80 | 120.0 | 96.0 | 80.0 | 68.6 | 60.0 | 53.3 | 48.0 | 43.6 | 40.0 |
| | 3 | 0.98 | 146.3 | 117.0 | 97.5 | 83.6 | 73.1 | 65.0 | 58.5 | 53.2 | 48.8 |
| | 4 | 1.13 | 168.8 | 135.0 | 112.5 | 96.4 | 84.4 | 75.0 | 67.5 | 61.4 | 56.3 |
| | 5 | 1.25 | 187.5 | 150.0 | 125.0 | 107.1 | 93.8 | 83.3 | 75.0 | 68.2 | 62.5 |
| | 6 | 1.38 | 206.3 | 165.0 | 137.5 | 117.9 | 103.1 | 91.7 | 82.5 | 75.0 | 68.8 |
| | 7 | 1.48 | 221.3 | 177.0 | 147.5 | 126.4 | 110.6 | 98.3 | 88.5 | 80.5 | 73.8 |

L/ha for nozzle size, pressure at the nozzle (bar) and speed (km/h) – based on a 50 cm nozzle spacing.

**Ask yourself:** Are you likely to spend much of your spraying time below the minimum speed?

If you are, there are two possible outcomes:

1. If no minimum hold is set* in the automatic rate controller, the nozzle may not work as effectively when you reduce speed, e.g. fan angles may collapse, spray quality will change.
2. If the minimum hold function is set and you travel at lower speeds, you will be overdosing those areas. With some products this may cause crop damage or create plant back problems (best not to use the minimum hold for in-crop herbicide or pre-emergent applications).
   To reduce overdosing, a small increase in the application volume will increase the speed range available (this may require a different nozzle choice), or use larger headlands (where practical).

***Minimum hold could refer to speed, litres per minute pressure or litres per minute per nozzle.**

**STEP 5:** Identify the practical volume range that could be obtained for each nozzle, based on the useful pressure range or the limits of pressure for your machine.

**STEP 6:** Determine which nozzle types provide the greatest flexibility with the pressure range you have available on your machine.

**STEP 7:** Use manufacturer's spray quality charts to select nozzles that produce the spray qualities required at the application volumes you prefer. You should also consult product labels to determine if there are any restrictions on the types of nozzles that may be used for particular jobs.

| Nozzle Type | Useful Pressure Range | Volume Range @ 16 km/h* |
|---|---|---|
| 015 high pressure air induction | 5.0 - 8.0 bar | 56.3 L/ha to 74 L/ha |
| 02 low pressure air induction | 3.0 - 6.0 bar | 58.5 L/ha to 82.5 L/ha |
| 025 pre-orifice | 2.0 - 5.0 bar | 60 L/ha to 93.8 L/ha |

*Volume range if speed is maintained at 16 km/h to ensure that pressure remains constant.

## Examples of spray quality charts for various nozzle types

**PRE-ORIFICE**

| HARDI ISO LD | bar | | | | | |
|---|---|---|---|---|---|---|
| | 1.5 | 2.0 | 2.5 | 3.0 | 4.0 | 5.0 |
| LD-110-01 | M | M | M | M | M | F |
| LD-110-015 | M | M | M | M | M | M |
| LD-110-02 | M | M | M | M | M | M |
| LD-110-025 | C | C | M | M | M | M |
| LD-110-03 | C | C | C | C | M | M |
| LD-110-04 | C | C | C | C | C | M |

**LOW PRESSURE AIR INDUCTION**

| HARDI ISO MINIDRIFT | bar | | | | | |
|---|---|---|---|---|---|---|
| | 1.5 | 2.0 | 2.5 | 3.0 | 4.0 | 5.0 |
| MINIDRIFT-015 | C | C | C | C | M | M |
| MINIDRIFT-02 | VC | C | C | C | C | M |
| MINIDRIFT-025 | VC | VC | C | C | C | M |
| MINIDRIFT-03 | VC | VC | VC | C | C | C |
| MINIDRIFT-04 | VC | VC | VC | VC | C | C |

**HIGH PRESSURE AIR INDUCTION**

| HARDI ISO INJET | bar | | | | | |
|---|---|---|---|---|---|---|
| | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 |
| INJET - 01 | VC | VC | VC | C | C | C |
| INJET - 015 | VC | VC | VC | VC | VC | C |
| INJET - 02 | VC | VC | VC | VC | VC | VC |
| INJET - 025 | VC | VC | VC | VC | VC | VC |
| INJET - 03 | VC | VC | VC | VC | VC | VC |
| INJET - 04 | VC | VC | VC | VC | VC | VC |

**HYBRID PRE-ORIFICE**

| Turbo TeeJet® | bar | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 6.0 |
| TT110-01VP | C | C | M | M | M | M | F | F | F | F |
| TT110-015VP | VC | C | M | M | M | M | F | F | F | F |
| TT110-02VP | VC | C | C | M | M | M | M | M | F | F |
| TT110-025VP | VC | C | C | M | M | M | M | F | F | F |
| TT110-03VP | VC | VC | C | C | C | M | M | M | M | M |
| TT110-04VP | XC | VC | C | C | C | M | M | M | M | M |

**AIR INDUCTED TWIN JET**

| Air Induction Turbo TwinJet® | bar | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 | 6.0 | 7.0 |
| AITTJ110-02VP | VC | VC | C | C | C | M | M | M | M | M |
| AITTJ110-025VP | VC | VC | C | C | C | M | M | M | M | M |
| AITTJ110-03VP | XC | XC | VC | VC | C | C | C | C | M | M |
| AITTJ110-04VP | XC | VC | VC | VC | C | C | C | M | M | M |

**HYBRID AIR INDUCTION**

| Turbo TeeJet® Induction | bar | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 | 6.0 | 7.0 |
| TTI110-015VP | UC | UC | UC | UC | XC | XC | XC | XC | XC | VC |
| TTI110-02VP | UC | UC | UC | UC | UC | UC | XC | XC | XC | VC |
| TTI110-025VP | UC | UC | UC | UC | UC | UC | XC | XC | XC | XC |
| TTI110-03VP | UC | UC | UC | UC | UC | UC | UC | XC | XC | XC |
| TTI110-04VP | UC | UC | UC | UC | UC | UC | XC | XC | XC | XC |

| UC | XC | VC | C | M | F | VF |
|---|---|---|---|---|---|---|
| Ultra Coarse | Extra Coarse | Very Coarse | Coarse | Medium | Fine | Very Fine |

## How many sets of nozzles are needed to cover most jobs?

Most grain growers need at least two sets of nozzles, such as a winter set and a summer fallow and pre-emergent set. Before purchasing a set of nozzles, ask what else you can do with the nozzles. Well-chosen nozzles should do more than one job, but not necessarily all jobs.

## Suggested spray quality and application volumes for most broadacre applications

The arrows on the table below indicate some well-chosen nozzles can do more than one job.

| Typical Application Volume | Medium Spray Quality (lower drift risk areas) | Coarse Spray Quality | Extremely Coarse Spray Quality (higher drift risk areas) |
|---|---|---|---|
| **Lower range**<br>50 L/ha (low stubble load)<br>to<br>70 L/ha (high stubble load) | *Only where permitted on label:<br><br>Fully translocated herbicides<br>Small to moderate-sized targets. | Fallow spraying<br>Fully translocated herbicides such as glyphosate, MCPA.<br>Mandatory for 2,4-D | Fully translocated herbicides, moderate-sized targets.<br>Very sensitive areas or<br>NIGHT SPRAYING |
| **Higher range**<br>70 L/ha (low stubble load)<br>to<br>plus 100 L/ha (high stubble load/dense crop canopy) | *Only where permitted on label:<br><br>Contact type products.<br>Small targets.<br>In-crop spraying.<br>Penetration and coverage in large & broadleaf crops. | Pre-emergents.<br>Fully translocated herbicides, good stubble penetration.<br>Some contact herbicides at the higher application volumes. | Pre-emergents.<br>Moderate-sized targets with fully translocated summer fallow herbicides.<br>Very sensitive areas or<br>NIGHT SPRAYING |

## Nozzle selection - calculations for different set-ups

Nozzle charts are only useful if the sprayed width of your sprayer matches the one used on the chart. Often banded set-ups and shielded sprayers do not have sprayed widths of 50cm, so we must make calculations to select appropriate nozzle sizes or to determine the application rate of the machine.

**The most useful formulas are:**

- **L/ha = L/min/nozzle x 600 ÷ speed (km/h) ÷ width (m)**
- **L/min/nozzle = L/ha x width (m) x speed (km/h) ÷ 600**
- **Speed (km/h) = L/min/nozzle x 600 ÷ L/ha ÷ width (m)**
  **OR (kph) = distance (m) x 3.6/time (seconds)**
- **Width (m) = L/min/nozzle x 600 ÷ L/ha ÷ speed (km/h)**

These formulas apply to any type of sprayer and are based on the sprayed width per nozzle. The only thing that changes is the sprayed width (explained further below).

## Terms used in the formula

**L/ha** = litres per sprayed hectare (or total application volume)

**L/min/nozzle** = the flow rate of each nozzle at a given pressure

**600** = a constant conversion factor (when using width in metres)

**Width** = individual spray width per nozzle in metres. Can be any of the following:

- The nozzle spacing on the boom in metres, *(e.g. 50 cm spacing = a width of 0.5 m)*
- The width of a band from a single nozzle at the target in metres (m)
- The average sprayed width per nozzle (for a band or under a shield) in metres (m).
  *(e.g. 2 nozzles under a 90 cm-wide shield = average width of 0.45 m)*

## Selecting nozzles for banded applications and shielded sprayers

The reason for a banded application is to apply the full rate of product to an area smaller than the whole paddock. When we do this the sprayed area will be less that the total paddock area the machine covers.

**Use Sprayed ha to calculate mixing rates, and Paddock ha to program the rate controller.**

## Determining the required flow rate (L/min/nozzle) to select nozzle size and pressure for a shield or band

- The first step is to calculate the average sprayed width per nozzle (m).
- Then calculate the required flow rate per nozzle (L/min/nozzle)

  *Example: What nozzle size and pressure are required to deliver 80 L/sprayed ha at a speed of 11 kmh using 2 nozzles per 90cm shield (or band)?*

  Average width per nozzle (m) = 0.9 m ÷ 2 nozzles = 0.45 m

  L/min/nozzle = L/ha x speed (km/h) x width (m) ÷ 600

  = 80 L/ha x 11 (km/h) x 0.45m ÷ 600

  = 0.66 L/min/nozzle

  *(using a nozzle chart, 0.66 L/min = an 015 @ 4.0 bar or an 02 @ 2.0 bar)*

- If a different pressure or nozzle size is preferred or available, adjust the L/ha and/or speed (km/h) so the chosen nozzle is working at its optimum pressure.

## Determining application and mixing rates (L/sprayed ha) for shields and bands


- L/sprayed ha is the rate used to calculate how much chemical to put in the tank.

  **L/sprayed ha** = L/min/nozzle x 600 ÷ speed (km/h) ÷ width (m)
  **Sprayed ha per tank** = tank size ÷ L/sprayed ha
  **Chemical per tank** = chemical rate per ha x Sprayed ha per tank

## What to put In the rate controller (L/paddock ha) for banded or shielded spraying

- L/paddock ha is the rate that should be entered into the automatic rate controller
- L/paddock ha takes into account how much of the paddock is actually sprayed
- When making calculations for banded or shielded applications, the L/paddock ha will always be less than the L/sprayed.

## L/paddock ha = L/sprayed ha x (total width of bands or shields ÷ sprayer width per pass)

**Example:** A 12m-wide shielded sprayer set-up with 11 x 90 cm shields (with 2 x 015 nozzles per shield) and 2 x 45cm guess row shields (with 1 x 015 nozzle per shield). It is operated at 10 kmh and a pressure of 4.0 bar (an 015 @ 4.0 bar = 0.68 L/min/nozzle)

**L/sprayed ha** = 0.68 L/min/nozzle x 600 ÷ 10 km/h ÷ 0.45 m
= 90.7 L/sprayed ha (mix to this rate)

**L/paddock ha** = 90.7 L per sprayed ha x (11 x 0.9 m + 2 x 0.45 m) ÷ 12 m
= 90.7 L per sprayed ha x 10.8 m ÷ 12 m
= 81.6 L per paddock ha (this rate goes into the controller)

## Selecting nozzle types for banded and shielded spraying

Even nozzles are best for spraying bands. Suitable even nozzles can be hard to find. Two useful examples are TeeJet® 95° even nozzles, only available in 015 or larger.

**e.g. TeeJet® DG-95-04-EVS, a 95° even nozzle (producing mostly medium spray quality until you use larger than an 03 orifice). These may be OK for banded applications over the row with fungicides and insecticides.**

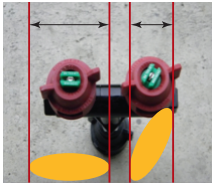
**e.g. TeeJet® AI-95-04-EVS, a 95° high pressure air induction with an even pattern, best run above 4 bar producing coarse droplets or larger. OK for many herbicide applications, where the machine can produce adequate pressure.**

There are also narrower angled even fans and even twinjets available, suitable for narrower bands, and banding over the top of the row. Some are available in 40°, 65° and 80°. WeedSeeker® are commonly fitted with TP-65-04-EVS nozzles which are coarse at 2.5 to 3.0 bar.

## Matching rates for full shields and guess row shields (where fitted)

It is worth checking that the L/sprayed ha for full shields and guess row shields match. If the L/sprayed ha for the guess rows differs, the sprayed width can be adjusted by using round nozzle caps and turning the nozzle inside the cap. Required width can be calculated using the formula:

**Width (m) = L/min/nozzle x 600 ÷ L/sprayed ha ÷ speed (km/h)**



**The nozzle on the left will spray a wider band width.**
**The nozzle on the right will spray a narrower band width due to the angle in its cap.**

**Note: Adjusting sprayed width changes the L/sprayed ha.**
**If using nozzles with smaller orifice sizes in the guess row shields, make sure they produce the same spray quality as the larger nozzles under the full shields.**

## Sprayer checks and calibration

It is a good idea to ensure that the tank, lines, filters and non-drip check valves are clean before carrying out a calibration.

Set the machine to manual pressure, or use the test speed or auto calibration function to set an application volume (L/Ha) and speed (kmh) that will give you a known pressure at the nozzle.

For example, enter a test speed of 22 kmh and an application volume of 50 L/ha into the controller. With 02 (yellow) nozzles the pressure should be 4.0 bar at the nozzle. If you have 49 nozzles on the boom the total flow rate should be 45 L/min through the boom.

Useful steps to carry out:

1. Check the pressure at the nozzle with a pressure gauge screwed into a ¼" female threaded nozzle cap or dropper fitting.
2. Check the pressure at the nozzle across each boom section (every few nozzles) and for each section across the whole boom.
3. If there is a difference in pressure check plumbing for restrictions, non-drip valves and proportional valves (where fitted).
4. When pressure is the same across the whole boom use a tip-tester to compare flow rates. Replace any nozzle that has a poor spray pattern. Ensure all nozzles produce the same flow rate per minute (less than 10% variation) by replacing nozzles that are excessively worn.
5. If all nozzles are now within 10% variation, use a calibrated jug to measure the flow rate from one of the nozzles to determine the average flow rate for 1 minute (L/min/nozzle).
6. Compare this flow rate to that of a reference nozzle (ideally one kept aside from original purchase).

**Revised June 2017**

**The GRDC wishes to acknowledge Bill Gordon and Graham Betts in the provision of images and content to this guide.**

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**Nozzle selection for boom, band and shielded spraying Back Pocket Guide is part of a series of Back Pocket Guides published by the GRDC.**

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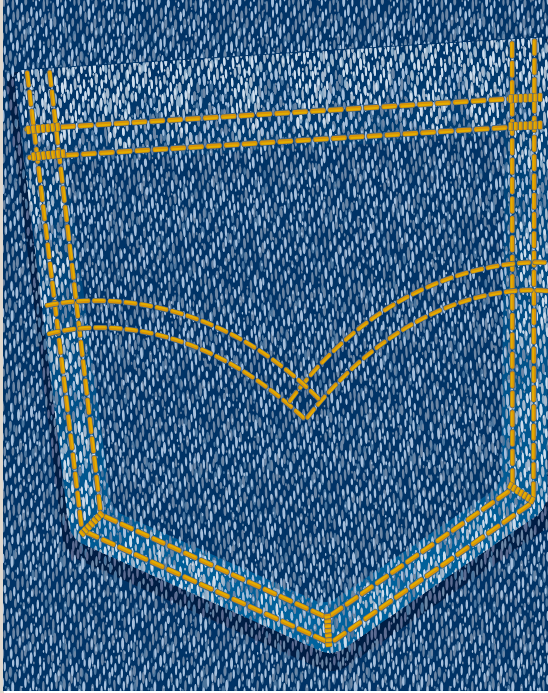

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