



SPRAY APPLICATION MANUAL FOR GRAIN GROWERS

Module 8 Calibration of the spray system

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Ensuring accuracy

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Key points

- Check all components that can affect the sprayer's output
- Have the right equipment on hand to calibrate all components
- Never assume that the equipment you use to calibrate is accurate – check (by weight)
- Do not assume that the controller settings or increments on the spray tank are correct
- Know what to measure and how to make adjustments to improve your accuracy

1. What to calibrate and why?

Spraying is about placing the correct dose of product at the right place, at the right time.

Calibration is the process of checking, and adjusting, where necessary, the accuracy of all components that have an impact on the performance of the spray application equipment. It is more than just measuring the individual parameters of speed, flow and width.

When calibrating a sprayer it is important to consider areas of potential error, including:

- speed;
- nozzle pressure;
- flow meters and liquid density;
- tank capacity;
- section widths and nozzle spacing;
- measuring jugs, buckets and scales; and
- tractor speedometer.



1.1 Before you calibrate

To minimise risk, prepare your sprayer components before you begin to calibrate:

- complete a spray plan* and know how you need to apply each product;
- select appropriate personal protection equipment;
- ensure the sprayer is cleaned internally and externally, including nozzles and filters;
- check, adjust if necessary, and record tyre pressures;
- fit the appropriate nozzles (according to the spray plan);
- record all rate controller settings flow meter constant, speed constants, boom width/nozzle count per section; and
- ensure oil is at operating temperature where hydrostatic drive sprayers are in use (never calibrate cold).

2. Speed calibration

Speed calibrations should be carried out under field conditions. Operate the sprayer with three-quarters of a load of water, at the desired operating speed, with booms folded out, the sprayer pump engaged, nozzles running and agitation occurring. If the sprayer has a wheel-speed sensor or radar, calibration can be achieved by ensuring the rate-controller speed is the same as the accurate or GPS speed.

2.1 Approach 1: by calculation (an accurate GPS is not fitted to the sprayer or tractor)

Speed=Distance travelled (metres) x 3.6(kilometres per hour)Time taken (in seconds)

Using a calculator:

Speed (km/h) = distance travelled (m) x 3.6 ÷ time taken (seconds)

For example, if the time taken to travel 100 metres was 18 seconds, then: Speed (km/h) = distance travelled (m) x $3.6 \div$ time taken (seconds) Speed (km/h) = 100 (m) x $3.6 \div 18$ (seconds) Speed (km/h) = 20 km/h



*A good spray plan provides the basis for the calibration process. An applicator should carefully consider how each product is to to be applied, including: the desired application volume, spraying speed, nozzle type, spray quality and operating pressures.

For more information go to Module 5: Spray plans



 Table 1 Examples of time taken to travel 100 metres and the calculated speed (km/h)

Time taken to travel 100 metres in seconds	60	40	30	24	20	18	15
Calculated speed (km/h) using formula	6	9	12	15	18	20	24





Photo: Graham Betts

2.2 Approach 2: by matching the controller speed to an accurate GPS speed

Operate the sprayer under field conditions as per your spray plan. Record the rate controller speed and the GPS speed. (This applies to rate controllers that are running a wheel sensor or radar that is external to the GPS.)

Use the following formulas to adjust the rate controller speed constant to match the GPS or actual speed.

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Formula 1 – rate controllers where the constant is in pulses per unit (PPU):

New PPU (speed constant) Old PPU (speed constant) Rate controller speed (km/h) GPS (actual) speed (km/h)

Using a calculator:

New PPU = Old PPU x Rate controller speed (km/h) ÷ GPS speed (km/h)



Formula 2 – rate controllers where the constant is in units per pulse (UPP):

New UPP	_	Old UPP	V	GPS (actual) speed (km/h)					
(speed constant)	_	(speed constant)	~ -	Rate controller speed (km/h)					

Using a calculator:

New UPP = Old UPP x GPS speed (km/h) ÷ Rate controller speed (km/h)



Once this calibration has been effected, record the new speed constant in the 'Spray Controller Values Table' of your manual and record the gear and RPM that was used in the calibration process. Record your tyre pressure.

Approach 2 allows the operator to quickly calibrate speed when paddock conditions change, for example, when spraying on worked ground.

2.3 Travel speed considerations during spraying

Tractor transmission issues

Before speed can be calibrated, the tractor needs to be driven to ensure that the desired operating speed is not between clutch packs and, preferably, that the minimum and average speeds can be achieved within the same clutch pack. This is an issue with electronic command gearboxes, full power shifts and sprayers that have automatic transmissions. A constant speed means achieving a consistent dose rate.

New sprayers

Speed challenges arise when purchasing a new sprayer. A new sprayer will usually have a larger capacity than the one it replaced and might require the purchase of a new tractor. It may be prudent to delay the purchase of nozzles for the new sprayer until you can fully test the machine to determine appropriate operating speeds in your conditions. This will avoid a situation where nozzles are not operated correctly.

3. Section widths and nozzle spacing

The accuracy of the nozzle spacing can vary quite dramatically depending on where and how your boom was manufactured. Operators should be aware that nozzle spacing might not be what they expect.

Most operators expect that the spacing will be in metric units, often assuming that the spacing is 50 centimetres (0.5 metres). But when they physically measure the spacing they discover it is actually 50.8cm (0.508m), which coincides with a 20-inch spacing (even when the boom width was quoted in metres).

A spacing of 0.508m means that a standard nozzle chart that quotes litres per hectare based on a 50cm (0.5m) spacing will not be accurate: it would include a 1.6 per cent error. If the section width entered into the controller is based on the wrong nozzle spacing, the sprayer output will also be in error.

TIPS

Check the nozzle spacing across each boom section using an accurate tape measure.

Check the section widths entered into the rate controller.



Section width = number of nozzles per section x the nozzle spacing (metres) Don't assume this will be correct when a new sprayer has been delivered.

4. Pressure at the nozzle and nozzle outputs

Nozzles are the part of the sprayer that require the most attention and have the greatest potential impact on the performance of chemicals.

When purchasing new nozzles make sure they have all come from the same batch (blister packed). Within a batch, the variation in flow rate should be less than three per cent. Flow rates between batches may vary by up to five per cent. This means that nozzles from different batches may vary in flow rate by up to eight per cent.

Ensure nozzles are calibrated under field conditions. Conduct calibrations with the nozzle operating at the average pressure (as per your spray plan).



Equipment required to accurately calibrate nozzles includes:

- calibrated measuring containers;
- calibrated pressure gauge;
- tape measure;
- scales (accurate to 0.1 gram or better);
- one dollar coin (reference weight = 9 grams)
- nozzle chart

4.1 Steps to calibrate your nozzles

Step 1: Start clean and check nozzle patterns

- Fold out the boom and operate the entire boom section. If fitted, adjust proportional return taps.
- Make sure the boom has been fully decontaminated.
- Operate the boom with clean water, check nozzle patterns and clean and replace nozzles where required.



GRDC A3 Nozzle Selection Guide

poster

From left: Chemical jug weighed using accurate scales.

Scales for weighing nozzle output.

Container for catching nozzle output – weighed for accuracy.

Photos: Bill Gordon



Photo: Bill Gordon



Options for measuring pressure at the nozzle



Measuring nozzle pressure and output to check flow meter accuracy

Step 2: Check pressure



Check the pressure in each boom section adjacent to the inlet and ends of the section. If only using one calibrated testing gauge, set the pressure to achieve, for example, 3 bar at the nozzle outlet.

Mark the spray unit's master gauge with a permanent marker. This will ensure the same pressure is achieved when moving the test gauge from section to section.

Step 3: Check flow meter output

- If pressure across a boom section is uneven check for restrictions in flow – kinked hoses, delamination of hoses and blocked filters. Make the required repairs before continuing.
- When the pressure is even, set at the desired operating pressure. Record litres per minute from the rate controller display to fine-tune the flow meter (see flow meter calibration).
- Without turning the spray unit off, collect water from at least four nozzles per section for one minute (check ends and middle of the section and note where the samples came from).



Step 4: Perform a rapid wear test

If checking an existing set of nozzles, install a reference nozzle. Ideally, this will be one kept aside at purchase, or, where this is not available, use a nozzle of the same brand, type and size as the one you are checking.



- Check and record the output of the reference nozzle at your operating spray pressure.
- Nozzle outputs are best weighed using an accurate set of scales – the increments on many jugs are not accurate.
- Weight is important when calibrating air-induction or twin-fluid nozzles – the spray solution (even clean water) will include some air. This reduces the density and makes volume-based measurements inaccurate.
- Use a known test weight to check the scales for accuracy. A \$1 coin weighs nine grams and is a handy reference.
- Tare the jug, collect clean water from the sprayer for one minute and weigh this (one gram is equal to one millilitre).
- Record the weight and calculate the flow rate of your reference nozzle.
- Calculate the maximum tolerated flow rate: flow rate of the reference nozzle + 10 per cent. On a calculator this can be done by multiplying the reference nozzle flow rate (litres per minute) by 1.1.
- Collect the spray from at least four nozzles per section for one minute (at the same operating pressure as the reference nozzle), weigh the outputs and compare these to the maximum tolerated flow.
- If one or more of the nozzles tested per section exceeds the maximum tolerated flow, replace all nozzles.



TIP

From each set of nozzles purchased, keep one aside as a reference for calibration later on.



Photo: Bill Gordon



Measuring nozzle output by weight



Keeping a reference nozzle

Step 5: Uniformity test (checking all nozzle outputs)

A uniformity check should be undertaken to check new nozzles or when the wear test shows nozzles are below the maximum tolerated flow.

Uniformity tolerance for all the nozzles across the boom should be within plus or minus 5 per cent of the average flow rate for all of the nozzles.

To do this, measure the output of all nozzles on the boom and calculate the average flow rate.

Average flow rate (L/min) = total of all flow rates tested ÷ the number of nozzles tested

Ways to check the output of every nozzle include the following.

- Use an accurately calibrated jug(s) or weigh the output of each nozzle.
 This is the slowest, but most accurate method.
- Use a tip tester this is the fastest method, but requires that you weigh a number of samples to calculate the total flow rate through the boom to check the controller.
- Use an off-the-shelf nozzle flow meter this is a relatively fast method, but flow meters can only measure the total volume per unit of time. Total volume may not be accurate enough to measure the outputs of air-induction or twin fluid nozzles, as the total volume may contain both liquid and air. Where air may be included in the volume, it is best to measure nozzle outputs by weight of the spray solution for a given period of time.



Photo: Graham Betts

HOW TO USE TIP TESTERS

When a liquid with a density of one (water, no air included) flows through the tip tester the flow rates indicated are reasonably accurate. However, the increments of flow on some models may not be small enough to accurately measure some of the smaller nozzles sizes (01 and 015) to plus or minus five per cent.

Typically the graduations on a tip tester increase in 40 millilitres perminute increments. This is 10 per cent of the flow rate of a 01 orifice at 3 bar pressure (not suitable for this size), but is 5 per cent of an 02 orifice at 3 bar, which is suitable for this purpose.

Do not rely on tip testers to give an accurate reading of flow rate when testing air-induction nozzles as the density of the volume will affect the accuracy of the reading.

However, tip testers can be used for air-induction nozzles – as a measure



of relativity. If a mark is placed on the tip tester for the flow rate of your reference nozzle (same air induction) at the desired operating pressure, this can be used to compare with the outputs of other nozzles.

Make sure that all nozzle outputs are within 5 per cent of the reference nozzle output, then weigh several samples from individual nozzles, calculate and record the total flow rate through the boom and the average L/min for each of the nozzles.



Step 6 Final step

Check the controller flow rate (litres per minute) against your measurements (total L/ min - actually measured). This will give an indication of the accuracy of the flow meter and flow meter calibration.

TIPS

- Install a new set of nozzles before calibrating flow meters.
 - Check scales for accuracy use a \$1 coin (nine grams) as a reference weight. Make adjustments to scales if necessary/possible. (One litre of water is equal to 1000 grams).
 - Multiply the size of the nozzle by four to give litres per minute at 3 bar, for example $0.2 \times 4 = 0.8$ L/min at 3 bar. This equals 0.8 kilograms. This formula should work for all ISO nozzles.
 - Tare the jug to ensure accuracy remember that the incremental volume marks on jugs may be inaccurate.
 - Discard and replace nozzles that vary by plus or minus (±) 5 per cent or more from the manufacturer's specifications.
 - If installing a new set of nozzles, keep at least one nozzle as a reference for future calibration checks.



5. Flow meter calibration

Flow meter calibration should be carried out at least once every 12 months, preferably more often, or when a replacement flow meter is installed.

Calibration of the flow meter is also recommended when increasing the litres per minute delivered by the spray unit as a result of fitting significantly larger nozzles, for example, going from 02 to 04 orifice sizes.



Flow meter: PPU figure on cable Photo: Teejet

All flow meters come with a factory calibration number tag figure. For example, a tag figure of 120 pulses per unit (PPU) indicates the number of pulses that come from the flow meter to the rate controller while one litre of water passes through it. The adjustment of this flow constant can be achieved by fine-tuning this figure using the following steps.

NB: before commencing, it is assumed that you have already measured the pressure at the nozzle.

Step 1: Record the flow meter constant.

- Step 2: Operate the entire boom at the desired working pressure. Record the total litres per minute for the entire boom from the rate controller.
- Step 3: Compare the rate controller readout to the actual litres per minute already calculated from weighing the nozzle outputs.

Alternative to steps 2 and 3: Disconnect the main feed hose after the flow meter (before boom valves) and run the boom for a known period of time into a calibrated drum (at least 100L), or use an accurate scale to weigh the output for a set time and calculate L/min.



Step 4: If there is a difference between actual litres per minute and rate controller litres per minute, use the following formula to fine-tune the flow meter.



New UPP	_	Old UPP	v	Actual (weight) L/min					
(flow constant)	=	(flow constant)	^	Rate controller flow rate (L/min)					

Using a calculator:

Formula 2: Units per pulse (UPP)

New UPP = Old UPP x Actual (weighed) L/min ÷ Rate controller flow rate (L/min)

5.1 Spraying liquids other than water (density differences)

The density of the solution being sprayed can affect the accuracy of the impellerbased flow meters, as they are factory calibrated using water. Electromagnetic flow meters will be less affected by density.

Some rate controllers allow the operator to determine a density factor. Where this feature is not available, a conversion factor can be used when spraying liquids that are heavier or lighter than water (Table 1).

To determine the density of a liquid, accurately weigh one litre of water (1000 grams). Mark the container at this point, ideally at the bottom of the meniscus.

Fill the container to the one-litre mark with spray solution from the agitated spray tank. (When testing actual tank mixes, ensure you use appropriate personal protective equipment.)

Weigh this sample and record density in kilograms per litre. If the spray solution is found to have a density of 1.2kg/L, using the figures in Table 1, the conversion factor would be 1.10.



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Impact of density on the accuracy of a calibration

Density (kg/L)	Conversion factor
0.84	0.92
0.96	0.98
1.00 WATER	1.00
1.08	1.04
1.2	1.10
1.28 – 28% NITROGEN	1.13
1.32	1.15
1.44	1.20
1.68	1.30

Table 1

Source: TeeJet® Technologies Catalog 51-AM p.141

For a rate controller without density settings, use the conversion factor to manipulate the application rate. For example, if the required application rate is 100 litres per hectare, mix the spray solution at 100L/h, but set the rate controller to deliver 110 litres per hectare:

100L/ha x 1.1 conversion factor = 110L/ha

Entering 110L/ha into the controller will actually deliver 100 L/ha for the tank mix with a density of 1.2

Applicators will notice when spraying liquids heavier than water that the pressure indicated on the pressure gauge will be higher than would normally be the case (to achieve the desired flow rate).

WARNING

Some rate controllers allow the operator to set a liquid density figure to a number higher or lower than one (where one litre of water weighs one kilogram).

If this setting is altered, the operator needs to ensure it is readjusted at the completion of the specific application.



6. Inflow meters or tank filling meters

Match inflow meters to the rate controller

Once the rate controller has been calibrated and fine-tuned, use it as the calibration standard for the inflow meter.

- Step 1: Record the tag figure or calibration number of the inflow meter.
- Step 2: Drain the spray tank until empty.
- Step 3: Pump 1000 litres of water into the spray tank though the inflow meter. If using a petrol-driven pump, mark the location of the accelerator on the pump motor. Record the volume per minute from the inflow meter – this enables you to check the consistency of supply over time.



Infill meter used to fill the tank

Photo: Graham Betts

Step 4: In the tractor, clear the total litres sprayed in the rate controller. Operate the sprayer at the operating pressure according to your spray plan until the sprayer is empty. Record the total volume pumped out from the rate controller.

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Step 5: Calculate a new constant for the inflow meter.

New PPU (inflow constant) Old PPU (inflow constant) Inflow meter (total litres) Accurate controller (total litres)

Using a calculator:

New PPU = Old PPU x inflow meter (total litres) ÷ rate controller (total litres)



Worked example:

Inflow meter tag indicates the PPU is 650 Our inflow meter reads 1000 litres The accurate rate controller pumped out 990 litres

New PPU (inflow) =

Old PPU x Inflow meter total litres ÷ rate controller total litres

- = 650 x 1000 ÷ 990
- = 656.56 as the new PPU constant for the inflow meter

Step 6: Make a final check.

Drain the sprayer again. For this final check, put 20 litres in the spray tank to prevent the sprayer sucking air. Use the inflow meter to add 1000 litres. Use the same RPM as before. Check that the volume per minute is the same as in Step 2.

Clear the rate controller total volume. Operate the spray unit at the operating pressure as per your spray plan until 1000 litres has been applied. Drain the sprayer and 20 litres should be recovered.



7. Tank calibration

7.1 Preferred method

Before starting your tank calibration, make sure the spray unit is on level ground.

- Use a calibrated inflow meter to check and re-mark tank graduations.
- This is a two-person job a constant supply is critical.
- Using the same supply-pump RPM, water source and volume per minute, add water to the spray tank.
- One person should mark the tank as the other calls out the volume from the flow meter in 100-litre increments.
- Use the inflow meter to check the capacity of the fresh water tank as well.



When connecting to different water sources, inflow meters may vary in their accuracy. A simple check is to flow water to the point of run-off into your calibrated induction (mixing) hopper. This will quickly check flow meter accuracy.

7.2 Alternative method (where an in-fill meter is not available)

If the sprayer flow meter is accurately calibrated, fill the tank to a known point (full mark) and add a mark to the tank or site gauge at this point. As you pump out liquid, record marks on the tank or site gauge for every 100L through the rate controller.

Once the tank is empty, note the total litres through the controller and record this volume at the full mark. Work your way down the tank or site glass, recording the volume at each mark by reducing the previous figure by 100L each time.

The tank capacity at the full mark can also be checked using an accurate weighbridge. Check the weight when the sprayer is empty and when it has been filled to the full mark and subtract the difference. Remember, one litre of water is equal to one kilogram.





Tank calibration

8. Calibrate induction hoppers

Never assume that the graduations on an induction hopper are correct.

To calibrate the graduations on the induction hopper:

- make sure the hopper is level;
- use a one or five-litre calibrated jug (one litre is equal to one kilogram);
- add known volumes to the hopper, marking the levels as the hopper fills;
- continue this process until the total capacity, to the point of run-off, has been determined; and
- mark this full capacity (volume) on the side of the hopper.

Once the hopper has been calibrated, the hopper capacity can be used to check the inflow meter accuracy when connecting to different water sources. If the hopper becomes damaged or misshapen, repeat the process to ensure the calibration is still accurate.



Fenceline spraying introduction



Calibration of fenceline nozzles is critical to avoiding under or over-dosing. This is true for all nozzles used to apply bands.

The key to calibrating any nozzle applying a band is to know the sprayed width in metres.

9.1 Sprayed width per nozzle

"Sprayed width per nozzle" usually refers to the nozzle spacing on a boom, but the term can also be applied to other situations.

Fenceline nozzle sprayed width



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Calibrating fenceline nozzles and banded sprayers



Sprayed width can also be:

- the actual width sprayed by a single nozzle onto the ground (a fenceline nozzle may spray a width of three metres or more);
- the average width of nozzles under a shield (2 nozzles under a 90-centimetre shield = 0.45m);
- the average width of multiple nozzles directed at a plant row (3 nozzles per 1-metre row = 0.333m).

Once the sprayed width per nozzle is known, the same formulas can be applied to calculate the L/ha, regardless of the spraying situation.

Litres per hectare (L/ha) = Litres per minute per nozzle x 600 \div width (metres) \div speed (kilometres per hour)

Rearranging this formula, we can also determine the required nozzle flow rate, width or speed:

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

9.2 Calibrating and adjusting fenceline nozzles

The use of high-flow fenceline jets, such as XP (TeeJet[®]) or XT (Hypro), is becoming more popular.

Fenceline nozzles are often not adjusted correctly to ensure that the sprayed width matches the actual flow rate to deliver the same dose as the rest of the boom. These jets have the capacity to throw a significant distance (up to five metres) as well as applying a significant volume of water.

It is important to check the effect of these nozzles when attached to the end boom section as they can reduce the operating pressure of this boom section. This may result in efficacy reductions near the paddock's edge.

However, if set up correctly – plumbed as a separate section with the width recorded in the controller – high-flow jets can be valuable to maintain fenceline hygiene.

Steps for calibrating and adjusting high-flow fenceline nozzles.

Step 1: Set the boom to operating height and set the operating pressure.

Set the pressure to represent the actual operating parameters – remember that operators will often drive more slowly along fencelines to avoid damage. One way of achieving this is to enter a test speed and application rate into the rate controller to simulate field conditions.



Step 2: Use a calibrated testing gauge on the end section.

Turn the end jet on and check for a pressure drop in the end boom section. Test the pressure at the fenceline jet and record this pressure.

- Step 3: Catch and weigh the volume per minute (L/min) delivered from the end jet.
- **Step 4:** Determine the required sprayed width to match your intended application rate using the following formula.

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

Worked example:

Using an XP 10R nozzle at 3 bar pressure the nozzle output was measured at 3.95 litres per minute.

Nozzle height was set at 70 centimetres.

Spraying speed is 18 kilometres per hour.

The target application rate to match the rest of the boom is 90L/hectare.

Using the formula: Width (m) = litres per minute per nozzle x 600 L/ha \div speed (km/h) \div L/ha

Width (m) = 3.95L per minute x 600 \div 18 km/h \div 90 L/ha = 1.46 metres

Step 5: Adjust the angle or orientation of the nozzle to achieve the required sprayed width at the target weed height.

Alternative method to calculation

Where the nozzle height and flow rate match the manufacturers charts, they may be used to work out the applied rate.



		25	km/h	22	23	25	25	25	39	42	44	44	45	48	47	53	54	55	73	71	81	83	83	113	3 122	3 141	145	153
		20	km/ł	28	29	31	31	31	49	52	55	56	56	60	58	67	67	69	91	89	101	104	104	141	153	176	181	192
	0cm	16	km/h	35	36	39	39	39	61	65	69	69	70	76	73	83	84	86	114	112	127	130	130	176	191	220	226	240
	ght of 9	12	km/h	47	48	52	52	52	82	87	92	93	93	101	97	111	112	114	151	149	169	173	174	235	255	293	302	320
	zzle hei	10	km/h	56	57	62	62	62	98	104	110	111	112	121	116	133	134	137	182	179	203	208	208	282	306	352	362	384
speeds	Ž	œ	km/h	20	71	78	78	78	123	130	137	139	140	151	145	167	168	171	227	223	254	260	260	353	383	440	453	479
irious sp		9	km/h	94	95	104	104	103	164	174	183	185	186	201	194	222	223	229	303	298	338	347	347	470	510	587	604	639
de at va		4	km/h	141	143	156	156	155	245	261	275	278	279	302	291	333	335	343	454	447	507	520	521	705	765	880	905	959
gle nozz		25	km/h	26	26	28	27	27	49	44	46	46	48	51	52	57	57	58	79	62	89	89	06	133	133	152	159	162
or a sin		20	km/h	32	32	35	34	34	62	55	58	58	59	64	64	71	72	73	66	98	111	111	113	166	166	190	199	203
L/ha f	30cm	16	km/h	41	40	44	42	43	77	69	72	73	74	80	81	89	89	91	124	123	139	139	141	207	208	238	249	253
	ight of (12	km/h	54	54	58	56	57	103	92	96	97	66	107	107	119	119	122	165	164	185	185	188	276	277	317	332	338
	Nozzle he	10	km/h	65	65	70	67	68	124	110	115	116	119	128	129	143	143	146	198	197	222	222	225	332	333	381	398	405
			- h/m>	81	81	87	84	85	154	138	144	145	149	161	161	179	179	183	247	246	277	277	282	414	416	476	498	507
			tm/h	108	108	116	112	114	206	184	192	194	198	214	215	238	239	243	329	328	370	370	376	553	554	635	664	675
			m/h	162	162	174	168	171	309	276	288	290	297	321	322	357	358	365	494	491	555	554	563	829	832	952	996	1013
	د ژ	Ō	E	3.0	3.4	3.8	4.1	4.4	3.4	3.7	4.3	4.6	4.9	3.4	4.1	4.4	4.7	4.9	3.7	4.4	4.7	4.9	5.3	4.7	5.0	5.3	5.5	5.6
Spra	width (metre	0	о Е	2.6	3.0	3.4	3.8	4.0	2.7	3.5	4.1	4.4	4.6	3.2	3.7	4.1	4.4	4.6	3.4	4.0	4.3	4.6	4.9	4.0	4.6	4.9	5.0	5.3
		Flow rate 6 for one	nozzle (L/min)	2.81	3.23	3.95	4.26	4.55	5.56	6.43	7.87	8.52	9.12	6.85	7.95	9.77	10.5	11.2	11.2	13.1	15.9	17.0	18.4	22.1	25.5	31.1	33.2	35.8
		Spray quality		nc	UC	NC	NC	nc																				
		Pressure (bar)		1.5	2.0	3.0	3.5	4.0	1.5	2.0	3.0	3.5	4.0	1.5	2.0	3.0	3.5	4.0	1.5	2.0	3.0	3.5	4.0	1.5	2.0	3.0	3.5	4.0
		Nozzle size		10					20					25					40					80				

10. Tips for calibrating other sprayers

Pulse-width modulation

- Calibrate flow meter in manual with nozzles operating at full capacity (100 per cent duty cycle).
- Ensure density setting is on 1.
- Measure the output against the rate-controller flow rate (litres per minute), or disconnect the hose to a single section and accurately measure or weigh the output.

Multi-step sprayers

- Use the test speed function and volume (L/hectare) to make the sprayer operate at the desired pressure at the nozzle to check the nozzle outputs.
- Adjust test speeds to ensure each step is activated and operated at a known pressure to check nozzle outputs.

Twin-fluid sprayers

- Check nozzle flow outputs with the air on as this may affect liquid flow through some nozzles.
- Always check the nozzle outputs using the weight of the spray solution, rather than volume, as the spray solution after leaving the nozzle may include a lot of air in it.



NEXT MODULE

SPRAY APPLICATION MANUAL FOR GRAIN GROWERS Module 9 Mixing, filling and transfer systems Techniques and tips to increase efficiency



