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MANAGING VARIATION IN SPRAYING SPEED FACT SHEET

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OPTIONS FOR MANAGING VARIATIONS IN SPRAYING SPEED AND MAINTAINING SPRAY QUALITY

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KEY POINTS

- Spraying systems that allow for an increased range of spraying speeds can help to reduce overdosing or can prevent nozzle patterns from collapsing when the sprayer slows down
- Systems that can maintain spray quality as the spraying speed changes can improve spray coverage and minimise drift potential
- Pulse width modulation systems and twin fluid systems can maintain spray quality over a wider range of spraying speeds than a standard single line sprayer
- All spraying systems, including the newer ones, will require more than one set of nozzles (or set-ups) to cover all spraying situations

Pulse width modulation systems utilise standard fans or pre-orifice nozzles. Air induction nozzles should not be fitted to these systems.

Introduction

With the trend towards increased spraying speeds, particularly where the average is above 20 kilometres per hour, there is a need to be able to better control application volume and spray quality when the sprayer slows down. This is particularly important when negotiating obstacles, such as trees and contour banks, or travelling up and down slopes and sand hills.

As spraying speed changes, most standard, single line sprayers fitted with automatic rate controllers adjust the pressure to maintain the target application volume (litres per hectare). This change in pressure results in a change in the spray quality (droplet sizes) produced by the nozzles.

Most standard spraying systems fitted with hydraulic nozzles can only reduce the spraying speed by between 5 and 8 km/h below the average spraying speed before the pressure will become too low for the nozzles to function effectively. When the pressure at the nozzle is too low the spray quality can become too coarse, or the fan angle can collapse and the spray pattern becomes too narrow.

Alternatively, where the minimum setting (for speed, pressure or flow) in the automatic rate controller has been activated,

preventing the pressure from dropping too low, overdosing may occur. This can lead to increased chemical costs and may cause damage to crops or increase the risk of exceeding residue limits.

Options for managing variations in spraying speed and maintaining spray quality

There are a number of newer spraying systems that can assist the operator in managing speed variation and some that also maintain spray quality.

These options can be grouped into two general categories:

- systems that can maintain the application volume over a wider range of spraying speeds; and
- systems that maintain spray quality and can increase the range of spraying speeds.

Systems that maintain application volume over a wider range of the spraying speeds

Variable rate nozzle bodies (e.g. the VariTarget® Nozzle)

These systems employ a retrofit nozzle body that reduces changes in spray line pressure at the nozzle without affecting flow rates, which minimises changes in spray quality when compared to a standard hydraulic nozzle.

A single VariTarget® nozzle effectively gives the operator flow rates equivalent to using two or three different nozzle sizes. For example, the blue coarse nozzle will maintain a coarse droplet size from 0.57 L/minute up to 1.5 L/min. The range in flow rates is similar to going from an 02 orifice through to an 04 orifice. (The nozzle can produce a wider range of flows, but the droplet size is reduced at higher pressures).

PHOTO: WWW.SPRAYTARGET.COM

VariTarget® nozzles allow a wider range of flow rates with minimal change in pressure at the tip.

Strengths

- Less expensive than re-plumbing the whole boom
- Utilise the existing automatic rate controller
- Good option for variable rate fertiliser applications as a streaming nozzle

Dual boom on a single line at 25cm spacings fitted with 015 and 02 size nozzles, each size controlled by air valves and air solenoids.

PHOTO: BILL GORDON

Possible limitations

- Tend to stick out from most boom designs, increasing the risk of damage
- Nozzle choice is limited (e.g. a single type for coarse)
- Spray quality data according to ASABE S572.1 does not appear to be published and droplet size information is based on droplet size classed dV0.1, 0.5 and 0.9

Multiple-tier or multi-step systems (dual booms or systems equivalent to two or more spray lines)

These systems employ two or more sets of nozzles, either on a single spray line or on two separate spray lines, relying on an automatic rate controller that is designed to switch between the two (or more) sets of nozzles when particular speeds or flow rates are reached.

Typically these systems are set up to switch from one nozzle, to the next, then to both (if required). Some older versions only switch directly from one nozzle to both, making it difficult to run air-induction nozzles on these systems unless a larger orifice size is used as the first nozzle, and a smaller one as the second (e.g. 025 and 015).

Versions available are:

- two separate spray lines controlled by dual boom rate controller; and
- single spray line with multiple nozzle bodies, plumbed either in line with each other, or at a narrower nozzle spacings (typically 25 centimetres). Individual nozzles can be controlled by air valves /solenoids or by using electronic solenoids.

Strengths

- Increased range of spraying speeds or greater range of application volumes than a standard single line sprayer (at least double the effective speed range)
- Potential for narrower nozzle spacings when both spray lines are operating together
- Air valves and electronic solenoids can allow for boom recirculation / boom prime
- Electronic solenoids can allow for individual nozzle section control

Possible limitations

- Continuous changes to spray quality as spraying speed changes, given that the flow rate and pressure still are still controlled by a rate controller in response to the speed
- Certain speed and volume combinations need to be avoided as they can result in the wrong spray quality (often when both lines start to run at the same time)
- Nozzle selection to match desired or legal spray qualities for all speeds and volumes can be very challenging
- Typically smaller orifice sizes required may increase blockages unless good filtration and correct mixing are used
- The current draw on some solenoid-based systems needs to be considered for wider booms
- Systems utilising air valves may not offer individual nozzle section control, but typically rely on the number of sections the machine has been plumbed with.

Spray systems that can manage both speed variation and spray quality

Pulse width modulation (PWM) (for example, Capstan Sharpshooter®, Case AIM command®, Raven Hawkeye®)

Pulse width modulation maintains the desired pressure in the spray line, which means that the spray quality (droplet sizes) does not change as the spraying speed changes.

The flow rate is controlled electronically at the nozzle by adjusting the length of time that a high-speed solenoid in the nozzle body is open and closed, which causes the nozzle to pulse many times each second. The higher the number of pulses per second, the more accurate the application is likely to be.

To operate these systems effectively the operator needs to consider the percentage of time that the nozzle is open (as compared to closed). The percentage of the time the system is open is often referred to as the duty cycle, and generally needs to be operated so that the minimum duty cycle (at the lowest operating speed) remains above 50 per cent for coarse droplets, but can be as low as 30 to 40 per cent for smaller droplet sizes as they redistribute more easily than the larger ones.

Typically these systems will provide a greater range of spraying speeds than a standard single line sprayer. When operating at average spraying speeds and volumes close to 100 per cent of the duty cycle, the minimum speed would be about half of the average spraying speed to keep the duty cycle above 50 per cent.

Strengths

- Spray quality (droplet size) does not change when speed is changed
- Spray quality can be adjusted on the go, from the sprayer cab
- Control at the nozzle allows for boom recirculation / boom prime systems
- Many models can allow for single nozzle section control
- Many models can now provide turn compensation (flow adjustment across the boom)
- Some models may allow flow to be increased on wheel tracks without changing nozzles

Possible limitations

- Duty cycle must be considered to determine realistic range of spraying speeds
- Two different sets of nozzles should be used for different situations (a coarse set and a medium set)
- Increased maintenance may be required, compared to a standard spray system

Twin Fluid Systems (Utilise air from a compressor injected into the spray liquid, which is delivered through hydraulic, anvil-style nozzles)

These systems operate the nozzles in a similar way to standard air-induction nozzles, but rather than using a venturi to draw air into the nozzle, a compressor is used to produce either air-included droplets or solid droplets. By controlling the air pressure from the compressor the droplet size can be adjusted, so that a range of spray qualities can be obtained from a single nozzle.

Liquid flow is regulated by a standard automatic rate controller. However, there are two main differences in the systems

FIGURE 1 Boom outputs (L/ha) for various nozzle size, pressure and speed combinations (three-step system, each step – spray line – is based on a 50cm spacing).

Nozzle size	Pressure (bar)	Flow rate (L/min/nozzle)	Speed (km/h)													
			6	8	10	12	14	16	18	20	22	24	26	28	30	32
015	2	0.48	96.0	72.0	57.6	48.0	41.1	36.0	32.0	28.8	26.2	24.0	22.2	20.6	19.2	18.0
	3	0.59	117.0	87.8	70.2	58.5	50.1	43.9	39.0	35.1	31.9	29.3	27.0	25.1	23.4	21.9
	4	0.68	135.0	101.3	81.0	67.5	57.9	50.6	45.0	40.5	36.8	33.8	31.2	28.9	27.0	25.3
	5	0.75	150.0	112.5	90.0	75.0	64.3	56.3	50.0	45.0	40.9	37.5	34.6	32.1	30.0	28.1
	6	0.83	165.0	123.8	99.0	82.5	70.7	61.9	55.0	49.5	45.0	41.3	38.1	35.4	33.0	30.9
	7	0.89	177.0	132.8	106.2	88.5	75.9	66.4	59.0	53.1	48.3	44.3	40.8	37.9	35.4	33.2
02	2	0.64	128.0	96.0	76.8	64.0	54.9	48.0	42.7	38.4	34.9	32.0	29.5	27.4	25.6	24.0
	3	0.78	156.0	117.0	93.6	78.0	66.9	58.5	52.0	46.8	42.5	39.0	36.0	33.4	31.2	29.3
	4	0.90	180.0	135.0	108.0	90.0	77.1	67.5	60.0	54.0	49.1	45.0	41.5	38.6	36.0	33.8
	5	1.00	200.0	150.0	120.0	100.0	85.7	75.0	66.7	60.0	54.5	50.0	46.2	42.9	40.0	37.5
	6	1.10	220.0	165.0	132.0	110.0	94.3	82.5	73.3	66.0	60.0	55.0	50.8	47.1	44.0	41.3
	7	1.18	236.0	177.0	141.6	118.0	101.1	88.5	78.7	70.8	64.4	59.0	54.5	50.6	47.2	44.3
035	2	1.12	224.0	168.0	134.4	112.0	96.0	84.0	74.7	67.2	61.1	56.0	51.7	48.0	44.8	42.0
	3	1.37	273.0	204.8	163.8	136.5	117.0	102.4	91.0	81.9	74.5	68.3	63.0	58.5	54.6	51.2
	4	1.58	315.0	236.3	189.0	157.5	135.0	118.1	105.0	94.5	85.9	78.8	72.7	67.5	63.0	59.1
	5	1.75	350.0	262.5	210.0	175.0	150.0	131.3	116.7	105.0	95.5	87.5	80.8	75.0	70.0	65.6
	6	1.93	385.0	288.8	231.0	192.5	165.0	144.4	128.3	115.5	105.0	96.3	88.8	82.5	77.0	72.2
	7	2.07	413.0	309.8	247.8	206.5	177.0	154.9	137.7	123.9	112.6	103.3	95.3	88.5	82.6	77.4

* Note that the output related to an orifice size of 035 is what would occur when both 015 and 02 nozzles are running together.

PHOTO: WWW.AIRTECAUSTRALIA.COM.AU

Airtec nozzle: Twin fluid nozzles utilise compressed air to manipulate droplet size.

that are available, those that require air pressure to be adjusted manually and those which can do this automatically.

Systems where the air pressure has to be adjusted manually (Standard Airtec or Optispray®)

These systems usually have the ability to hold a spray quality over a slightly wider range of speeds than a standard single line sprayer. Generally, the Optispray® has a wider range of operating speeds than the standard Airtec system.

Systems that can adjust the air pressure in response to liquid flow

These systems maintain spray quality as spraying speed changes (examples include Airtec fitted with a Magic Box or the TeeJet Airmatic®).

Strengths

- Spray quality can be adjusted without changing nozzles
- Some systems can adjust air pressure automatically to maintain droplet size as speed changes
- The system utilises only one set of nozzles, with inserts/restrictors that can be changed for large changes in the target application volume (L/ha).

Possible limitations

- A single orifice size (inserted into nozzle body) may not cover all application volumes without adjusting speed
- The insert that controls the flow rate may need to be changed to maintain spray quality when switching application volumes or to increase the spraying speed range
- Nozzles are typically angled backwards, which may increase drift potential
- Compressors add additional weight and may require additional maintenance.

Conclusion

The decision to upgrade your spraying system should be based on your needs. A careful analysis of the costs and potential benefits of a new spray system should be undertaken before purchase. The benefits of maintaining droplet size or avoiding overdosing should not be underestimated.

An increased speed range where the sprayer will operate effectively can be useful for some operators, particularly in situations where large variations in spraying speed are unavoidable.

Many of the options discussed in this fact sheet can be retrofitted onto almost any sprayer.

THE TWO MOST FREQUENTLY ASKED QUESTIONS (EVER)

Is there a spraying system where I will never have to change the nozzles?

Probably not.

Which system should I buy?

This should be based on your own needs, so it helps to make a list of what you need the sprayer to do, as well as an additional wish list of what you would like it to do.

Always consider the range of travel speeds you would normally do in a season. Also think about the range of application volumes and spray qualities you need to cover all spraying situations.

Then do your homework on what each of the spraying systems can actually do, what nozzles they would require to meet your needs, and how well it can integrate with existing equipment such as GPS.

The decision should also be based on service availability. Whichever system(s) you narrow your choice down to, choose the system that will have someone there to repair it quickly when something goes wrong. After all, many of these systems can be retrofitted onto your favourite platform.

MORE INFORMATION

Contact the spray manufacturers or the local agent for technical information about their spray systems.

For assistance with nozzle selections or advice before purchase contact Bill Campbell, bill@farmanco.com.au or 0427 545 553

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