Sprayers 101 Workshops

*4 August 2026, **Leeston***

*5 August 2026, **Ashburton & Timaru***

*6 August 2026, **Oamaru***

*7 August 2026, **Gore***

*10 August 2026, **Masterton***

*11 August 2026, **Ongaonga***

*12 August 2026, **Bulls***

*13 August 2026, **Te Awamutu***

*14 August 2026, **Te Puke***

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- **Timaru:** Fraser Park, 382 Church Street, West End, Timaru 7910
- **Oamaru:** Weston Hall, 20 Main Street, Weston 9401
- **Gore:** Croydon Lodge Hotel, 100 Waimea Street, Croydon, Gore, 9776
- **Masterton:** Copthorne Hotel, 230 High Street, Solway, Masterton 5810
- **Ongaonga:** Ongaonga Golf Club, 1647 Sate Highway 50, Ongaonga 4278
- **Bulls:** Bulls Community Centre, 4 Criterion Street, Bulls 4818
- **Te Awamutu:** St Andrews Presbyterian Church Te Awamutu, 80 Mutu Street
- **Te Puke:** The Orchard Church Te Puke, 20 MacLoughlin Drive, Te Puke 3153

Thank you to A Lighter Touch for providing refreshments for these events.

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The droplet size debate

Tom Wolf, Sprayers 101

Key takeaways:

- Droplet size is a tradeoff: small droplets improve coverage and water efficiency, large droplets reduce drift; priorities determine the ideal choice.
- Evaporation and drift disproportionately affect small droplets due to higher surface area to volume ratios and lower mass.
- Small droplets penetrate complex canopies and follow air eddies; larger droplets travel straighter and tend to hit the first objects encountered.
- Retention depends on leaf surface chemistry, droplet dynamics, and surfactant speed; small droplets often stick better but formulation matters.
- Use Coarse to Very Coarse sprays at 70 to 120 L/ha; modern nozzles, air inclusion, and PWM help tune performance and cut drift.

This text was generated by OpenAI GPT 5 Mini

Funny how some issues never go away. For as long as I've been in the sprayer business, the question of ideal droplet size for pesticide application has remained a hot topic. At its root are the basic facts that small droplets provide better coverage, making better use of water, but large droplets drift less. So why are we still debating this? Because we need both of these properties to be efficient, effective, and environmentally responsible. Ultimately, the droplet size question is reduced into one of values, where everyone's individual priorities play a role.

First, let's talk about basic principles. To be effective, an active ingredient must make its way from the nozzle to the site of action in the target organism. On the way, it encounters several obstacles as summarized by Brian Young in 1986.

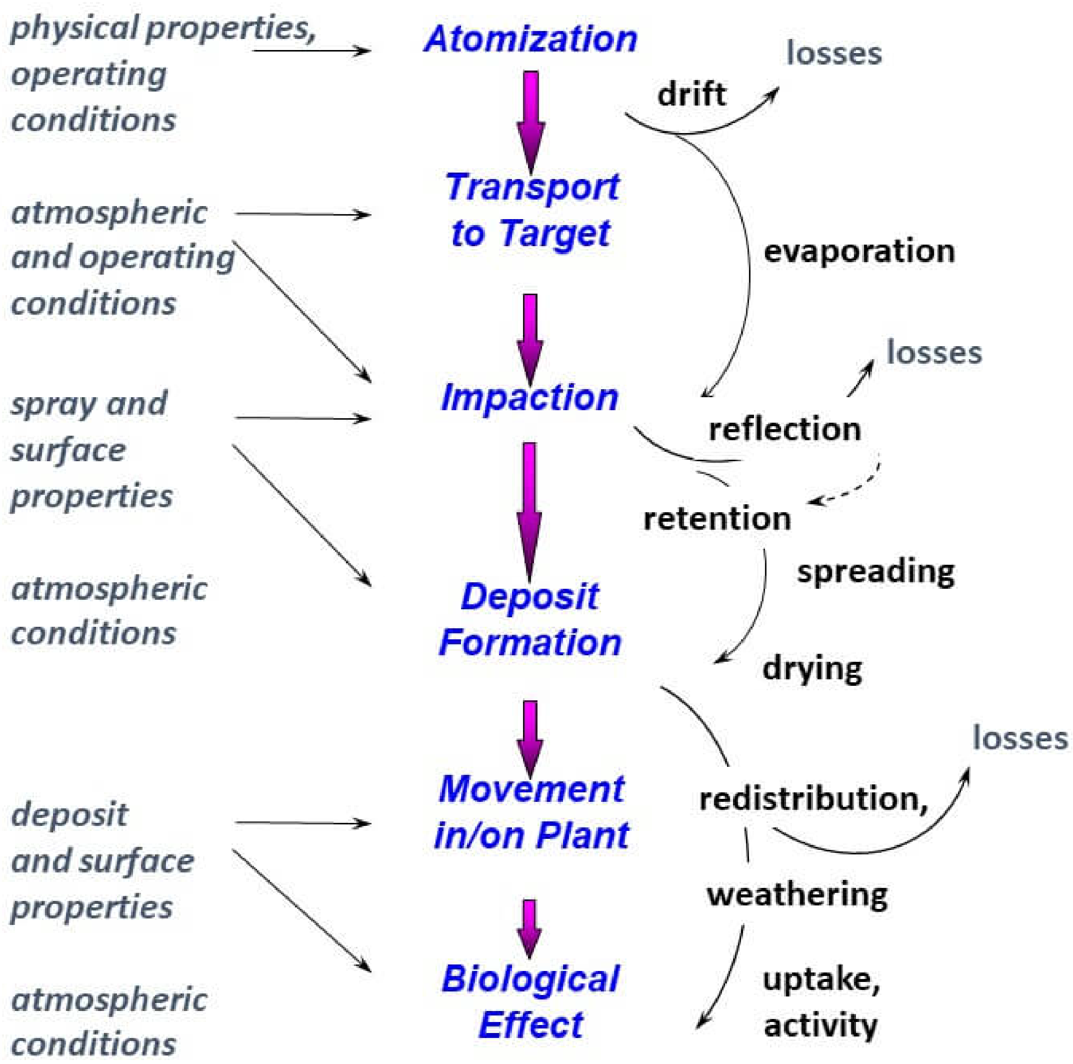

Figure 1. The dose transfer process of pesticides (after Young, 1986)

After atomization and before impaction, the spray encounters two main losses, evaporation and drift. Both of these are more severe for smaller droplets. Smaller droplets have a greater ratio of surface area to volume for any given spray volume, and can evaporate to a much smaller size, even to dryness depending on the formulation, in seconds. For water-soluble formulations, one consequence is lower uptake. Oily formulations may maintain efficacy, but neither type can escape the second effect, spray drift.

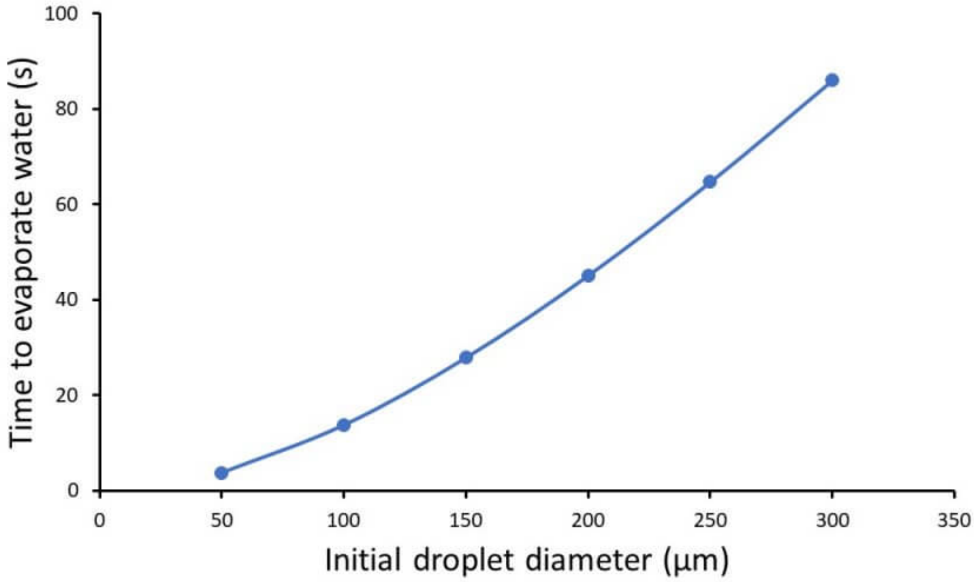

Figure 2. Time to evaporate all water from droplets of various sizes, based on the "two-fluid" model developed by Wanner (1980). Based on 0.8% v/v non-volatile, non-soluble addition, 20 ºC, and 50% RH. This model suggests that final droplet diameter is 20% of initial diameter. Reproduced from Microclimate and Spray Dispersion by Bache and Johnstone (1992, Ellis Horwood Ltd).

Small droplets are more susceptible to displacement by wind currents due to their small mass. There is no magical size above which drift is no longer possible, but we've generally used diameters of 100, 150, or 200 µm as a theoretical cutoff. The proportion of the spray's volume in droplets smaller than these diameters can be called "drift potential", and this value is useful to measure the impact of nozzle type, pressure, or formulation on that phenomenon.

But it's not quite that simple. Even a small droplet may resist drift if its exposure to wind is limited, perhaps through a protective shield shroud, or lower boom height. Or by increasing its speed through air assist. Higher energy droplets resist displacement.

These mitigating strategies aren't lost on sprayer manufacturers who have used them for decades to build lower drift sprayers.

The next phase of the dose transfer process is interception. The droplet has to encounter its target, but the process is mostly coincidence. Simply put, the target has to be in the way of the droplet's flight path for the two to meet. Denser canopies are therefore more effectively targeted. A larger number of droplets (smaller droplets or more carrier) also improve the odds. But it's not that simple. Flight paths can change. That's where small droplets are more inventive. Because they respond to small air currents, and because such small currents surround most objects, the smaller droplets can weave around objects, following the small eddies generated by air flows. As a result, we're more likely to find smaller droplets further down in denser, more complex canopies where the eye can't follow. They simply cascade through.

Larger droplets, on the other hand, resist displacement by air and travel in straighter lines. They tend to hit the objects they encounter. For that reason, larger droplets are intercepted by the first object they reach and only make their way deeper into a canopy if the path is clear. In other words, vertical, sparser objects allow larger droplets to pass by.

These properties are related to the droplet's inertia, and are best described by a parameter known as "stop distance". Assuming an initial velocity, stop distance is the distance required by a droplet to slow to its terminal velocity.

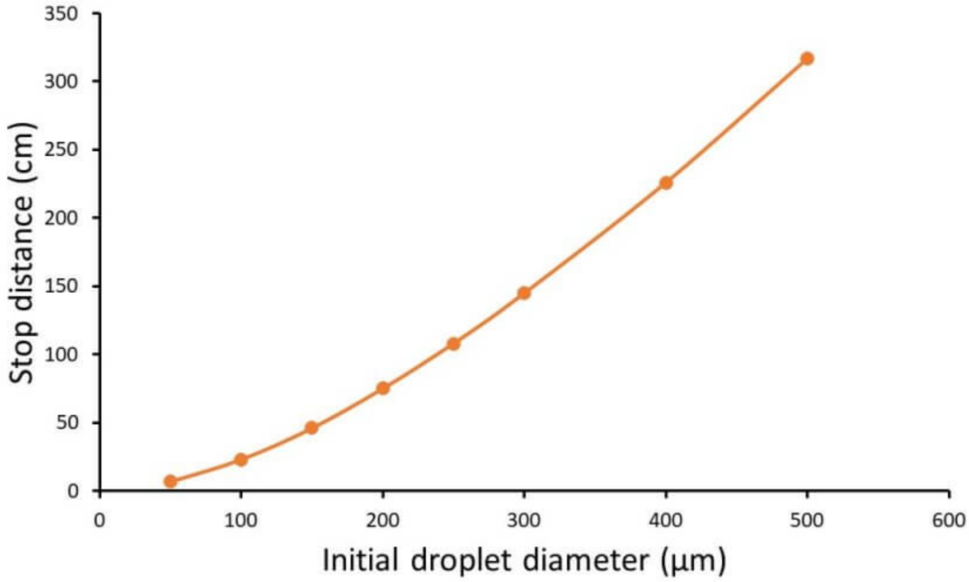

Figure 3. Stop distance as a function of droplet size. Assuming a 20 m/s initial velocity (similar to exit velocity of a hydraulic nozzle) and gravity assistance. Note that smaller droplets without the benefit of air assist lose their initial velocity within a few cm of the nozzle exit. Reproduced from Microclimate and Spray Dispersion by Bache and Johnstone (1992, Ellis Horwood Ltd).

These characteristics, combined with the aerodynamic properties of objects such as tiny insects, cotyledons, leaves, stems, etc. govern the collection efficiency of sprays. Small, slow moving droplets are thus best captured by small objects that don't create strong enough deflections of airflow to steer the droplets past. Large objects that redirect air around them very effectively are better collectors of the larger or faster droplets whose kinetic energy can guide them through this turbulence. It's also a matter of probability, as the smaller objects tend to have a lower likelihood of encountering the relatively scarce large droplets of any given spray.

But once again, that's not the end of the story. Interception is followed by a critical stage, retention. Objects must be able to hold onto the droplets they intercept. Slow motion video has shown that droplets flatten out on contact with an object as the liquid converts impaction velocity into lateral spread. Once at full extension, the flattened droplets will collapse even beyond their original round shape, pushing them away from the surface and possibly causing rebound. A rebounding droplet may eventually land on target, but that would be a matter of fortune. It's better if the leaf can offer enough adhesion, diminishing the power of the rebound oscillation, allowing droplet to stick the first time.

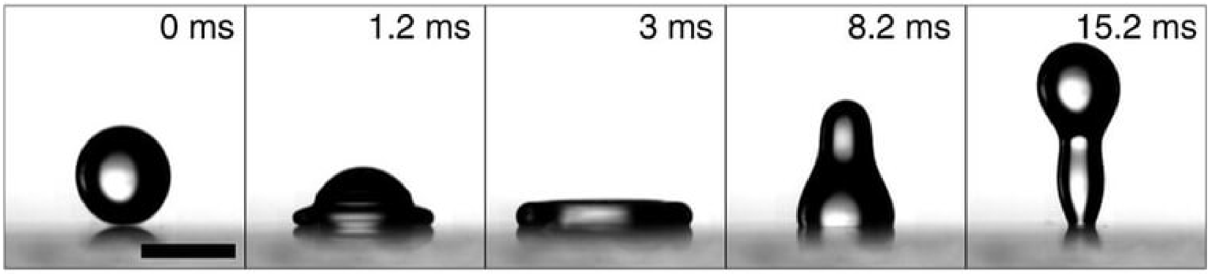

Figure 4. Droplet deformation during impact (C. Hao, et al. 2015. Superhydrophobic-like tunable droplet bouncing on slippery liquid interfaces. Nature Communications. August 2015).

Small droplets have less mass, and tend to be retained more easily. But more than size is at play here. The morphology and chemistry of the leaf surface is also important, with crystalline or more oily surfaces offering less adhesion for droplets. The physico-chemical properties of the spray mixture becomes important, as characteristics such as dynamic surface tension and visco-elasticity affect spray retention. These properties are optimized through the product formulation effort, and possibly via adjuvants added to the tank.

We sometimes classify targets as "easy to wet" or "difficult to wet" to summarize these properties. Most grassy plants (foxtails, cereals) are difficult to wet (there are exceptions, such as the sedges) and broadleaf plants vary from the easy to wet pigweeds to the difficult to wet lambsquarters and brassicas. Easy to wet species can retain larger droplets than difficult to wet species, and that's one reason why finer sprays are preferred for grassy weed control (leaf orientation and size are another).

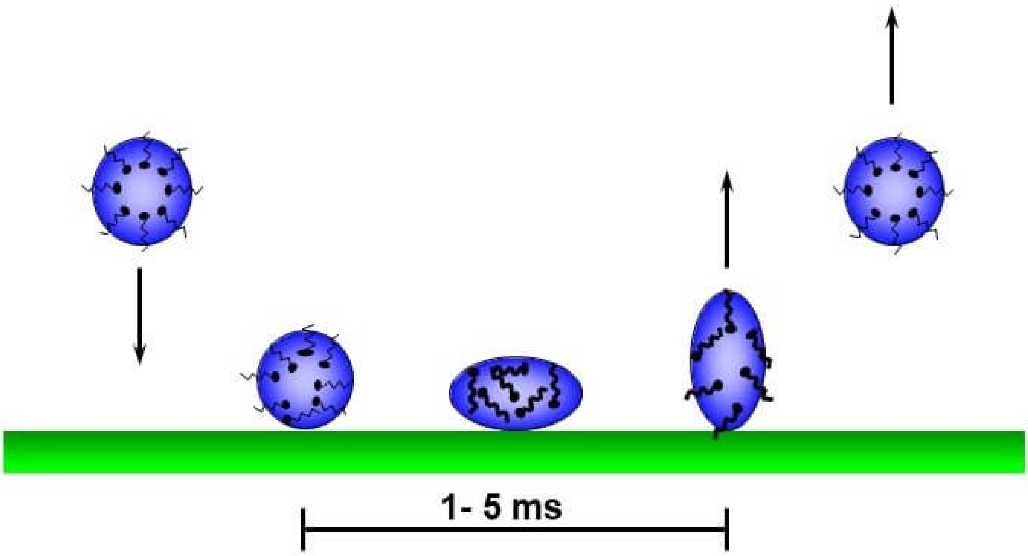

Figure 5: Droplet deformation, and surfactant molecule alignment, during impaction. The inability of surfactants to reach optimal alignment quickly, and for the target surface to absorb these forces, leads to rebound.

A few words about surface tension. Although surfactants reduce surface tension and facilitate spreading, this may not be enough to improve spray retention. To be effective, surfactant molecules need to align themselves with the surface of the droplet so they can be a "bridge" at the interface where the droplet meets the target surface. This takes time. The oscillations that occur during impaction continuously create new surfaces, and if surfactant molecules don't follow suit immediately, the droplet will behave as if no surfactant is present. Specialists measure "dynamic" surface tension, i.e., the surface tension at young surface ages – a few milliseconds – to better predict spray retention. Very young surface ages have surface tensions of plain water, even with a surfactant present. Only certain surfactants, or higher concentrations of surfactants, can actually improve spray retention.

When air-induced nozzles were introduced in the mid 1990s, one of their claims was the improved spray retention due to air inclusions (bubbles) in the individual droplets. These bubbles made the droplets lighter, and also reduced their internal integrity, promoting breakup on impaction. As a result, the coarser sprays they produced actually had some of the same efficacy performance as the finer sprays they replaced. And indeed, research showed that coarser, air-induced sprays did in fact maintain good performance. Interestingly, performance of non-air-induced coarse sprays used with pulse-width modulation also showed similar robustness of performance. Research comparing air-induced to conventional sprays of similar droplet size rarely showed differences, and when they occurred, they were small in magnitude and could be corrected through improved pattern overlap.

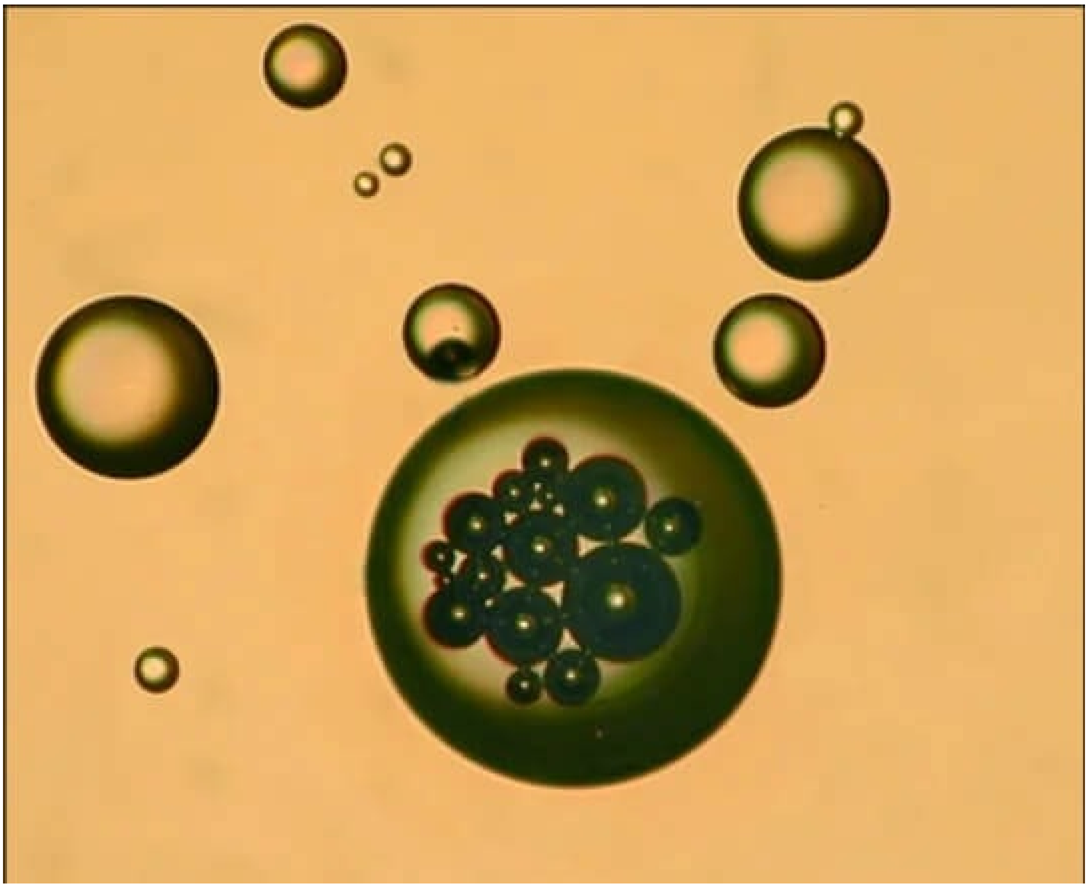

Figure 6. Air Bubbles in spray droplets (Source: EI Operator. Believed to originate with Silsoe Research Institute, UK)

One reason larger droplets still work well is due to the pre-orifice designs of modern low-drift nozzles. This design reduces the internal pressure of the nozzle itself, with the effect being a slower moving large droplet. This reduced velocity takes away some of the force at impaction, reducing rebound.

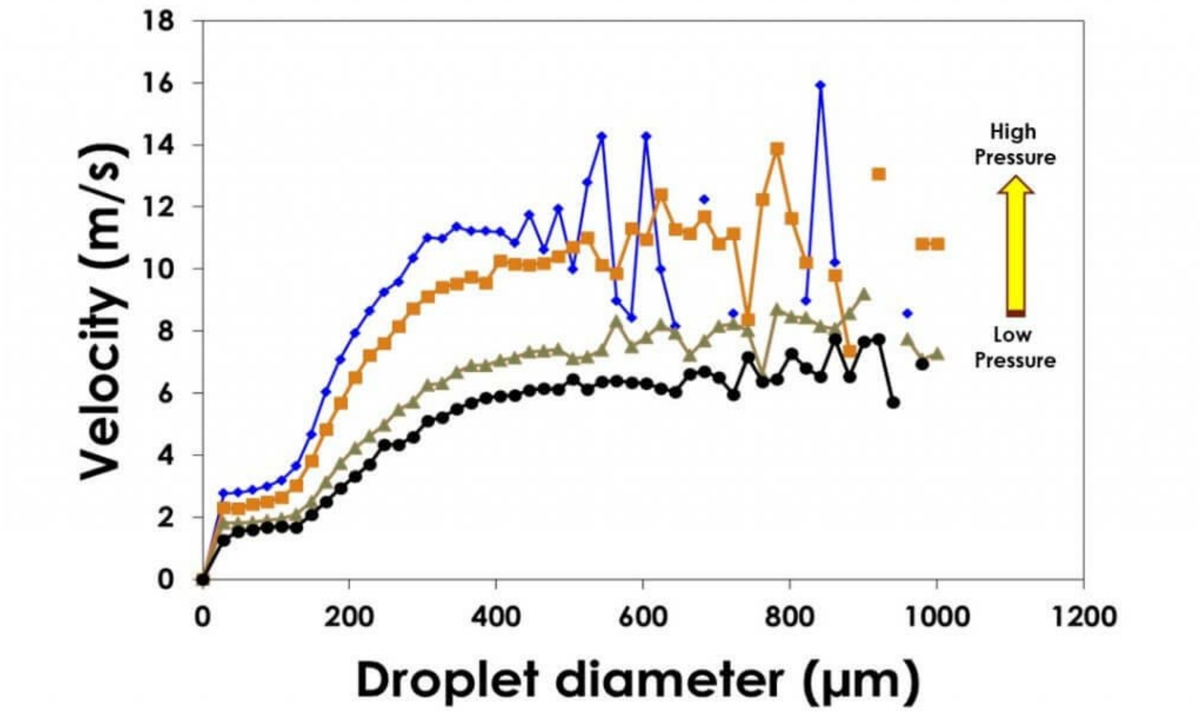

Figure 7. Droplet velocity of larger droplets is reduced by lower pressures from pre-orifice and air-induced design nozzles. Lower velocities reduce droplet rebound.

Another neat effect of coarser sprays is their ability to entrain air. All sprays move air (simply spray into a bucket to see this), and larger droplets do this better and for longer distances. The entrained air is a form of air assist for the smaller droplets, increasing their average velocity and thus reducing their drift potential while they move in the spray pattern.

The final stage of the dose transfer process is deposit formation and biological effect, and that's where we once again see differences attributable to droplet size.

Once established on a target surface, the active ingredient usually needs to move to its site of action. In some cases, resting on the surface is sufficient, it depends on the specific product. But for the majority of herbicides, the active ingredient must move across the cuticle into the cytoplasm where it eventually migrates to the enzymes involved in photosynthesis or biosynthesis of fatty- or amino acids. The cuticle is waxy, with only a few water-loving pathways and the uptake process is basically driven by diffusion and concentration gradients. As such, it is more effective when the product is in solution and the longer the droplet can stay wet, the better. That's one reason why spraying during hot, dry days may reduce performance. Again, it depends on the formulation and the mode of action. Too high a concentration can damage membranes, physiologically isolating the active ingredient and reducing its subsequent translocation. It's always a balancing act.

If you've been keeping track of the score, it's more or less a tie between large and small droplets. One deposits better and makes more efficient use of lower water volumes, while the other has lower losses from drift and evaporation, helps smaller droplets resist drift, and may improve uptake of some products.

And this draw is why the venerable hydraulic nozzle has been so successful for so many decades. Hydraulic atomization, by its nature, creates a wide diversity of droplet sizes, ranging from 5 to 2000 µm or greater. As Dr. Ralph Brown of the University of Guelph used to say, this nozzle provides a drop for all seasons. Some small ones for coverage and retention in hard to reach places, and some large ones for uptake and drift-reduction. The result is a robust delivery system that provides reliable results on many different targets under many conditions. In recognition of the heterogeneity of sprays, we don't refer to specific droplet sizes, but rather their composite, grouped into international categories of Spray Quality such as Medium, Coarse, and Very Coarse.

Our challenge is to find the spray quality sweet spot, the ideal blend of these contradictory and yet complementary features of our agricultural sprays. And I believe that task is very achievable. Simply put, broadcast agricultural sprays in field crops work reliably when applied as Coarse and Very Coarse sprays in volumes between 7 and 12 US gpa. There is no need to spray any finer than Coarse for good efficacy, as coverage is already sufficient and any additional coverage has small marginal returns. There is, however, value in adding more water when canopies are denser or when leaf area index grows as the crop matures. To gain coverage, adding water is preferred to reducing droplet size because of the value of environmental protection. It so happens that Coarse to Very Coarse sprays provide or exceed the drift protection required by most agricultural labels.

There is occasional reason for spraying even coarser than what I've suggested. It's certainly required by law for dicamba products on Xtend traited soybeans and cotton, but even then, only in conjunction with higher water volumes to offset losses in droplet numbers. In practice, moving to Extremely Coarse or Ultra Coarse sprays may allow an application to proceed in higher than average wind without adding drift risk. The use of some additional water is a relatively small price to pay for that additional capability.

There will always be opportunities for efficacy improvement in specific cases for those willing to spend the extra time to optimize that situation. That's one of the reasons I'm excited to see the widespread adoption of pulse width modulation (PWM) in the industry, allowing users to change spray pressure and therefore spray quality with no impact on application rate or travel speed. Or the introduction of nozzle switching from the cab, employing the optimal atomizer for a specific situation. Although it remains difficult to define the ideal spray, selecting a spray quality has never been so easy.

Increase sprayer productivity without driving faster

Tom Wolf, Sprayers 101

Key takeaways:

- Timing matters more than application speed; a mediocre spray at the right time beats a perfect spray at the wrong time.
- Cut downtime by shortening fill time; 20 to 10 minutes boosted spraying share and raised productivity by 20% from 33 to about 40 ha per engine hour.
- Increase boom width; moving from 28 to 36 m raised productivity similarly to higher speed, reaching about 38 acres per engine hour.
- Lower water volume or larger tanks reduce fill frequency; 50 L/ha or 4500 L tanks improved productivity to around 38 to 40 ha per hour.
- Prepare and minimize on-field delays: carry spare nozzles, use low-drift nozzles, ensure pumps and inductor capacity, and consider faster plumbing and rinsing.

This text was generated by OpenAI GPT 5 Mini

Timing trumps most things in crop protection. A great spray applied at the wrong time isn't nearly as valuable as a mediocre spray at the right time. So how do we improve our ability to get things done at the right time?

Often, we try to win races by driving faster. In our last article, we looked at driving speed and concluded that faster speeds can lead to more drift and less uniform deposition. Driving slower can be viewed as a sort of insurance policy: You may not notice the benefits right away, but on days when that extra bit of performance is required, you're covered.

So how do you get the job done quickly if you can't drive faster? To answer, we have to look to other opportunities for boosting productivity.

Recently, we built a productivity model to capture all the elements of a normal spray operation that affect timeliness. These were:

- Travel speed
- Boom width
- Tank size
- Water volume
- Field length
- Number of headlands
- Turning speed
- Fill time

First, we identified a reasonable base condition. For the sprayer, that was a travel speed of 23 km/h, a 28 m boom, a 3000 L tank, a 100 L/ha water volume, and a 20 minute fill time. Then, we set up a typical field situation, which was spraying an 800 m run (sorry, those are Canadian field sizes) on a paddock with two sprayed headlands and a turning speed of 13 km/h. Finally, we changed one factor at a time to determine its relative importance.

Before we discuss the results, let's make it clear that just because changing some of these factors improves productivity doesn't mean we're recommending them! For example, adequate water volume remains an important input that improves coverage and permits the use of low-drift sprays. Larger tanks increase compaction and take more power, and so forth.

Here's what we found:

All productivity values were expressed as acres per engine hour. For this reason, our numbers will be lower than what a typical sprayer monitor reports, most of which calculate acres per spraying hour.

For the base condition, the sprayer spent 15% of its driving time turning, and 37% of its on-field time stationary (i.e. filling). For every hour spent on the field, less than half the time (48%) was spent spraying. This resulted in an average productivity of 33 ha/h.

Increasing the spray speed to 29 km/h increased average productivity to 38 ha/h, but it also increased the proportion of time spent turning and loading, resulting in just 40% of the field time spent spraying.

Decreasing the loading time from 20 to 10 minutes reduced the proportion of field time spent stationary to 23%, covering 40 ha/h at 23 km/h. Surprisingly, this was the productivity-winner, resulting in 62% of on-field time spraying.

We discovered other powerful productivity factors, and chief among them was boom width. A 33% increase in boom width from 28 to 36 m gave a productivity boost to 38 ha/h, close to the same result as increasing the travel speed to 29 km/h earlier. Similar side effects occurred: more time turning, and a greater proportion of time filling, as we saw with faster travel speeds.

Two other factors that had similar effects to fill time were water volume and tank size. Less water and larger tanks increased productivity by decreasing the fill frequency, with effects similar in magnitude to speeding up the fill time. Decreasing the water volume from 100 to 50 L/ha increased productivity to 40 ha/h by decreasing the proportion of time the sprayer was stopped from 37% to 23%. Increasing from an 3000 to a 4500 L tank increased productivity to 38 ha/h, again by decreasing the proportion of time spent filling to 28%.

Taken together, a sprayer with a 36 m boom, a 4500 L tank, applying 100 L/ha and filling in 10 min had an average productivity of 53 ha/h. And this was achieved without driving faster than 23 km/h.

The perspective of minimizing downtime extends to other tasks, too:

- Be more prepared for the job by reviewing the product label in advance, noting the correct mixing order.
- Keep extra nozzles, clamps, and nozzle bodies in the cab.
- Don't clean plugged nozzles, replace them.
- Use low-drift nozzles so a small increase in wind doesn't shut you down.
- Ensure all the products needed are on the tender truck (e.g. pesticide, adjuvant, tank cleaner, anti-foamer, etc.).
- Consider switching to 3" plumbing (pump rates of 1100 – 1500 L/min are possible).

- Make sure your inductor won't be the limiting factor. For example, product pumps can be awfully slow when the product is cold. It might be worthwhile to explore a venturi system.

Speeding up the fill process is a good idea, but be careful with certain products. Dry materials such as the sulfonyl ureas and some fungicides require time to hydrate in water so they mix properly. Some operators pre-hydrate these in a smaller tank, while others get an extra tank to pre-mix whole loads and simply transfer them over.

Also think about the time spent cleaning the sprayer. Thoroughness is important, but perhaps there are efficiencies to be gained there as well, like never letting a sprayer sit after spraying. We've written about continuous rinsing, for example, to improve cleaning speed and effectiveness.

So, the quicker we can spray, while ensuring a quality job, the more effective our crop protection practices will be. We encourage you to use our to determine your best configuration.

Remember: In spraying, the race is won in the pits.

Factor	Base	Drive Faster	Fill Faster	Spray Wider	Less Water	Bigger Tank	New Sprayer
Travel Speed	23 km/h	**29 km/h**	23 km/h	23 km/h	23 km/h	23 km/h	**23 km/h**
Fill time	20 min	20 min	**10 min**	20 min	20 min	20 min	**10 min**
Boom Width	28 m	28 m	28 m	**36 m**	28 m	28 m	**36 m**
Water Volume	100 L/ha	100 L/ha	100 L/ha	100 L/ha	50 L/ha	100 L/ha	**100 L/ha**
Tank Size	3000 L	3000 L	3000 L	3000 L	3000 L	**4500 L**	**4500 L**
Field Length	800 m	800 m	800 m	800 m	800 m	800 m	**1600 m**
Time Turning	15%	19%	15%	20%	15%	15%	20%
Time Loading	37%	42%	23%	42%	23%	28%	19%
Time Spraying	48%	39%	62%	38%	62%	57%	61%
Productivity	**33 ha/h**	**38 ha/h**	**40 ha/h**	**38 ha/h**	**40 ha/h**	**38 ha/h**	**53 ha/h**

How to size a nozzle for pulse width modulation (PWM)

Tom Wolf, Sprayers 101

Key takeaways:

- Aim for 60-80% duty cycle (about two thirds open) at average speeds; DC equals nozzle flow proportion.
- 60-80% DC enables turn compensation, speed flexibility, pressure compensation, and selective higher flows where needed.
- Use Wilger's Tip Wizard or the provided worksheet to find nozzle sizes; they report expected DC, speeds, and spray quality.
- Calibrate by selecting a larger gpa on charts to reach desired DC; prioritize nozzle pressure and avoid DC below 50% or above 90%.

This text was generated by OpenAI GPT 5 Mini

PWM is gaining popularity, and there is an ever-increasing number of first-time users that need to make nozzle selections for their system. We've written about it here, here, and here.

Recall the PWM replaces spray pressure with Duty Cycle (DC) of a pulsing solenoid as the primary means of controlling nozzle flow. The solenoid shuts off the flow to the nozzle intermittently, between 10 and 100 times per second depending on the system. The Duty Cycle is defined as the proportion of time that the solenoid is open, and for low-frequency systems, DC is more or less linearly related to flow rate.

The first rule of PWM nozzle selection is to understand that under average travel speeds, we'd like to see the duty cycle of the system at between 60 and 80%. This means that the nozzle solenoid is open about 2/3 of the time. This value also describes the flow rate as a proportion of the full capacity that nozzle.

The reason for this 2/3 duty cycle rule is to enable four key features of PWM:

1. It's ideal for turn compensation, allowing the outer nozzles to increase their flow 20 to 40%, and the inner nozzles to decrease flow about three-fold, in accordance with boom speed.
2. It allows speed flexibility, providing some additional speed, but more importantly, reduced speeds should conditions require it, without a change in spray pressure.
3. It compensates for pressure changes so that spray quality can be adjusted without requiring a speed change. Less pressure reduces nozzle flow, and increasing DC recoups accordingly.
4. It allows for customized higher flows of certain nozzles, perhaps behind wheels, to address reduced deposition in their aerodynamic wake (available on some PWM systems).

The best tool for selecting the right nozzle size is Wilger's Tip Wizard. This site asks for your desired average speed (although it calls this "Max Sprayer Speed"), and reports the expected DC for a host of nozzle size solutions and pressures. It also reports maximum and minimum travel speeds and other useful information such as spray quality.

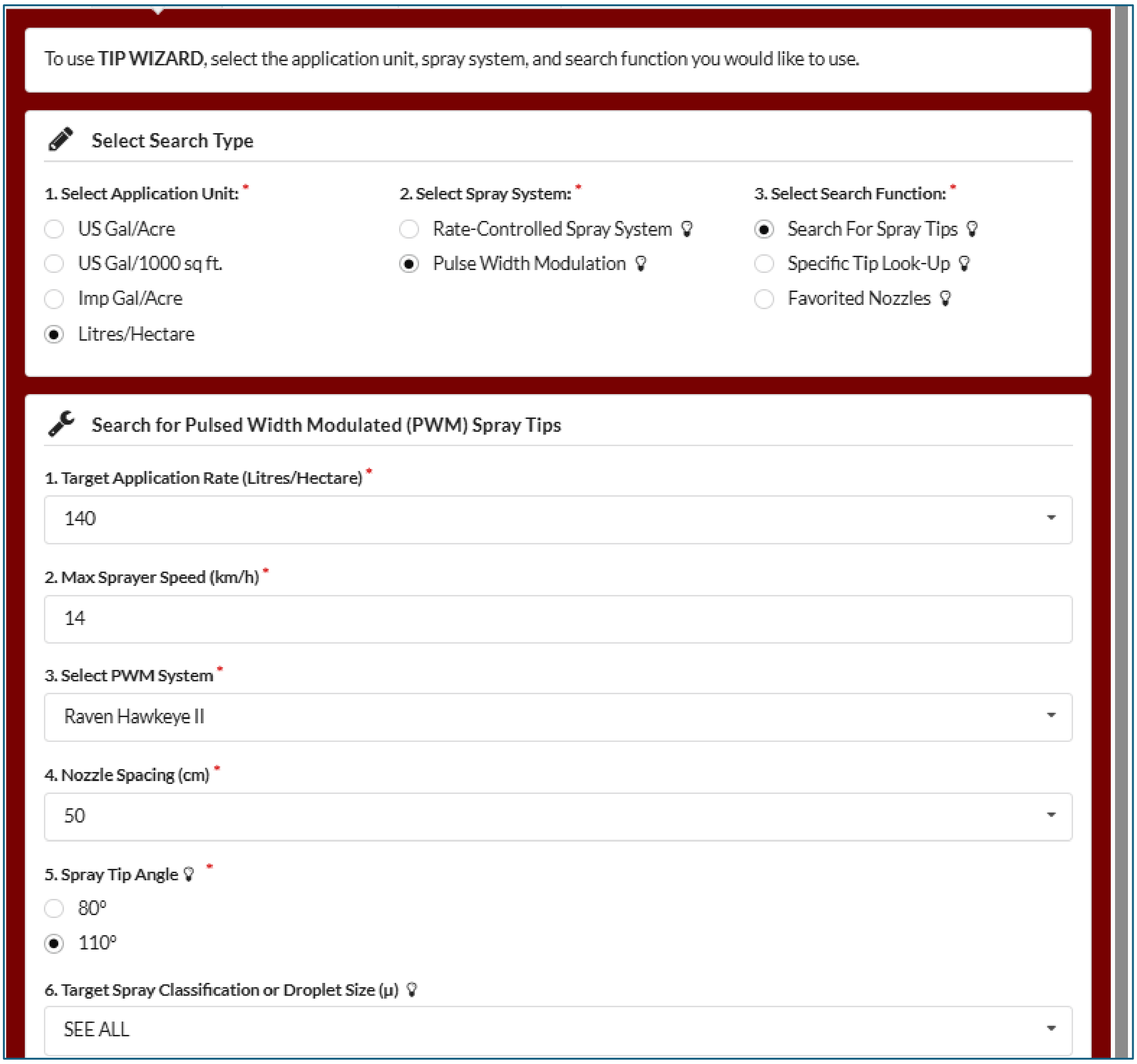

Figure 1. The Tip Wizard is a useful tool for sizing nozzles on any PWM system. Sizing information applies to any nozzle. Spray quality information is for Wilger ComboJet nozzles only.

Although intended for Wilger nozzles, the site's sizing feature works for any nozzle brand. It asks the user which PWM system they have for the purpose of calculating the documented pressure drop across the solenoid.

Combo-Jet® ER110-06
Part No: 40281-06 Color: Grey
Screen No: Not Required

Combo-Jet® SR110-06
Part No: 40287-06 Color: Grey
Screen No: Not Required

Pressure (bar)	Speed Range (km/h)	DC (%) @ 14 km/h	Class	VMD (µ)	<141 (%)	<600 (%)
1.7	3.6-14.6	96	XC	461µ	3	76
2.1	4.0-16.0	87	VC	433µ	5	81
2.4	4.3-17.3	81	VC	409µ	6	85
2.8	4.6-18.5	76	C	388µ	7	87
3.1	4.9-19.6	71	C	370µ	8	89
3.4	5.2-20.6	68	C	354µ	9	90
3.8	5.4-21.6	65	C	339µ	10	91
4.1	5.7-22.6	62	C	325µ	11	92
4.5	5.9-23.5	60	C	313µ	12	93

Combo-Jet® MR110-06
Part No: 40291-06 Color: Grey
Screen No: Not Required

Figure 2. Tip Wizard results for the Wilger SR11006 tip at 140 L/ha and 14 km/h. Look for a solution that provides 60 to 80% Duty Cycle (DC).

In this case, the 06 size nozzle provides good flexibility. Note that it can be operated at a range of spray pressures and still be within an acceptable Duty Cycle range.

If you don't have access to the site, a basic calibration chart can still work with a simple trick. Recall that we use the top row to identify the desired water volume, and the table's interior values are speeds.

Below are several solutions for someone wanting to apply 140 L/ha 14 km/h without PWM. The correct choice depends on the required pressure to produce the needed spray quality.

Nozzle size	Pressure (bar)	Flow (mL/min)	Numbers in Table Body are km/h (50 cm nozzle spacing)									
			80 L/ha	90 L/ha	100 L/ha	120 L/ha	140 L/ha	160 L/ha	180 L/ha	200 L/ha	250 L/ha	300 L/ha
02 Yellow	1.0	462	6.9	6.2	5.5	4.6	4.0	3.5	3.1	2.8	2.2	1.8
	2.0	653	9.8	8.7	7.8	6.5	5.6	4.9	4.4	3.9	3.1	2.6
	3.0	800	12.0	10.7	9.6	8.0	6.9	6.0	5.3	4.8	3.8	3.2
	4.0	924	13.9	12.3	11.1	9.2	7.9	6.9	6.2	5.5	4.4	3.7
	5.0	1033	15.5	13.8	12.4	10.3	8.9	7.7	6.9	6.2	5.0	4.1
	6.0	1131	17.0	15.1	13.6	11.3	9.7	8.5	7.5	6.8	5.4	4.5
	7.0	1222	18.3	16.3	14.7	12.2	10.5	9.2	8.1	7.3	5.9	4.9
025 Lilac	1.0	577	8.7	7.7	6.9	5.8	4.9	4.3	3.8	3.5	2.8	2.3
	2.0	816	12.2	10.9	9.8	8.2	7.0	6.1	5.4	4.9	3.9	3.3
	3.0	1000	15.0	13.3	12.0	10.0	8.6	7.5	6.7	6.0	4.8	4.0
	4.0	1155	17.3	15.4	13.9	11.5	9.9	8.7	7.7	6.9	5.5	4.6
	5.0	1291	19.4	17.2	15.5	12.9	11.1	9.7	8.6	7.7	6.2	5.2
	6.0	1414	21.2	18.9	17.0	14.1	12.1	10.6	9.4	8.5	6.8	5.7
	7.0	1528	22.9	20.4	18.3	15.3	13.1	11.5	10.2	9.2	7.3	6.1
03 Blue	1.0	693	10.4	9.2	8.3	6.9	5.9	5.2	4.6	4.2	3.3	2.8
	2.0	980	14.7	13.1	11.8	9.8	8.4	7.3	6.5	5.9	4.7	3.9
	3.0	1200	18.0	16.0	14.4	12.0	10.3	9.0	8.0	7.2	5.8	4.8
	4.0	1386	20.8	18.5	16.6	13.9	11.9	10.4	9.2	8.3	6.7	5.5
	5.0	1549	23.2	20.7	18.6	15.5	13.3	11.6	10.3	9.3	7.4	6.2
	6.0	1697	25.5	22.6	20.4	17.0	14.5	12.7	11.3	10.2	8.1	6.8
	7.0	1833	27.5	24.4	22.0	18.3	15.7	13.7	12.2	11.0	8.8	7.3
035 Brown Red	1.0	808	12.1	10.8	9.7	8.1	6.9	6.1	5.4	4.8	3.9	3.2
	2.0	1143	17.1	15.2	13.7	11.4	9.8	8.6	7.6	6.9	5.5	4.6
	3.0	1400	21.0	18.7	16.8	14.0	12.0	10.5	9.3	8.4	6.7	5.6
	4.0	1617	24.2	21.6	19.4	16.2	13.9	12.1	10.8	9.7	7.8	6.5
	5.0	1807	27.1	24.1	21.7	18.1	15.5	13.6	12.0	10.8	8.7	7.2
	6.0	1980	29.7	26.4	23.8	19.8	17.0	14.8	13.2	11.9	9.5	7.9
	7.0	2139	32.1	28.5	25.7	21.4	18.3	16.0	14.3	12.8	10.3	8.6
04 Red	1.0	924	13.9	12.3	11.1	9.2	7.9	6.9	6.2	5.5	4.4	3.7
	2.0	1306	19.6	17.4	15.7	13.1	11.2	9.8	8.7	7.8	6.3	5.2
	3.0	1600	24.0	21.3	19.2	16.0	13.7	12.0	10.7	9.6	7.7	6.4
	4.0	1848	27.7	24.6	22.2	18.5	15.8	13.9	12.3	11.1	8.9	7.4
	5.0	2066	31.0	27.5	24.8	20.7	17.7	15.5	13.8	12.4	9.9	8.3
	6.0	2263	33.9	30.2	27.2	22.6	19.4	17.0	15.1	13.6	10.9	9.1
	7.0	2444	36.7	32.6	29.3	24.4	20.9	18.3	16.3	14.7	11.7	9.8
05 Brown	1.0	1155	17.3	15.4	13.9	11.5	9.9	8.7	7.7	6.9	5.5	4.6
	2.0	1633	24.5	21.8	19.6	16.3	14.0	12.2	10.9	9.8	7.8	6.5
	3.0	2000	30.0	26.7	24.0	20.0	17.1	15.0	13.3	12.0	9.6	8.0
	4.0	2309	34.6	30.8	27.7	23.1	19.8	17.3	15.4	13.9	11.1	9.2
	5.0	2582	38.7	34.4	31.0	25.8	22.1	19.4	17.2	15.5	12.4	10.3
	6.0	2828	42.4	37.7	33.9	28.3	24.2	21.2	18.9	17.0	13.6	11.3
	7.0	3055	45.8	40.7	36.7	30.6	26.2	22.9	20.4	18.3	14.7	12.2
06 Gray	1.0	1386	20.8	18.5	16.6	13.9	11.9	10.4	9.2	8.3	6.7	5.5
	2.0	1960	29.4	26.1	23.5	19.6	16.8	14.7	13.1	11.8	9.4	7.8
	3.0	2400	36.0	32.0	28.8	24.0	20.6	18.0	16.0	14.4	11.5	9.6
	4.0	2771	41.6	37.0	33.3	27.7	23.8	20.8	18.5	16.6	13.3	11.1
	5.0	3098	46.5	41.3	37.2	31.0	26.6	23.2	20.7	18.6	14.9	12.4
	6.0	3394	50.9	45.3	40.7	33.9	29.1	25.5	22.6	20.4	16.3	13.6
	7.0	3666	55.0	48.9	44.0	36.7	31.4	27.5	24.4	22.0	17.6	14.7

Figure 3. A conventional calibration chart, solving a 140 L/ha application for 14 km/h.

If you want to apply the same 140 L/ha using PWM, simply solve for a larger volume that offers the right DC. For example, choosing 200 L/ha will over-apply by 60 L/ha, or 40%. The PWM system adjusts by running at 70% DC (200 * 0.7 = 140).

Nozzle size	Pressure (bar)	Flow (mL/min)	Numbers in Table Body are km/h (50 cm nozzle spacing)									
			80 L/ha	90 L/ha	100 L/ha	120 L/ha	140 L/ha	160 L/ha	180 L/ha	200 L/ha	250 L/ha	300 L/ha
02 Yellow	1.0	462	6.9	6.2	5.5	4.6	4.0	3.5	3.1	2.8	2.2	1.8
	2.0	653	9.8	8.7	7.8	6.5	5.6	4.9	4.4	3.9	3.1	2.6
	3.0	800	12.0	10.7	9.6	8.0	6.9	6.0	5.3	4.8	3.8	3.2
	4.0	924	13.9	12.3	11.1	9.2	7.9	[illegible]	[illegible]	5.5	4.4	3.7
	5.0	1033	15.5	13.8	12.4	10.3	8.9	7.7	6.9	6.2	5.0	4.1
	6.0	1131	17.0	15.1	13.6	11.3	9.7	8.5	7.5	6.8	5.4	4.5
	7.0	1222	18.3	16.3	14.7	12.2	10.5	9.2	8.1	7.3	5.9	4.9
025 Lilac	1.0	577	8.7	7.7	6.9	5.8	4.9	4.3	3.8	3.5	2.8	2.3
	2.0	816	12.2	10.9	9.8	8.2	7.0	6.1	5.4	4.9	3.9	3.3
	3.0	1000	15.0	13.3	12.0	10.0	8.6	7.5	6.7	6.0	4.8	4.0
	4.0	1155	17.3	15.4	13.9	11.5	9.9	8.7	7.7	6.9	5.5	4.6
	5.0	1291	19.4	17.2	15.5	12.9	11.1	9.7	8.6	7.7	6.2	5.2
	6.0	1414	21.2	18.9	17.0	14.1	12.1	10.6	9.4	8.5	6.8	5.7
	7.0	1528	22.9	20.4	18.3	15.3	13.1	11.5	10.2	9.2	7.3	6.1
03 Blue	1.0	693	10.4	9.2	8.3	6.9	5.9	5.2	4.6	4.2	3.3	2.8
	2.0	980	14.7	13.1	11.8	9.8	8.4	7.3	6.5	5.9	4.7	3.9
	3.0	1200	18.0	16.0	14.4	12.0	10.3	9.0	8.0	7.2	5.8	4.8
	4.0	1386	20.8	18.5	16.6	13.9	11.9	10.4	9.2	8.3	6.7	5.5
	5.0	1549	23.2	20.7	18.6	15.5	13.3	11.6	10.3	9.3	7.4	6.2
	6.0	1697	25.5	22.6	20.4	17.0	14.5	12.7	11.3	10.2	8.1	6.8
	7.0	1833	27.5	24.4	22.0	18.3	15.7	13.7	12.2	11.0	8.8	7.3
035 Brown Red	1.0	808	12.1	10.8	9.7	8.1	6.9	6.1	5.4	4.8	3.9	3.2
	2.0	1143	17.1	15.2	13.7	11.4	9.8	8.6	7.6	6.9	5.5	4.6
	3.0	1400	21.0	18.7	16.8	14.0	12.0	10.5	9.3	8.4	6.7	5.6
	4.0	1617	24.2	21.6	19.4	16.2	13.9	12.1	10.8	9.7	7.8	6.5
	5.0	1807	27.1	24.1	21.7	18.1	15.5	13.6	12.0	10.8	8.7	7.2
	6.0	1980	29.7	26.4	23.8	19.8	17.0	14.8	13.2	11.9	9.5	7.9
	7.0	2139	32.1	28.5	25.7	21.4	18.3	16.0	14.3	12.8	10.3	8.6
04 Red	1.0	924	13.9	12.3	11.1	9.2	7.9	6.9	6.2	5.5	4.4	3.7
	2.0	1306	19.6	17.4	15.7	13.1	11.2	9.8	8.7	7.8	6.3	5.2
	3.0	1600	24.0	21.3	19.2	16.0	13.7	12.0	10.7	9.6	7.7	6.4
	4.0	1848	27.7	24.6	22.2	18.5	15.8	13.9	12.3	11.1	8.9	7.4
	5.0	2066	31.0	27.5	24.8	20.7	17.7	15.5	13.8	12.4	9.9	8.3
	6.0	2263	33.9	30.2	27.2	22.6	19.4	17.0	15.1	13.6	10.9	9.1
	7.0	2444	36.7	32.6	29.3	24.4	20.9	18.3	16.3	14.7	11.7	9.8
05 Brown	1.0	1155	17.3	15.4	13.9	11.5	9.9	8.7	7.7	6.9	5.5	4.6
	2.0	1633	24.5	21.8	19.6	16.3	14.0	12.2	10.9	9.8	7.8	6.5
	3.0	2000	30.0	26.7	24.0	20.0	17.1	15.0	13.3	12.0	9.6	8.0
	4.0	2309	34.6	30.8	27.7	23.1	19.8	[illegible]	[illegible]	13.9	11.1	9.2
	5.0	2582	38.7	34.4	31.0	25.8	22.1	19.4	17.2	15.5	12.4	10.3
	6.0	2828	42.4	37.7	33.9	28.3	24.2	21.2	18.9	17.0	13.6	11.3
	7.0	3055	45.8	40.7	36.7	30.6	26.2	22.9	20.4	18.3	14.7	12.2
06 Gray	1.0	1386	20.8	18.5	16.6	13.9	11.9	10.4	9.2	8.3	6.7	5.5
	2.0	1960	29.4	26.1	23.5	19.6	16.8	14.7	13.1	11.8	9.4	7.8
	3.0	2400	36.0	32.0	28.8	24.0	20.6	18.0	16.0	14.4	11.5	9.6
	4.0	2771	41.6	37.0	33.3	27.7	23.8	20.8	18.5	16.6	13.3	11.1
	5.0	3098	46.5	41.3	37.2	31.0	26.6	23.2	20.7	18.6	14.9	12.4
	6.0	3394	50.9	45.3	40.7	33.9	29.1	25.5	22.6	20.4	16.3	13.6
	7.0	3666	55.0	48.9	44.0	36.7	31.4	27.5	24.4	22.0	17.6	14.7

Figure 4. By pretending to require 200 L/ha instead of the actual 140 L/ha, the conventional calibration chart is tricked into solving for a nozzle size that will work with PWM at 70% Duty Cycle.

Now solve for the same target speed, 14 km/h. The solution will run at 70% DC. Again, there is more than one choice, and that will depend on the spray pressure needed.

Nozzle size	Pressure (bar)	Flow (mL/min)	Numbers in Table Body are km/h (50 cm nozzle spacing)									
			80 L/ha	90 L/ha	100 L/ha	120 L/ha	140 L/ha	160 L/ha	180 L/ha	200 L/ha	250 L/ha	300 L/ha
02 Yellow	1.0	462	6.9	6.2	5.5	4.6	4.0	3.5	3.1	2.8	2.2	1.8
	2.0	653	9.8	8.7	7.8	6.5	5.6	4.9	4.4	3.9	3.1	2.6
	3.0	800	12.0	10.7	9.6	8.0	6.9	6.0	5.3	4.8	3.8	3.2
	4.0	924	13.9	12.3	11.1	9.2	7.9	6.9	6.2	5.5	4.4	3.7
	5.0	1033	15.5	13.8	12.4	10.3	8.9	7.7	6.9	6.2	5.0	4.1
	6.0	1131	17.0	15.1	13.6	11.3	9.7	8.5	7.5	6.8	5.4	4.5
	7.0	1222	18.3	16.3	14.7	12.2	10.5	9.2	8.1	7.3	5.9	4.9
025 Lilac	1.0	577	8.7	7.7	6.9	5.8	4.9	4.3	3.8	3.5	2.8	2.3
	2.0	816	12.2	10.9	9.8	8.2	7.0	6.1	5.4	4.9	3.9	3.3
	3.0	1000	15.0	13.3	12.0	10.0	8.6	7.5	6.7	6.0	4.8	4.0
	4.0	1155	17.3	15.4	13.9	11.5	9.9	8.7	7.7	6.9	5.5	4.6
	5.0	1291	19.4	17.2	15.5	12.9	11.1	9.7	8.6	7.7	6.2	5.2
	6.0	1414	21.2	18.9	17.0	14.1	12.1	10.6	9.4	8.5	6.8	5.7
	7.0	1528	22.9	20.4	18.3	15.3	13.1	11.5	10.2	9.2	7.3	6.1
03 Blue	1.0	693	10.4	9.2	8.3	6.9	5.9	5.2	4.6	4.2	3.3	2.8
	2.0	980	14.7	13.1	11.8	9.8	8.4	7.3	6.5	5.9	4.7	3.9
	3.0	1200	18.0	16.0	14.4	12.0	10.3	9.0	8.0	7.2	5.8	4.8
	4.0	1386	20.8	18.5	16.6	13.9	11.9	10.4	9.2	8.3	6.7	5.5
	5.0	1549	23.2	20.7	18.6	15.5	13.3	11.6	10.3	9.3	7.4	6.2
	6.0	1697	25.5	22.6	20.4	17.0	14.5	12.7	11.3	10.2	8.1	6.8
	7.0	1833	27.5	24.4	22.0	18.3	15.7	13.7	12.2	11.0	8.8	7.3
035 Brown Red	1.0	808	12.1	10.8	9.7	8.1	6.9	6.1	5.4	4.8	3.9	3.2
	2.0	1143	17.1	15.2	13.7	11.4	9.8	8.6	7.6	6.9	5.5	4.6
	3.0	1400	21.0	18.7	16.8	14.0	12.0	10.5	9.3	8.4	6.7	5.6
	4.0	1617	24.2	21.6	19.4	16.2	13.9	12.1	10.8	9.7	7.8	6.5
	5.0	1807	27.1	24.1	21.7	18.1	15.5	13.6	12.0	10.8	8.7	7.2
	6.0	1980	29.7	26.4	23.8	19.8	17.0	14.8	13.2	11.9	9.5	7.9
	7.0	2139	32.1	28.5	25.7	21.4	18.3	16.0	14.3	12.8	10.3	8.6
04 Red	1.0	924	13.9	12.3	11.1	9.2	7.9	6.9	6.2	5.5	4.4	3.7
	2.0	1306	19.6	17.4	15.7	13.1	11.2	9.8	8.7	7.8	6.3	5.2
	3.0	1600	24.0	21.3	19.2	16.0	13.7	12.0	10.7	9.6	7.7	6.4
	4.0	1848	27.7	24.6	22.2	18.5	15.8	13.9	12.3	11.1	8.9	7.4
	5.0	2066	31.0	27.5	24.8	20.7	17.7	15.5	13.8	12.4	9.9	8.3
	6.0	2263	33.9	30.2	27.2	22.6	19.4	17.0	15.1	13.6	10.9	9.1
	7.0	2444	36.7	32.6	29.3	24.4	20.9	18.3	16.3	14.7	11.7	9.8
05 Brown	1.0	1155	17.3	15.4	13.9	11.5	9.9	8.7	7.7	6.9	5.5	4.6
	2.0	1633	24.5	21.8	19.6	16.3	14.0	12.2	10.9	9.8	7.8	6.5
	3.0	2000	30.0	26.7	24.0	20.0	17.1	15.0	13.3	12.0	9.6	8.0
	4.0	2309	34.6	30.8	27.7	23.1	19.8	17.3	15.4	13.9	11.1	9.2
	5.0	2582	38.7	34.4	31.0	25.8	22.1	19.4	17.2	15.5	12.4	10.3
	6.0	2828	42.4	37.7	33.9	28.3	24.2	21.2	18.9	17.0	13.6	11.3
	7.0	3055	45.8	40.7	36.7	30.6	26.2	22.9	20.4	18.3	14.7	12.2
06 Gray	1.0	1386	20.8	18.5	16.6	13.9	11.9	10.4	9.2	8.3	6.7	5.5
	2.0	1960	29.4	26.1	23.5	19.6	16.8	14.7	13.1	11.8	9.4	7.8
	3.0	2400	36.0	32.0	28.8	24.0	20.6	18.0	16.0	14.4	11.5	9.6
	4.0	2771	41.6	37.0	33.3	27.7	23.8	20.8	18.5	16.6	13.3	11.1
	5.0	3098	46.5	41.3	37.2	31.0	26.6	23.2	20.7	18.6	14.9	12.4
	6.0	3394	50.9	45.3	40.7	33.9	29.1	25.5	22.6	20.4	16.3	13.6
	7.0	3666	55.0	48.9	44.0	36.7	31.4	27.5	24.4	22.0	17.6	14.7

Figure 5. Three possible solutions for achieving 140 L/ha at 14 km/h with PWM.

As with the Tip Wizard, the best solution for 140 gpa at 14 km/h is the 06 size nozzle at 3 bar. This is not engraved in stone. One of the nice things about PWM is that it has inherent flexibility. Make the nozzle pressure a priority to get the correct spray quality. It really doesn't matter whether the resulting DC is 65 or 80%, the system will still work well. Simply avoid extremes that take you below 50% or above 90%, they will limit the system's capabilities.

Drone spraying – key regulatory points

Chris Smith, FAR

- Drone spraying is generally treated as **aerial application** in New Zealand.
- **Always check the product label** before applying any agrichemical by drone.
- If the label allows **aerial application**, drone use is generally more straightforward.
- Where the hazardous substance approval is for ground-application only, the agricultural chemical cannot be applied by drone/UAV.
- If label wording is unclear, seek clarification from the **product registrant and/or ACVM**.
- Follow all label requirements, including **application method, water rates, droplet size, buffer zones, and weather conditions**.
- Off-label use may be possible, but operators remain responsible for **compliance, residues, and market access requirements**.
- No agrichemical labels currently contain **drone-specific application instructions**.
- Compliance extends beyond ACVM and includes:
  - EPA hazardous substance controls
  - Civil Aviation Authority (CAA) requirements
  - NZS 8409:2021
  - Regional council rules
- When uncertain, take a **conservative approach and seek clarification**.

Operator Checklist

- Confirm the product label and permitted application method.
- Verify aerial use is allowed or obtain clarification.
- Check rates, water volumes, and droplet size requirements.
- Ensure operator qualifications and certifications are current.
- Ensure they have appropriate commercial insurance.
- Assess weather, drift risk, and sensitive areas.
- Confirm appropriate insurance for aerial application work.
- Plan flight height and speed to achieve adequate coverage.
- Maintain spray records and meet assurance programme requirements.
- Verify coverage and results after application.

Scan the QR code for more information on drones

Conventional Rate Control

Nozzle size	Pressure (bar)	Flow (mL/min)	*Numbers in Table Body are km/h (50 cm nozzle spacing)*									
			80 L/ha	*90 L/ha*	*100 L/ha*	*120 L/ha*	*140 L/ha*	*160 L/ha*	*180 L/ha*	*200 L/ha*	*250 L/ha*	*300 L/ha*
02 Yellow	1.0	462	6.9	6.2	5.5	4.6	4.0	3.5	3.1	2.8	2.2	1.8
	2.0	653	9.8	8.7	7.8	6.5	5.6	4.9	4.4	3.9	3.1	2.6
	3.0	800	12.0	10.7	9.6	8.0	6.9	6.0	5.3	4.8	3.8	3.2
	4.0	924	13.9	12.3	11.1	9.2	7.9	6.9	6.2	5.5	4.4	3.7
	5.0	1033	15.5	13.8	12.4	10.3	8.9	7.7	6.9	6.2	5.0	4.1
	6.0	1131	17.0	15.1	13.6	11.3	9.7	8.5	7.5	6.8	5.4	4.5
	7.0	1222	18.3	16.3	14.7	12.2	10.5	9.2	8.1	7.3	5.9	4.9
025 Lilac	1.0	577	8.7	7.7	6.9	5.8	4.9	4.3	3.8	3.5	2.8	2.3
	2.0	816	12.2	10.9	9.8	8.2	7.0	6.1	5.4	4.9	3.9	3.3
	3.0	1000	15.0	13.3	12.0	10.0	8.6	7.5	6.7	6.0	4.8	4.0
	4.0	1155	17.3	15.4	13.9	11.5	9.9	8.7	7.7	6.9	5.5	4.6
	5.0	1291	19.4	17.2	15.5	12.9	11.1	9.7	8.6	7.7	6.2	5.2
	6.0	1414	21.2	18.9	17.0	14.1	12.1	10.6	9.4	8.5	6.8	5.7
	7.0	1528	22.9	20.4	18.3	15.3	13.1	11.5	10.2	9.2	7.3	6.1
03 Blue	1.0	693	10.4	9.2	8.3	6.9	5.9	5.2	4.6	4.2	3.3	2.8
	2.0	980	14.7	13.1	11.8	9.8	8.4	7.3	6.5	5.9	4.7	3.9
	3.0	1200	18.0	16.0	14.4	12.0	10.3	9.0	8.0	7.2	5.8	4.8
	4.0	1386	20.8	18.5	16.6	13.9	11.9	10.4	9.2	8.3	6.7	5.5
	5.0	1549	23.2	20.7	18.6	15.5	13.3	11.6	10.3	9.3	7.4	6.2
	6.0	1697	25.5	22.6	20.4	17.0	14.5	12.7	11.3	10.2	8.1	6.8
	7.0	1833	27.5	24.4	22.0	18.3	15.7	13.7	12.2	11.0	8.8	7.3
035 Brown Red	1.0	808	12.1	10.8	9.7	8.1	6.9	6.1	5.4	4.8	3.9	3.2
	2.0	1143	17.1	15.2	13.7	11.4	9.8	8.6	7.6	6.9	5.5	4.6
	3.0	1400	21.0	18.7	16.8	14.0	12.0	10.5	9.3	8.4	6.7	5.6
	4.0	1617	24.2	21.6	19.4	16.2	13.9	12.1	10.8	9.7	7.8	6.5
	5.0	1807	27.1	24.1	21.7	18.1	15.5	13.6	12.0	10.8	8.7	7.2
	6.0	1980	29.7	26.4	23.8	19.8	17.0	14.8	13.2	11.9	9.5	7.9
	7.0	2139	32.1	28.5	25.7	21.4	18.3	16.0	14.3	12.8	10.3	8.6
04 Red	1.0	924	13.9	12.3	11.1	9.2	7.9	6.9	6.2	5.5	4.4	3.7
	2.0	1306	19.6	17.4	15.7	13.1	11.2	9.8	8.7	7.8	6.3	5.2
	3.0	1600	24.0	21.3	19.2	16.0	13.7	12.0	10.7	9.6	7.7	6.4
	4.0	1848	27.7	24.6	22.2	18.5	15.8	13.9	12.3	11.1	8.9	7.4
	5.0	2066	31.0	27.5	24.8	20.7	17.7	15.5	13.8	12.4	9.9	8.3
	6.0	2263	33.9	30.2	27.2	22.6	19.4	17.0	15.1	13.6	10.9	9.1
	7.0	2444	36.7	32.6	29.3	24.4	20.9	18.3	16.3	14.7	11.7	9.8
05 Brown	1.0	1155	17.3	15.4	13.9	11.5	9.9	8.7	7.7	6.9	5.5	4.6
	2.0	1633	24.5	21.8	19.6	16.3	14.0	12.2	10.9	9.8	7.8	6.5
	3.0	2000	30.0	26.7	24.0	20.0	17.1	15.0	13.3	12.0	9.6	8.0
	4.0	2309	34.6	30.8	27.7	23.1	19.8	17.3	15.4	13.9	11.1	9.2
	5.0	2582	38.7	34.4	31.0	25.8	22.1	19.4	17.2	15.5	12.4	10.3
	6.0	2828	42.4	37.7	33.9	28.3	24.2	21.2	18.9	17.0	13.6	11.3
	7.0	3055	45.8	40.7	36.7	30.6	26.2	22.9	20.4	18.3	14.7	12.2
06 Gray	1.0	1386	20.8	18.5	16.6	13.9	11.9	10.4	9.2	8.3	6.7	5.5
	2.0	1960	29.4	26.1	23.5	19.6	16.8	14.7	13.1	11.8	9.4	7.8
	3.0	2400	36.0	32.0	28.8	24.0	20.6	18.0	16.0	14.4	11.5	9.6
	4.0	2771	41.6	37.0	33.3	27.7	23.8	20.8	18.5	16.6	13.3	11.1
	5.0	3098	46.5	41.3	37.2	31.0	26.6	23.2	20.7	18.6	14.9	12.4
	6.0	3394	50.9	45.3	40.7	33.9	29.1	25.5	22.6	20.4	16.3	13.6
	7.0	3666	55.0	48.9	44.0	36.7	31.4	27.5	24.4	22.0	17.6	14.7
08 White	1.0	1848	27.7	24.6	22.2	18.5	15.8	13.9	12.3	11.1	8.9	7.4
	2.0	2613	39.2	34.8	31.4	26.1	22.4	19.6	17.4	15.7	12.5	10.5
	3.0	3200	48.0	42.7	38.4	32.0	27.4	24.0	21.3	19.2	15.4	12.8
	4.0	3695	55.4	49.3	44.3	37.0	31.7	27.7	24.6	22.2	17.7	14.8
	5.0	4131	62.0	55.1	49.6	41.3	35.4	31.0	27.5	24.8	19.8	16.5
	6.0	4525	67.9	60.3	54.3	45.3	38.8	33.9	30.2	27.2	21.7	18.1
	7.0	4888	73.3	65.2	58.7	48.9	41.9	36.7	32.6	29.3	23.5	19.6

Pulse Width Modulation (PWM) Rate Control

Nozzle size	Duty Cycle (%)	Flow @ 3 bar (mL/min)	Numbers in Table Body are km/h (50 cm nozzle spacing) at 3 bar pressure									
			80 L/ha	90 L/ha	100 L/ha	120 L/ha	140 L/ha	160 L/ha	180 L/ha	200 L/ha	250 L/ha	300 L/ha
	20	200	3.0	2.7	2.4	2.0	1.7	1.5	1.3	1.2	1.0	0.8
	30	300	4.5	4.0	3.6	3.0	2.6	2.3	2.0	1.8	1.4	1.2
025	40	400	6.0	5.3	4.8	4.0	3.4	3.0	2.7	2.4	1.9	1.6
	50	500	7.5	6.7	6.0	5.0	4.3	3.8	3.3	3.0	2.4	2.0
Lilac	60	600	9.0	8.0	7.2	6.0	5.1	4.5	4.0	3.6	2.9	2.4
	70	700	10.5	9.3	8.4	7.0	6.0	5.3	4.7	4.2	3.4	2.8
	80	800	12.0	10.7	9.6	8.0	6.9	6.0	5.3	4.8	3.8	3.2
	90	900	13.5	12.0	10.8	9.0	7.7	6.8	6.0	5.4	4.3	3.6
	100	1000	15.0	13.3	12.0	10.0	8.6	7.5	6.7	6.0	4.8	4.0
	20	240	3.6	3.2	2.9	2.4	2.1	1.8	1.6	1.4	1.2	1.0
	30	360	5.4	4.8	4.3	3.6	3.1	2.7	2.4	2.2	1.7	1.4
03	40	480	7.2	6.4	5.8	4.8	4.1	3.6	3.2	2.9	2.3	1.9
	50	600	9.0	8.0	7.2	6.0	5.1	4.5	4.0	3.6	2.9	2.4
Blue	60	720	10.8	9.6	8.6	7.2	6.2	5.4	4.8	4.3	3.5	2.9
	70	840	12.6	11.2	10.1	8.4	7.2	6.3	5.6	5.0	4.0	3.4
	80	960	14.4	12.8	11.5	9.6	8.2	7.2	6.4	5.8	4.6	3.8
	90	1080	16.2	14.4	13.0	10.8	9.3	8.1	7.2	6.5	5.2	4.3
	100	1200	18.0	16.0	14.4	12.0	10.3	9.0	8.0	7.2	5.8	4.8
	20	320	4.8	4.3	3.8	3.2	2.7	2.4	2.1	1.9	1.5	1.3
	30	480	7.2	6.4	5.8	4.8	4.1	3.6	3.2	2.9	2.3	1.9
04	40	640	9.6	8.5	7.7	6.4	5.5	4.8	4.3	3.8	3.1	2.6
	50	800	12.0	10.7	9.6	8.0	6.9	6.0	5.3	4.8	3.8	3.2
Red	60	960	14.4	12.8	11.5	9.6	8.2	7.2	6.4	5.8	4.6	3.8
	70	1120	16.8	14.9	13.4	11.2	9.6	8.4	7.5	6.7	5.4	4.5
	80	1280	19.2	17.1	15.4	12.8	11.0	9.6	8.5	7.7	6.1	5.1
	90	1440	21.6	19.2	17.3	14.4	12.3	10.8	9.6	8.6	6.9	5.8
	100	1600	24.0	21.3	19.2	16.0	13.7	12.0	10.7	9.6	7.7	6.4
	20	400	6.0	5.3	4.8	4.0	3.4	3.0	2.7	2.4	1.9	1.6
	30	600	9.0	8.0	7.2	6.0	5.1	4.5	4.0	3.6	2.9	2.4
05	40	800	12.0	10.7	9.6	8.0	6.9	6.0	5.3	4.8	3.8	3.2
	50	1000	15.0	13.3	12.0	10.0	8.6	7.5	6.7	6.0	4.8	4.0
Brown	60	1200	18.0	16.0	14.4	12.0	10.3	9.0	8.0	7.2	5.8	4.8
	70	1400	21.0	18.7	16.8	14.0	12.0	10.5	9.3	8.4	6.7	5.6
	80	1600	24.0	21.3	19.2	16.0	13.7	12.0	10.7	9.6	7.7	6.4
	90	1800	27.0	24.0	21.6	18.0	15.4	13.5	12.0	10.8	8.6	7.2
	100	2000	30.0	26.7	24.0	20.0	17.1	15.0	13.3	12.0	9.6	8.0
	20	480	7.2	6.4	5.8	4.8	4.1	3.6	3.2	2.9	2.3	1.9
	30	720	10.8	9.6	8.6	7.2	6.2	5.4	4.8	4.3	3.5	2.9
06	40	960	14.4	12.8	11.5	9.6	8.2	7.2	6.4	5.8	4.6	3.8
	50	1200	18.0	16.0	14.4	12.0	10.3	9.0	8.0	7.2	5.8	4.8
Gray	60	1440	21.6	19.2	17.3	14.4	12.3	10.8	9.6	8.6	6.9	5.8
	70	1680	25.2	22.4	20.2	16.8	14.4	12.6	11.2	10.1	8.1	6.7
	80	1920	28.8	25.6	23.0	19.2	16.5	14.4	12.8	11.5	9.2	7.7
	90	2160	32.4	28.8	25.9	21.6	18.5	16.2	14.4	13.0	10.4	8.6
	100	2400	36.0	32.0	28.8	24.0	20.6	18.0	16.0	14.4	11.5	9.6
	20	640	9.6	8.5	7.7	6.4	5.5	4.8	4.3	3.8	3.1	2.6
	30	960	14.4	12.8	11.5	9.6	8.2	7.2	6.4	5.8	4.6	3.8
08	40	1280	19.2	17.1	15.4	12.8	11.0	9.6	8.5	7.7	6.1	5.1
	50	1600	24.0	21.3	19.2	16.0	13.7	12.0	10.7	9.6	7.7	6.4
White	60	1920	28.8	25.6	23.0	19.2	16.5	14.4	12.8	11.5	9.2	7.7
	70	2240	33.6	29.9	26.9	22.4	19.2	16.8	14.9	13.4	10.8	9.0
	80	2560	38.4	34.1	30.7	25.6	21.9	19.2	17.1	15.4	12.3	10.2
	90	2880	43.2	38.4	34.6	28.8	24.7	21.6	19.2	17.3	13.8	11.5
	100	3200	48.0	42.7	38.4	32.0	27.4	24.0	21.3	19.2	15.4	12.8
	20	800	12.0	10.7	9.6	8.0	6.9	6.0	5.3	4.8	3.8	3.2
	30	1200	18.0	16.0	14.4	12.0	10.3	9.0	8.0	7.2	5.8	4.8
10	40	1600	24.0	21.3	19.2	16.0	13.7	12.0	10.7	9.6	7.7	6.4
	50	2000	30.0	26.7	24.0	20.0	17.1	15.0	13.3	12.0	9.6	8.0
Lt. Blue	60	2400	36.0	32.0	28.8	24.0	20.6	18.0	16.0	14.4	11.5	9.6
	70	2800	42.0	37.3	33.6	28.0	24.0	21.0	18.7	16.8	13.4	11.2
	80	3200	48.0	42.7	38.4	32.0	27.4	24.0	21.3	19.2	15.4	12.8
	90	3600	54.0	48.0	43.2	36.0	30.9	27.0	24.0	21.6	17.3	14.4
	100	4000	60.0	53.3	48.0	40.0	34.3	30.0	26.7	24.0	19.2	16.0

Spray Day Time Accounting

(Time in minutes)

Sprayers101

Task	Estimated time	Frequency per day	Total est. time	Actual time	Rank
Fuel, Lube					
Clean cab, wash sprayer					
Load jugs and totes					
Check label (rates, rainfastness...)					
Fill tender tanks					
Load sprayer (in yard)					
Transport to field					
Unfold boom					
Enter field data into monitor					
Check, record weather					
Check for pest, crop stage					
Prime boom					
Change nozzles					
Spray one load					
Unplug, replace nozzles					
Repair component					
Make headland turn					
Fill sprayer in field					
Monitor boot-up after shutoff					
Get sprayer unstuck					
Drive to tender truck					
Wait for tender truck					
Spray out tank remainder					
Clean tanks					
Clean filters					
Flush boom, ends					
Drive back to driveway					
Fold boom					
Loading sprayer onto trailer					
Cool off idle					
Total (not counting spraying) (A)					
Spraying (B)					
Percent Downtime (A/(A&B)					

Three biggest productivity losses

Options for minimizing these losses

Goals for Winter 2027

Don't let resistance take a bite out of your bottom line.

Talk to your advisor now about resistance management.

keepwhatworksworking.co.nz

FAR®

Scan this QR code to go to the keep what works working website.

Herbicide resistance testing submission form

FAR is currently offering free testing for herbicide resistance. This is part of a four-year project *Integrated Weed Management in a World of Herbicide Resistance* (2025–2029), funded through MPI's Primary Sector Growth Fund and co-funding from VR&I and SIRC. Seed will be tested at AgResearch facilities.

Seed sampling instructions

1. **Mature** seed must be provided for the testing – seed would usually be collected just before harvest. Send in up to ten individual plants per weed species.
2. The plants/seed should be collected well-spaced across the area/paddock of concern.
3. Place seed from individual plants into a separate labelled bag (preferably paper or plastic ziplock).
4. Label bags with **weed species name** and **paddock name.** All identifying information will be kept private. If possible a **latitude** and **longitude** is useful.
5. Depending on the amount of seed available samples will be tested over 1-6 herbicides at label rates to determine resistance. Pre and post emerge herbicides if applicable. Percentage survival for each herbicide will be reported to the contact person (usually within 3-5 months).

Please complete details

Grower name	**Paddock name**	**Date**
Name and address of farm & GPS in decimal degrees		
Grower email	**Grower mobile**	
Name of person who took sample (if not grower):	**Sampling rep mobile:**	
	Sampling rep email	
Resistance is suspected for what herbicide(s)?		
Test sample species* (i.e. wild oats, ryegrass, phalaris)		

*Note: Use <u>one form per weed species</u>

Five year paddock history

Year	Herbicides applied	Crops (including variety name if ryegrass is the weed)
202*		
202*		
202*		
202*		
202*		

Courier samples and form/s to: Ben Harvey, FAR, Building 9, Innovation Park, 185 Kirk Road Templeton 7678	**For further information contact:** Ben Harvey Ben.Harvey@far.org.nz or 027 549 5661

Feedback survey

Scan the QR code to fill out the Sprayers 101 workshop feedback form.

Notes:

FAR Strategy 2026-2031

Vision for the arable sector

A confident, resilient and profitable arable sector, producing trusted foods, feeds and seeds

Purpose of FAR

Connecting growers with science and information to support successful arable farms and a valued arable sector

Trusted research, development and innovation

Goal - Contribute to arable farm success

We will...

- **Engage growers** to identify research that matters
- **Prioritise research** for maximum impact from available resources
- **Partner with growers**, research providers and industry in New Zealand and globally

Extension with impact

Goal - Deliver value to arable growers

We will...

- **Deliver results** promptly
- **Provide** trusted and timely information
- **Translate research results** to support practical on-farm decisions
- **Deliver to growers** through multiple channels and partners

Building arable sector understanding

Goal - A visible and valued arable sector

We will...

- **Champion arable's contributions** to New Zealand farmers and society
- **Build a robust evidence base** to promote the value of our industry
- **Strengthen and align relationships** with government, commercial providers and other primary sectors

An efficient and effective FAR

Goal - A focused and agile organisation

We will...

- **Be sound stewards** of grower investment
- **Monitor, evaluate and evolve** delivery to arable growers
- **Build** a connected and capable FAR team
- **Support and develop** our staff and grower and industry volunteers
- **Invest** in systems to improve efficiency and performance

Principles

Focused on growers

Enhancing arable community

Values

Trusted · Independent · Curious

Collaborative · Engaged

Foundation for Arable Research
PO Box 23133, Hornby
Christchurch 8441

Phone: 03 345 5783
Email: far@far.org.nz

Follow us
@FARarable

www.far.org.nz