SPRAYER TECHNOLOGY

PRODUCT BULLETIN

SharpShooter™:

Chemical Application Pressure Control in a Retrofit Package

CAPSTAN Ag Systems, Inc.

How New is the SharpShooter™ "Blended Pulse" Concept?

Technology History:
Capstan Ag Systems introduced its first blended pulse agricultural spraying system in 1996 under the ***Capstan Synchro®*** brand name.

Case IH took it to their customers starting in 1998 as ***AIM Command™,*** factory installed on their red sprayers. Now 7 years later, it is estimated that Capstan's blended pulse systems have covered over 100 million acres in the United States, Canada, Brazil and Australia. Blended pulse technology has thus proven itself completely valid while operating in all kinds of ag conditions.

The Natural Marketing Progression:
To date, Capstan's Synchro system has been limited to factory installation on Case IH sprayers, as AIM Command. In order to broaden the market for blended pulse systems, Capstan is now introducing the ***SharpShooter*** system.

SharpShooter is designed to be a simple retrofit onto practically any type of ag spraying equipment. Containing almost all of Synchro's features, SharpShooter provides the basics of independent pressure control in a system to integrate with the widest range of spray equipment, from tractor mounts to pull-behinds and up to the largest self-propelled units.

Summary of Customer Experience:
The principle reason Capstan's technology brings significant value to ag spraying is that, in contrast to conventional spraying systems and for the first time, an operator has the ability to adapt the sprayer to the field conditions at hand. For the first time, the operator can control spray pressure independently from flow rate and speed. The implications of this capability represent a huge step forward in the industry. Here is why a wide variety of experienced operators of Capstan's Synchro blended pulse system value it:

- "There are just fewer things to think about. Reduced stress from not having to be as concerned about pressure every time the machine goes up or down a hill, turns a row, comes out of a corner and maneuvers around a field obstruction."
- "At the end of the day, the operator KNOWS he has done a quality job in a timely fashion. There is no need to wait a week or two for the farmer to see the results."
- "The operator can focus on driving the terrain instead of worrying about the quality of the application."
- "The operator is less concerned about potential drift claims."
- "The operator does not have to over-drive the equipment to maintain tip pattern. Boom repairs have dropped, on the average, by 300% on blended pulse equipped sprayers."
- "Less time is spent fussing with different tips."
- "There are more days when the operator is done early and can go home sooner."
- "The producer spends less time in the cab, reduces fuel cost, minimizes machine hours and retains the equipment's resale value."

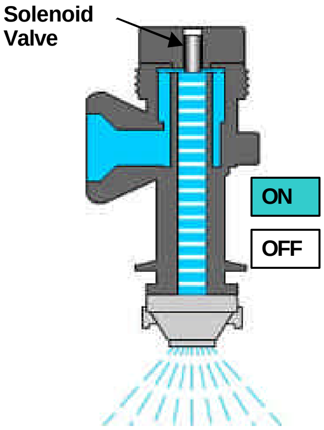
Technical Summary on Why Customers Make Such Claims:

1. Direct control of pressure independent of flow rate control.
2. Affords consistent droplet size and pattern over a wide speed range. (8:1 ratio compared to conventional 2:1 speed range)
3. Requires only one tip over these wide speed ranges because of constant pressure.
4. Enables consistent application during start-up, shut down and varying speed throughout the field.
5. In-the-cab pressure control lets the operator, without stopping, change droplet sizes in response to areas of heavy pest pressure, drift sensitive zones, meteorological conditions, etc.
6. Instant on and off spray control; no “W” patterns at start-up as pressure builds up gradually down the boom.
7. Droplet size control enables blended pulse spraying in higher winds than conventional systems for more timely applications and a wider spray window on the season.
8. Consistent controlled droplet size enables optimum chemical efficacy, which translates to the best kill rate and cleaner fields for the chemical dollar.
9. Cleaner fields logically lead to improved harvests.
10. Superior spraying characteristics over conventional spraying using minimum amounts of water while stretching tank capacity at lower gallons per acre (GPA) targets.
11. Increase operator comfort while spraying more acres per hour per day; less concentration on making allowance for spraying shortcomings of conventional sprayers.
12. Higher average field speeds get the job done quicker.
13. More spraying days available each season than with conventional sprayers through droplet size control at higher average speeds.
14. Direct operator control of speed, flow rate and pressure enables the machine’s spray performance to be customized to the field conditions at hand.
15. Operators no longer need to over-drive the machine to maintain a spray pattern or to prevent over-application.
16. The strategy in spraying a field can dramatically change to increase efficiency.

The following sections will cover in more depth topics important to understanding SharpShooter as it relates to contemporary agricultural spraying:

- **Understanding SharpShooter™ – Flow Control and Levels of Pressure Control**
- **SharpShooter™ Retrofits on Existing Technology**
- **Understanding the Agronomic and Production Impact of SharpShooter™**
- **Summary**
    - **Operator Convenience – the Hidden Factor**
    - **Competition**
    - **Conclusion**

Understanding SharpShooter™ – Flow Control and Levels of Pressure Control



SharpShooter's primary pulse mechanism is a solenoid valve at each nozzle, set to cycle ten (10) times per second. The length of time the valve remains open during each cycle determines the total amount of fluid released.

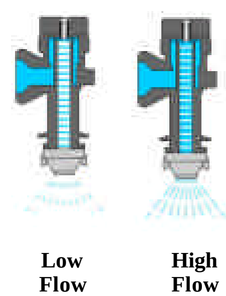
1. The period when the valve is open is a spray pulse – a liquid pulse from the nozzle tip.
2. The period when the valve is closed is a spray pause – no liquid pulse from the tip.
3. The time between the start of each cycle is always 1/10 of a second. The duration of the "on" or "off" part of each pulse of a cycle can be adjusted electronically.
4. When a low flow rate is needed, the spray pulse is short and the spray pause between the pulses is long.
5. When a moderate flow is needed, the pulses and pauses are about equal in length.
6. When a high flow is desired, the pulses are long and the pauses are short.

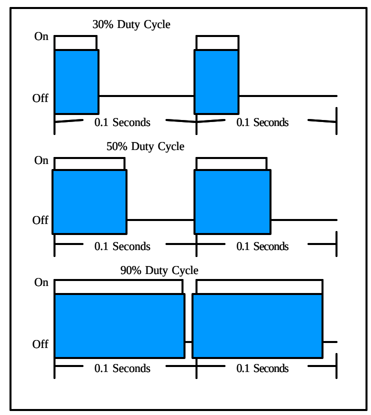
An electronically-controlled valve assembly automatically adjusts the spray pulse and pause time (the duty cycle) to the get the application rate needed.

A "100% duty cycle" means the pauses are reduced to zero and the liquid flow through the valve assembly is at its maximum.

A "50% duty cycle" means the pulses and pauses occupy the same amount of time.

A "10% duty cycle" represents the least amount of flow possible through the valve assembly. This electronic control allows flow rates to be changed almost instantaneously. When the valve assemblies remain closed, they act as the nozzle shutoff.





<u>Instant tip "ON" or "OFF" across the entire boom</u> is now a reality because the flow is controlled right at the valve assembly.

<u>Full boom pressure is instantaneously available</u> because it is maintained right up to the valve assembly tip.

How Is Tip Selection Different Than Conventional Technology?
Here's one example: A Wilger ER110-08 tip at 40 psi and at a 100% duty cycle permits a flow of 0.8 gallons per minute (gpm). But when SharpShooter pulses at a 50% duty cycle at 40 psi, that same ER110-08 tip acts like an ER110-04 tip. This is not possible with a conventional sprayer. So when used with SharpShooter, one tip can typically replace several tips with different orifice sizes. So generally, an operator will size his tip to the top end of the flow range desired.

Using Programmed Rate Changes: It is easy to see that a properly selected tip allows the operator to toggle between programmed rate values in the rate controller without having to change tips or speed. This is great for applying a heavier rate on spots of greater weed populations. It is plain to see that SharpShooter can be the foundational means for map-driven variable rate applications.

Specifically there are three (3) modes of action with SharpShooter™: PSI, PWM and OFF

<u>PSI Mode</u>: The full utility of SharpShooter is available in this mode. It can enable the operator to have fully independent control of speed, pressure and flow rate. Numbers on the dial, from 10 to 100, represent different boom pressures. Setting the dial on a specific psi enables the system to maintain that pressure regardless of speed and flow rate.

As speed and flow rate happen to change, SharpShooter senses the change and almost instantaneously modifies the duty cycle to offset what in conventional systems might cause changes in pressure.

Note: SharpShooter will maintain a constant pressure selection within a specific pulse range. If the pulse range is exceeded, the rate controller will override the SharpShooter, increasing or decreasing the spray pressure beyond the pressure set point dialed by the operator.

Examples of use:

The chemical application requires 15 GPA at a sufficient tip pressure to obtain Volume Median Diameter (VMD) droplet size of 250 microns. Assuming a desired maximum speed of about 16 mph, an ER110-08 would be chosen from the SharpShooter tip chart. The SharpShooter dial set at 50, for a 50 psi GAGE pressure, would yield a TIP pressure of 40 psi and a VMD of 256 microns.

As the spray machine slows, the rate controller would start to decrease pressure to the boom in order to lessen flow through the valve assemblies to maintain the 15 GPA, just as it would with a conventional plumbing system. SharpShooter, however, senses the incipient pressure change and shortens the duty cycle as needed, thus lessening flow through the valve assemblies directly without requiring a lowering in pressure to match the lowering speed. The rate controller would recognize the constant GPA and not impose a pressure drop. Since the 40 psi pressure does not change, neither does the 256 micron droplet size nor was a tip change required.

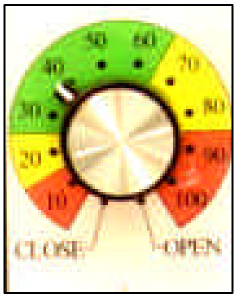
If the operator needed a smaller rate, say, 10 GPA still at 40 psi, he simply enters the new rate in the rate controller. Conventionally at the same speed, a lower GPA would require a lower pressure. Again, SharpShooter would recognize the rate controller dropping pressure and respond by shortening the duty cycle until the target 10 GPA is reached while maintaining the 40 psi. Again at 40 psi, the VMD droplet size stays at 256 microns

For another alternative, if an operator wants a larger droplet size for a drift sensitive area, the SharpShooter dial can be moved to a suitable lower pressure. SharpShooter's response would be to increase the duty cycle, which increases flow through the tips. The rate controller would sense increased flow and resultantly act to reduce pressure. The rate controller would cease reducing pressure when the GPA at new pressure is achieved. The lower pressure results in a larger VMD and reduced fines are achieved without changing tips or slowing down.

The operator has adapted the sprayer to the field conditions, at hand, directly from the seat.

How Does This Affect Tip Selection?
In the PSI mode, a tip is selected for the top end of the rate and speed range desired. This tip can be used for up to an 8:1 range combination of rate and speed.

PWM Mode: The full utility of Sharpshooter is NOT used. This mode is used primarily for fertilizer applications or for troubleshooting.



As in a conventional system, the rate controller determines the flow rate with the pressure reacting relative to speed changes. SharpShooter uses the duty cycle to simulate different tips sizes in adjusting to desired target application rates.

In this mode, the numbers on the SharpShooter dial represent % duty cycle from 10% to 100%.

> For example, if a rate of 15 GPA is desired, an ER110-08 can be selected and the SharpShooter dial set to a 100% duty cycle. The ER110-08 tips will do the 15 GPA at 15.8 mph and a tip pressure of 40 psi If a rate of 7.5 GPA is then needed, the operator can dial the SharpShooter to a 50% duty cycle. Now the ER110-08 tip acts like an ER110-04 tip. The machine will do the 7.5 GPA at about 15 mph but with a pressure of 50 psi, just as one would expect from an ER110-04 tip in a conventional system. Notice, no tip change was needed to go from 15 GPA to 7.5 GPA, but both the speed and pressure changed. In other words, the machine acted like a conventional sprayer regarding pressure control, but did not have to change tips.

How Does This Affect Tip Selection?
In this mode, a tip is sized to the top end of the rate range. As the duty cycle is changed to get different rates, the pressure will change according to the changes in speed while the rate controller works to maintain the desired rate. The speed range is limited by the developed pressure, either high or low.

OFF MODE: This mode serves as a conventional backup should SharpShooter have a problem; enabling the applicator to operate like a conventional sprayer until it is convenient. The rate controller in this situation would manage flow rate by adjusting pressure in response to speed.

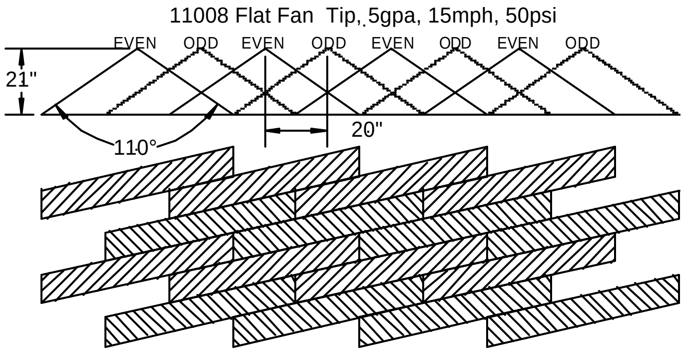
Is Instantaneous Variable Rate Control at a Constant Pressure Through a Single Tip Now Possible?
YES! The SharpShooter is the mechanism at the boom that can execute change in rates dictated by a rate controller governed by a rate controller map. Thus, SharpShooter is the "missing link" for GPS Mapping Technology and Variable Rate capable rate controllers.

An Even Spray Pattern Is Important
An even spray pattern is important for the professional application of agricultural chemicals. One might think that "pauses" in the spray's flow would result in skipping or striping in the field. "If there is no spray coming out of the valve assemblies, how can there not be unsprayed areas in the field?"

SharpShooter's Blended Pulse Spray Prevents Spraying Gaps

SharpShooter's "Blended Pulse" spray performance prevents unsprayed areas in three ways:

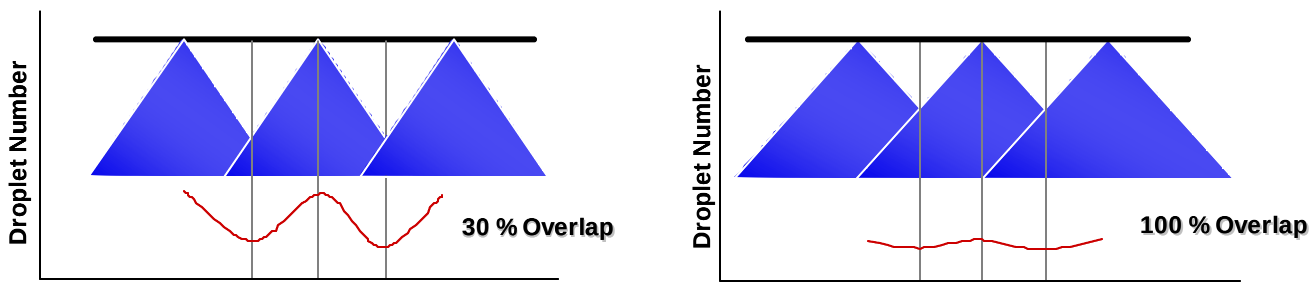
1. Spray droplets naturally tend to overlap, mix and whirl as they move from the valve assemblies down to the target. This mixing is partly due to the range of droplet sizes produced at the tip, the different exit velocities of the droplets and the airflow created as the boom and spray travel. These factors combine to create a hash of droplets moving down to the ground. This can be observed by looking at the spray pattern about 12" to 16" below the valve assembly tips.



2. The design of the spray pattern across the boom alternates the time of the spray so that the start of each spray pulse is delayed 1/20 of a second after the start of the pulse from its neighboring valve assembly. This mixes the spray pulse and pulses across the boom and allows them to blend into a consistent pattern.

3. Improving nozzle overlap also increases the blended pulse performance, either by using wider pattern tips or by slightly raising the boom about the canopy. For example, using 110-degree tips instead of 80-degree tips increases the overlap between neighboring valve assemblies and when combined with alternate pulse timing provides coverage between the spray pulses.

Pressure and Flow Control Summary



- The length of spray pulses and pauses executes the flow rate dictated by the vehicle speed and values programmed into the rate controller.
- There are three (3) modes of SharpShooter operation. In the PSI mode, pressure and flow can be controlled independently of each other, controlled independent of speed, through a speed range.
- SharpShooter's "Blended Pulse" design alternates the timing between neighboring valve assemblies to provide a spray overlap during the spray pauses.
- With properly selected tips, the operator can toggle between rate values programmed into the rate controller without changing tips or changing speed.
- With properly selected tips, the operator can dial ito ten (10) discrete pressure values, on-the-go, without changing tips or changing speed, as necessary to control spray quality or manage drift potential.

SharpShooter™ "Retrofits" Existing Technology

SharpShooter readily adapts to current spray technologies like rate controllers, various tips and chemical injection. The learning curve for the operator is a matter of just a few minutes of instruction and then a couple of supervised hours spraying in the field to gain confidence.

- Using production Wilger® Combo-Rate™ nozzle bodies and Combo-Jet™ tips, tip selection is made much simpler. While other nozzle body and tip manufacturers may be used, the Wilger products provide the greatest versatility with SharpShooter.

- In the dual nozzle body configuration, the outside body is used by SharpShooter to apply chemicals. The inside nozzle body can be used as a conventional means to apply high rates of liquid fertilizer or a backup to SharpShooter.

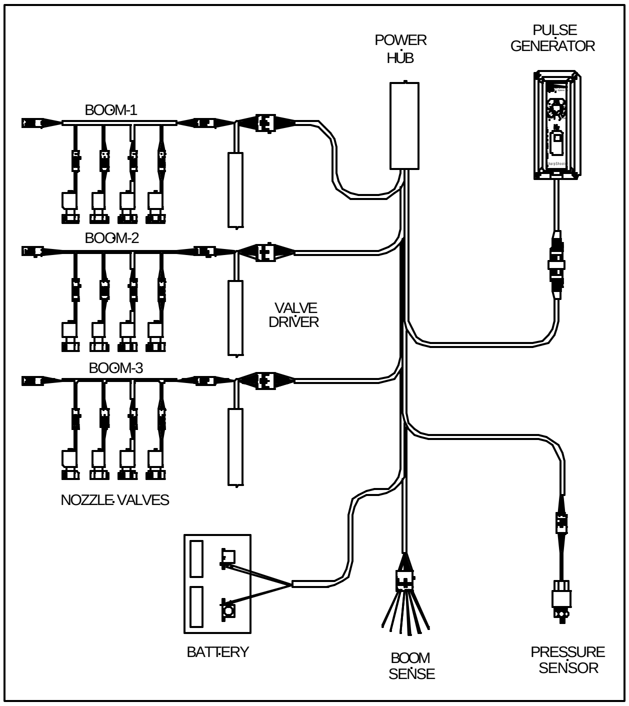
- Further application versatility in applying chemicals can be achieved using a Wilger rotary multiple tip nozzle body. The SharpShooter valve assembly mounts horizontally at the rotary body manual shutoff location. This could also be used with an inside Combo-Rate body for high rates of liquid fertilizer.

- Another adaptation, particularly good for canopy penetration, like for Asian soybean rust, is the Wilger "Y" adapter that allows two tips to be spraying with SharpShooter.

- SharpShooter can be installed to work with any flow-based controller. It is not directly connected to the rate controller.

- SharpShooter is designed to sense the changes in pressure caused by changes in the rate of application and by changes in vehicle speed. In the PSI Mode, it adjusts the duty cycle of the spray pulse to affect a simulated orifice size change to maintain the pressure value set by the operator on the SharpShooter pressure dial.

- SharpShooter's control reacts almost instantaneously to the rate and speed changes because the response time of its electric solenoid is so fast (only a fraction of a second). Compare this to conventional flow control response times of several seconds. Because of the independence of flow and pressure with SharpShooter, the range of rate from a single nozzle within a range of speeds increases from 2:1 in conventional systems to up to 8:1 with SharpShooter.



Retrofit Installation:

SharpShooter installations are quick and easy. See the SharpShooter retrofit guides for the setup details. In general, the following steps are required:

Step 1: Mount the SharpShooter Pulse Generator inside the cab, within reach of the operator.

Step 2: Install the valve assemblies, one per nozzle, replacing the "check valve" diaphragm cap.

Step 3: Install a pressure sensor in the boom manifold.

Step 4: Install the SharpShooter Power Hub and Valve Drivers on the boom, routing the cables as shown at right. The diagram shows a 3 section boom installation.

Step 5: Splice the boom sense wire into the rate controller wiring to turn on and off the boom sections.

Step 6: Attach the power leads to the battery.

Retrofit Summary

SharpShooter technology interfaces with current spray technologies. It is integrated into the product circuit, fitting along side the rate controller function ahead of the nozzle body and tips. It is almost invisible to the operator. Only a Mode Switch and Pressure Value Dial give any indication that SharpShooter is present.

Tip Selection

As noted earlier, this makes tip selection much simpler. First, a chemical droplet size and application rate is determined for the applied chemical. The following chart summarizes general droplet size ranges for different modes of chemical application.

Droplet Size Recommendations by Mode of Action		
Mode of Action	**Droplet Classification**	**VMD Range**
Fungicide	Very Fine to Fine	<135 - 235
Insecticide	Fine to Medium	135 - 340
Asian Soybean Rust	Medium	235-340
Contact Herbicide	Medium to Coarse	235 - 400
Systemic Herbicide	Coarse-Very Coarse	340 - 500
Fertilizer	Very-Extreme Coarse	>400

With that knowledge, the tip is then sized to the larger rate requirement and toward the upper end of the field speed range.

Using the SharpShooter Tip Selection Chart, shown in part on the next page, the application rate is found. The user scrolls down the Application Rate column until the desired "top field" speed is found. Then the user scans left to the pressure value for that rate and top speed. Boom pressure corresponds to the SharpShooter dial setting. The corresponding tip pressure yields the spray characteristics. Note the range of rates available for that tip.

Using the tip size and pressure, scroll to the second half of the chart. This chart will indicate, per tip type and tip brand, the choices of VMD (Volume Median Diameter) size and % driftable fines at the desired pressure. Check the change in the spray droplet characteristic when dialing to a lower pressure.

SharpShooter™ Tip Chart Excerpt:

Tip Rate, Pressure and Speed Ranges

	Flow	Pressure		Speed Range, mph					
	US gpm	Gage	Tip	5 GPA	8 GPA	10 GPA	12 GPA	15 GPA	20 GPA
0.6 (06)	0.391	20	17	5.8 to 23.2	3.6 to 14.5	1.5 to 11.6	1.2 to 9.7	1.0 to 7.7	0.7 to 5.8
	0.484	30	26	7.2 to 28.7	4.5 to 18.0	1.8 to 14.4	1.5 to 12.0	1.2 to 9.6	0.9 to 7.2
	0.600	40	35	8.9 to 35.6	5.6 to 22.3	2.2 to 17.8	1.9 to 14.9	1.5 to 11.9	1.1 to 8.9
	0.626	50	44	9.3 to 37.2	5.8 to 23.2	2.3 to 18.6	1.9 to 15.5	1.5 to 12.4	1.2 to 9.3
	0.684	60	52	10.2 to 40.6	6.3 to 25.4	2.5 to 20.3	2.1 to 16.9	1.7 to 13.5	1.3 to 10.2
0.8 (08)	0.506	20	16	7.5 to 30.1	4.7 to 18.8	1.9 to 15.0	1.6 to 12.5	1.3 to 10.0	0.9 to 7.5
	0.620	30	24	9.2 to 36.8	5.8 to 23.0	2.3 to 18.4	1.9 to 15.3	1.5 to 12.3	1.2 to 9.2
	0.800	40	32	11.9 to 47.5	7.4 to 29.7	3.0 to 23.8	2.5 to 19.8	2.0 to 15.8	1.5 to 11.9
	0.795	50	40	11.8 to 47.2	7.4 to 29.5	3.0 to 23.6	2.5 to 19.7	2.0 to 15.7	1.5 to 11.8
	0.867	60	47	12.9 to 51.5	8.0 to 32.2	3.2 to 25.8	2.7 to 21.5	2.1 to 17.2	1.6 to 12.9

Step 1

Step 3

Step 2

Tip Types, Droplet (VMD) Sizes, % Driftable Fines, Droplet Size Color Coding, Brands:

	Pressure		Tip Type	Wilger ER	Wilger ER	Wilger SR	Wilger MR	Wilger MR	Wilger DR	Wilger DR	TeeJet TJ	TeeJet XR	TeeJet XR	TeeJet TT	TeeJet AI	TeeJet DG	Deere ER	Deere ER	Deere LD	Deere LD
	Gage	Tip	Tip Angle	110	80	110	110	80	110	80	110	110	80	110	110	110	110	80	110	80
0.6 (06)	20	17	VMD	291	325	507	560	589	636	656		C	C	XC			C	C	VC	VC
			% Fines	26	18	6	4	2	3	1.7										
	30	26	VMD	268	303	438	528	540	583	611	M	M	C	VC	XC		C	C	VC	VC
			% Fines	32	23	9	6	4	4	2.6										
	40	35	VMD	252	287	389	498	506	546	579	M	M	C	VC	XC		M	C	C	VC
			% Fines	36	27	13	7	6	4	3.5										
	50	44	VMD	240	276	354	471	481	518	556	F	M	C	C	VC		M	M	C	C
			% Fines	39	30	17	9	8	5	4.35										
	60	52	VMD	231	266	324	[illegible]	[illegible]1	496	538	F	M	C	C	VC		M	M	C	C
			% Fines	42	33	21	10	9	7	5.2										
0.8 (08)	20	16	VMD	353	390	567	639	621	713	692		C	VC	XC			C		VC	VC
			% Fines	22	21	7	5	5	3.6	2										
	30	24	VMD	306	337	404	568	567	649	644	M	C	VC	VC	XC		C		VC	VC
			% Fines	28	26	11	7	9	4.4	4										
	40	32	VMD	278	305	435	521	531	607	612	M	C	C	VC	XC		C		C	VC
			% Fines	33	29	13	8	12	5.15	5										
	50	40	VMD	256	281	399	481	501	571	586	M	C	C	VC	XC		M		C	VC
			% Fines	36	33	15	10	14	5.95	6										
	60	47	VMD	241	264	373	451	478	544	565	M	M	C	C	VC		M		C	C
			% Fines	39	36	16	1[illegible]	[illegible]	5.7	7										

Step 5

Step 4

Understanding the Agronomy and Production Profitability Impact

Definitions

Agronomy*:* the theory and practice of crop production and soil science.

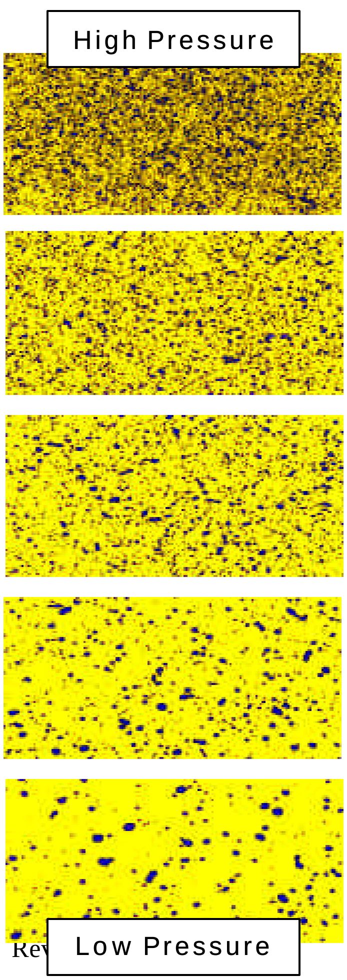
Production Profitability*:* to make money from growing/making something.

From an **agronomic** perspective, crop protection practices include:

- ✓ Application at the right agronomic moment
- ✓ The need for spray quality (consistent application of the right size and number of chemical droplets with control over canopy penetration) for the best use of the chemical, effective weed kill and maximum crop yield.

From a **production profitability** perspective, crop protection practices included:

- ✓ As many acres/day possible in as less time as possible
- ✓ Doing the job right once
- ✓ With least amount of chemical possible
- ✓ Control of off-target chemical trespass



So then, what sprayer feature has the most impact on agronomy and production profitability? <u>Answer: Whatever controls the application; the spray technology mounted to the iron.</u>

Pulse width modulation (PWM) flow control, working in concert with a conventional rate controller, represents the greatest breakthrough in spray technology.

Why a breakthrough? It's a matter of physics. The production expectation of high clearance sprayers is due, in part, to higher average field speeds.

The engineering challenge associated with increased speed is twofold. The first is managing the flow (gpm) through the nozzles to maintain a constant application rate per acre (GPA) and maintaining the proper number of droplets for good chemical coverage through a range of field speeds. The second is managing the larger range of pressures associated with the greater speed range.

For example, when sprayer speed doubles from 8 to 16 mph, the flow increases by a factor of two in order to maintain the GPA rate. But the pressure changes by a factor of four. With this pressure increase, the size of the droplets decreases (drift risk) and the exit tip velocity decreases (affecting canopy penetration). The number of droplets increases by a factor of 64. Change speed from 8 to 24 mph, the flow increases by a factor of 3, pressure by a factor of 9 and droplets increase by a factor of 729.

Pressure is directly related to spray quality, the size and number of droplets applied to the crop and the ability to penetrate the crop canopy.

Conventional sprayers equipped with rate controllers only manage ONLY the relationship between field speed and product flow (gpm). Typically, control is done ONLY within a 2:1 change in speed. Rate controller technology does not address changes in pressure. With a given rate, ONLY changing speeds or changing tips can affect the pressure in a conventional sprayer.

Capstan's SharpShooter, using pulse-width-modulation (PWM) control, works in concert with a rate controller to successfully manage the critical relationships between speed, flow and pressure up to an 8:1 change in speed with a single tip. On a sprayer equipped with SharpShooter, the operator has independent control of speed, flow and pressure.

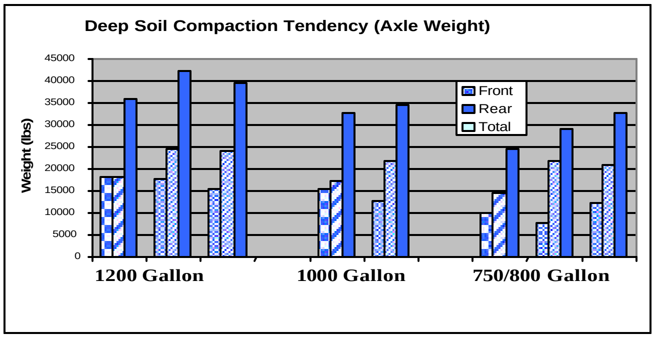
The operator can adapt a sprayer to a wider variety of crops, chemicals, weather conditions and terrain. All are easily controlled from the cab on-the-go!

1. The Right Agronomic Moment – Timeliness of Application

Obviously, the best application occurs when the job is done the right way at the right time. Spraying weeds at the young, moist two-leaf stage requires less chemical than spraying weeds at the 1000-leaf stage. However, nature does not always cooperate. The objective is to get into the field as quickly as possible and adjust the spray quality to the conditions at hand.

How does one enhance early field entry opportunity? How is this done in early spring or wet soil conditions, providing quality application and without leaving ruts?

Machine Configuration and Field Entry



First, a sprayer must be selected that is light, yet durable. For the larger capacity sprayers, it is important to select one whose weight distribution is evenly distributed over the front and rear axles, especially when the tank is full and the booms are out and down (spraying mode). This is the first consideration for timely application and early field entry.

Once in the field, soft or wet soils tend to lower the sprayer field speeds. As noted in a conventional spray, slower speeds often mean having another set of tips or compromising the spray quality because of the lower pressure associated with the slower speed. Often, these machines just stay in the shed and more expensive methods of application are employed.

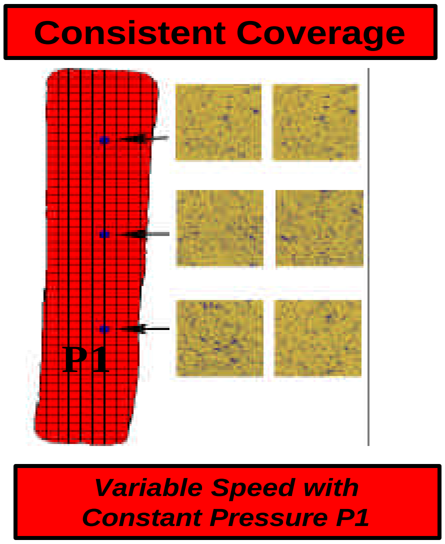
This is not the case with SharpShooter. Even at slower field speeds, SharpShooter maintains spray quality by maintaining the right pressure to deliver the optimum VMD droplet size.

Wind Conditions and Field Entry

Because of the discrete pressure and droplet size control, sprayers equipped with SharpShooter can spray on windier days when other machines are parked. Commercial users testify to saving 5-7 days per spraying season with SharpShooter.

2. Spray Quality – Chemical Performance

Spray quality covers a number of application concerns, including consistency of coverage, efficacy of coverage, canopy penetration, over- or under-application and spot spraying challenges while managing drift potential.



Consistent Application and Cleaner Fields

Open-field spraying is the easiest because vehicle speeds can be more consistent. Everyone expects good, clean coverage in open-field areas. A lack of good weed control often occurs in hills, ditches, soft or wet soil conditions, end rows, coming out of corners, or anytime there is a change in field speed of more than 2 to 3 mph. These factors generate the most complaints from producers.

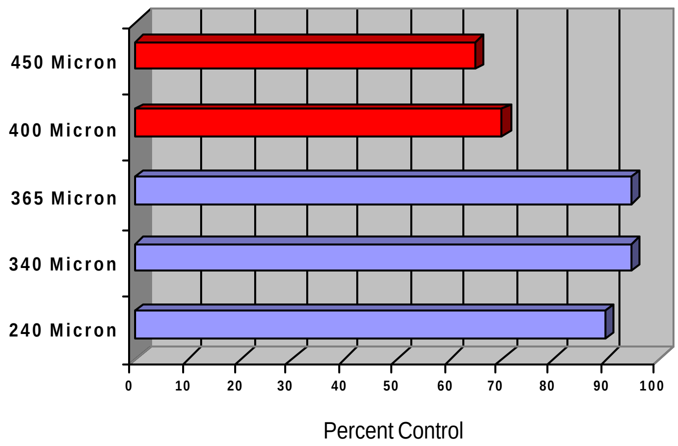
Because SharpShooter can be used to maintain the optimum chemical VMD droplet size independent of speed, pest eradication is better across the ENTIRE field, across any field big or small, square or irregular, smooth or hilly, free of obstruction or a maze. The operator stress level changes from 11 to 2 on a scale of 1 to 10!

This capability is extremely important with fast-producing pests, like Asian soybean rust or insects. An inconsistent application that leaves spots of under-treated areas permits the rapidly propagating pest to quickly re-infest the field. A more consistent application minimizes that potential, as well as unnecessary, expensive trips across the field.

Efficacy of Coverage

Common sense says that being able to spray an optimum chemical droplet size for the mode of action of the plant chemical uptake should improve performance. The plant uptake of a “contact chemical” is different than a “systemic chemical”. The mode of action droplet size chart in the “Tip Selection” section is evident of that fact.

The ability to adapt spray quality to climatic and weed conditions also makes sense. Dry weather conditions and more mature weed populations require better chemical coverage of smaller droplets. Typically, dusty field conditions require slower speeds, larger water rates and larger droplets. But even more important is field experience that provides the evidence of the “common sense” way of thinking.

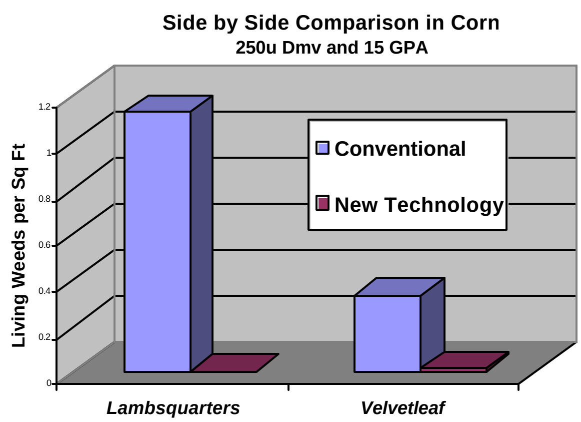


The chart to the left shows the results of a contact-type chemical sprayed with a desired VMD size range of 235-400 microns. In this test, the spray quality was optimum between the 340 and 365 microns. The application was in corn that was about 6” tall.

With a conventional sprayer, a decrease in speed of only 2 to 3 mph changed the VMD droplet size from 365 to 400 microns. The test showed a drop in weed kill from 93% to 68%.

A vehicle speed increase of just 3 to 4 mph decreased the VMD droplet size to 240 microns. The test showed a drop in weed kill from 92% to 88% and an increase in drift potential.

This pattern remains valid even for systemic-type chemical like glyphosates. The only difference is that the VMD droplet size cutoff for optimum performance is closer to 600 microns compared to the 400 microns for this contact herbicide.



The next chart compares the performance of the same chemical sprayed through two almost identical sprayers operating side-by-side. The only difference between the machines was that one sprayed with conventional rate control only, while the other used Blended Pulse Technology like the SharpShooter. The application difference was in the VMD droplet size control and the consistency by which the chemical was applied with typical field speed variations.

The chemical company tracked two weed responses, Lambsquarter and Velvetleaf. In both cases, the sprayer equipped with Blended Pulse technology significantly outperformed the conventional spray technology.

Canopy Penetration

Droplet mass and pressure have a significant impact on canopy penetration. Asian soybean rust studies illustrated that a medium droplet size and a pressure of 50-60 psi did a good job of penetrating to the bottom of a soybean canopy. With SharpShooter, a tip and pressure can be determined to define both the droplet size and pressure, and spray those required values consistently across the field independent of speed changes.

Reduced Over-Application “Burn Outs” Coming Out of Corners and at End Rows

Conventional sprayers over apply chemical when the spraying is started from a dead stop or when coming out of the corners of a field. The ground speed must increase enough to generate a boom pressure and a flow that allows the rate controller to operate and the drip checks to unlock. To compensate, the controller may be set to maintain a flow at some minimum pressure. This results in excess fluid flow at low vehicle speeds. So until the sprayer attains the minimum ground speed, it will over apply chemical. SharpShooter minimizes this problem with a

Run/Hold feature. When the operator shuts off the boom to back into a corner, Sharpshooter remembers that duty cycle. When the sprayer starts out of the corner and the boom is turned on, it will operate at the last recorded duty cycle. It will run for a set number of seconds, usually 3 seconds, at that duty cycle before it returns to normal operation.

No "Wedges" at the End Rows

With conventional systems, boom pressure must bleed off before the drop checks operate. When approaching the end of a row, the operator must anticipate when the boom will actually shutoff. Since the pressure drop "walks" from the inside of the boom to the outside, the nozzles nearer the machine tend to shutoff first, followed by the nozzles further out on the boom. This assumes all the drip checks are calibrated evenly. If not, there is a more random shutoff. The net result is a wedge-shape or "W" weed pattern at the end of each row.

SharpShooter uses the Run/Hold feature here as well. I this case the solenoids act as the drip checks. The solenoids all shutoff and turn on at the same time eliminating the "W" pattern at the end of the row.

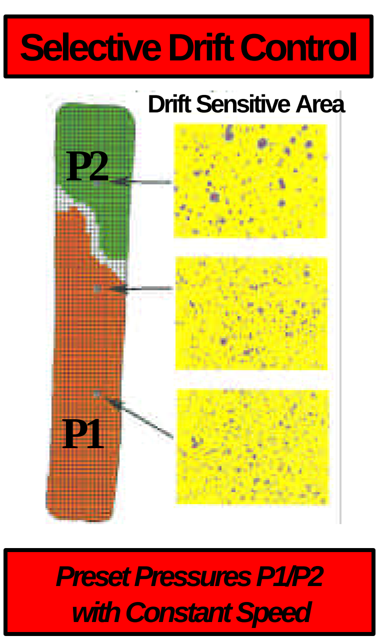
Spot Spraying

Often during field spraying applications, certain pest patches need an extra dose of chemical. With conventional systems, the operator can switch to a higher rate, provided the tip is not already at its maximum limit. In any event, the operator must slow down to avoid higher fogging and drift or to get sufficient flow through the tip. In either case, the droplet size changes to something less than optimum.

With SharpShooter and a proper tip, the spray rate is independent of vehicle speed and boom pressure. The operator can switch to a higher rate without a "drift cloud", without changing tips, without a change in the optimum droplet size and without changing speed.

Spray Quality – Drift Management

The simplest method of drift control is to select drift reduction tips available from a variety of manufacturers. However, there are two significant concerns to consider in this regard:



1. Drift reduction tips on a conventional sprayer are selected for a particular speed, pressure and rate. While there is some forgiveness, any deviation from these unique values still forces the operator to compensate by adjusting application practices or risk compromised results. SharpShooter frees the operator from these constraints.

2. There will be compromise in coverage. Research, particularly from Europe, continues to demonstrate that smaller droplets do a better job of pest control with less chemical. The tip determines the size profile and spray spectrum of the droplets. In other words, a large droplet-producing tip for drift control means the entire field experiences those larger droplets. For the same volume of liquid applied, larger droplets mean EXPONENTIALLY fewer droplets. Therefore large VMD droplets, while good for drift control, have a negative effect on the quality of the coverage. Ideally, an operator needs larger droplets ONLY in drift sensitive areas and smaller droplets for better coverage in the rest of the field. SharpShooter again provides the solution.

With SharpShooter, the operator can dial to a lower pressure for the drift sensitive areas and a higher pressure for the interior of the field. Furthermore, the operator can also switch to a higher rate in the drift sensitive area to provide more bullets to make up for those lost because of the larger droplets.

3. As Quickly As Possible – Maximizing Acres/Hour and/or Minimizing Time in the Cab

Productivity is a function of only four variables:

- ***Efficiency*** – a ratio of spray time to engine running time impacted primarily by time taken for tank refills and travel between locations
- ***Boom Width*** – a significant factor is the average speed is not compromised.
- ***Average Field Speed (AFS)*** – is not the same as "top field speed". AFS is impacted by horsepower, torque, propel efficiency, frame and suspension design, type of crop, field strategies for spraying, time spent in tips changes, lost time in machine repair, spray pressure and tip size limitations, field size, terrain, field obstructions and other factors.
- ***Spray Window*** – the largest factor in productivity, the amount of time to spray (hours/day and days available/season) is a function of wind and weather.

SharpShooter impacts the efficiency and the average field speed significantly and the spray window dramatically.

Efficiency Gain with Tendering and Carrier Rates

By "locking in" the optimum droplet size for a particular chemical and for climatic conditions, SharpShooter permits, in many cases, the reduction of the carrier rate by 2 to 3 GPA. This is particularly true if the application rate is at the higher end of the chemical label rate ranges.

The carrier rate should never be reduced to below the recommendation on the chemical's label. Applicators should also consider weed maturity, moisture conditions and the mode of chemical action. Note that the "carrier rate" is different than the "chemical rate" and should not be confused.

> For example, a carrier rate of 15 GPA with an 800-gallon tank can cover about 53 acres per tank fill. Reducing the carrier rate to 13 GPA yields about 61 acres per fill or 9 additional acres per refill. If it takes fifteen minutes to refill and the operator covers 50 acres/hour, that means up to 25 or more acres per day, every day of the season.

A two to three gallon reduction in the carrier rate means less refilling and potentially more acres sprayed, or for a given number of acres, less time spent in the cab and savings on fuel.

Average Field Speed

SharpShooter allows running at higher field speeds that were previously limited by tip size and pressure, improves efficiencies through better field spray drift strategies, reduces time spent on changing tips and improves efficiencies when spraying around field obstructions. It makes a big sprayer FEEL small.

The impact on average speed varies regionally from 2 to 5 mph over the whole season.

For example, a sprayer with an efficiency of 40%, equipped with a 90’ boom and operating at an average speed of 12 mph will cover 52.4 acres per hour.

Increasing the average field speed by 2 mph will cause the sprayer to cover 61.1 acres per hour. This results in a 16.6% increase in productivity. Instead of 10,000 acres, an applicator can cover 11,670 acres in the same amount of time.

A five mph increase in average speed means a 42.4% increase. So instead of 10,000 acres, an applicator can cover 14,240 acres in the same amount of time.

Wind

Typically, wind can cause an operator to lose spraying hours during a day or even lose entire days of spraying during a season. As mentioned earlier, SharpShooter makes it possible to control droplet size by controlling pressure, so operators can fully utilize the season’s available spraying hours.

For example, in challenging wind conditions, an operator can combine droplet size control with a lower pressure control, use Wilger drift reduction nozzles with a slightly higher carrier rate and continue to spray without significantly compromising chemical coverage.

For example, assume an operator has 10,200 application acres. At an average of 75 acres per hour, this acreage can be sprayed in 17 days spraying 8 hours a day (including shutting down 2 hours per day for wind).

But in reality, it may take 25 days because 4 whole days are lost to wind, and 4 more are lost to rain.

Spraying with SharpShooter, the same operator reclaims one of the two hours typically lost during the day, which means spraying 9 hours instead of the typical 8 hours. Then, the operator could also reclaim an additional two days when the machine would normally be shut down to wind.

So with SharpShooter, the operator is spraying 19 days and 9 hours per day in the same 25 day period. That is a total of 171 hours or at 75 acres per day, 1,425 acres. That’s a 39% productivity gain or 3,975 acres on the season.

Likewise, this operator could have covered the same 10,200 acres in 15 days over a 21 day period, shutting down 4 days for rain, one hour per day and two full days for wind. That’s a time reduction of 19% on the spray window and a 13% on the spraying time.

Temperature Inversions

Sprayed acres are reduced when temperature inversions occur because the operator slows down to reduce pressure and droplet fines. An operator with SharpShooter simply dials to a lower pressure and maintains the speed.

Acres/Hour Summary

Spray technology, for the dollar investment, can exceed gains in productivity from bigger booms, bigger tank and more horsepower, or even combinations of such. More importantly, there is greater gain from spray technology in terms of agronomy benefits of quality improvement, efficiency of kill and operator ease. Change in iron features cannot address these more important aspects of spraying. It makes good business sense to invest in Capstan’s SharpShooter.

Summary

Operator Convenience – The Hidden Factor

Capstan's SharpShooter is marketed for improved spray quality, drift control and for improved productivity. But the OVERWHELMING REASON applicators buy it a second time around is simply because it makes their job so much easier.

- "At the end of the day, the operator KNOWS he has done a quality job in a timely fashion. There is not need to wait a week or two for the farmer to see the results."
- "There are just fewer things to think about. Reduced stress from not having to be as concerned about pressure every time the machine goes up or down a hill, turns a row, comes out of a corner and maneuvers around a field obstruction."
- "The operator can focus on driving the terrain instead of worrying about the quality of the application."
- "The operator is less concerned about potential drift claims."
- "The operator does not have to over-drive the equipment to maintain tip pattern. Boom repairs have dropped, on the average, by 300% on SharpShooter equipped sprayers."
- "Less time is spent fussing with different tips."
- "There are more days when the operator is done early and can go home sooner."
- "The producer spends less time in the cab, reduces fuel cost, minimizes machine hours and retains the equipment's resale value."

Competition:

There are spray application technologies in the market place that can do the individual tasks of the SharpShooter, but there is none to date that can compete with the SharpShooter's comprehension application capability:

- In the breadth of application including coverage, drift control, and canopy penetration.
- In field productivity including a larger speed and rate range with a single tip..
- In versatility with capability to perform variable rate applications
- In reliability, simplicity and in operator ease of use.

Conclusion:

Is Capstan's SharpShooter too good to be true? It does not take long to find out.
SharpShooter, with its bigger brother Synchro (also known as AIM Command), is a major innovation in spray technology. It has proven to address the major principles of chemical application. Chemical applications can be done:

- With unmatched attention to spray quality by:
  - Truly delivering a consistent application of the right size and number of droplets
  - Controlling canopy penetration
  - Controlling off-target trespass
- At the right agronomic moment by:
  - Doing a quality job in a wet field sprayed at slower speeds
  - Spraying in windier conditions
- As quickly as possible by:
  - Expanding the season's spray window of opportunity
  - Improving average field speeds
  - Changing field spray strategies
- To the utter delight and pleasure of the operator.

For further questions on Capstan Ag Systems' SharpShooter™

Or

For information on other Capstan Ag Systems products,

- N-Ject™ LF: Liquid fertilizer application technology for toolbars
- N-Ject™: Anhydrous fertilizer application technology for toolbars
- Tattler™: Nozzle "ON/OFF" and "PLUGGING/WEAR" monitoring
- Capstan Synchro® or the Case IH AIM Command™

Contact Capstan at:

Website: **www.capstanag.com**

Phone: (785) 232-4477

Mail:
Capstan Ag Systems, Inc.
101 N. Kansas Ave.
Topeka, KS 66603