Application and Precision Ag Technology

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with assistance and materials from:
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Bob Wolf, Retired Application Specialist, Dept. of Biological & Agricultural Engineering

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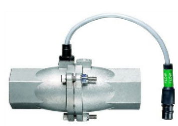
Knowledge for Life

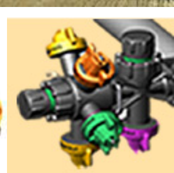
Sprayer Components:

- Tanks – poly, stainless
- Pump, Strainers, Agitation
- Pressure gauge
- Hoses, Flow control assemblies
- Electronics: monitors-computers- co
  (GPS/GIS)
- Distribution system
- Nozzles – Not expensive but KEY!








GPS Accuracy

Receiver System	Accuracy
Autonomous	1 – 3 m
Differentially corrected	less than 1 m (sub meter)
Dual Frequency	~ 10 cm
RTK	~ 1 cm

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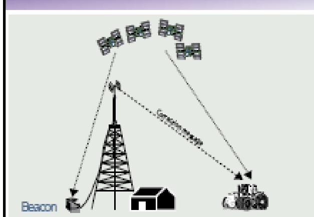
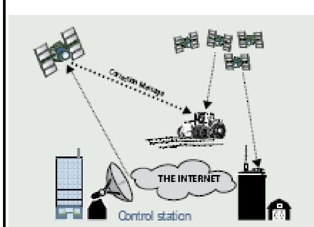
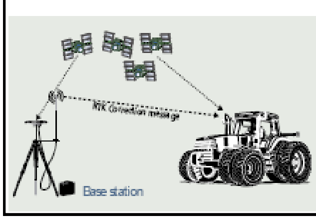
Differential Correction Sources



- **Coast Guard Beacon**
  - **Sub-meter**



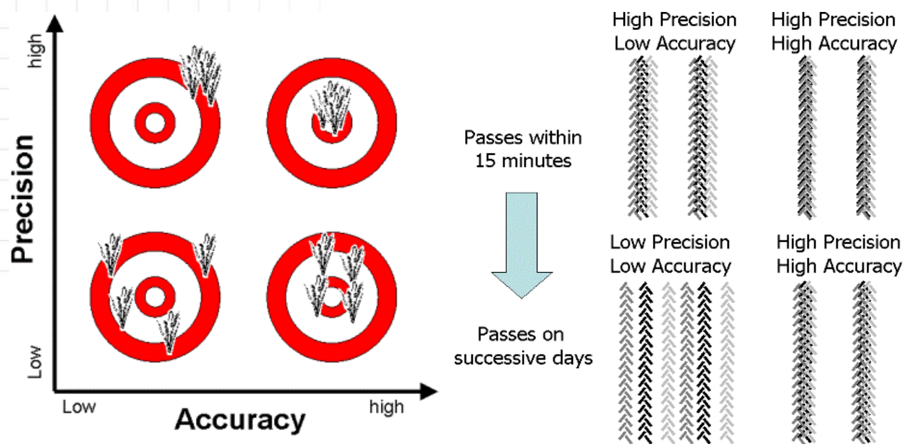
- **Single Frequency Satellite**
  Wide Area Augmentation System (WAAS)
  OmniStar VBS and StarFire1
  - **Sub-meter**
- **Dual Frequency Satellite Subscription**
  OmniStar XP, HP, and StarFire2
  - **Decimeter (2 - 6”)**



- **Real Time Kinematics (RTK)**
  - **Centimeter (sub-inch)**

Knowledge for Life

What's important, accuracy or precision?



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GPS Accuracy… *by the numbers*

- Pass-to-pass accuracy is typically measured at a percentage and within a timeframe:
  - 4-6" within 15 minutes, 95% of the time
- Receiver accuracy – horizontal, vertical, and spherical, is measured as a distance, percentage, and over a given timeframe.
- Statistical Axioms: 1 standard deviation contains ~ 68% of the data, 2 standard deviations contain ~ 95% of the data, 3 standard deviations contain ~ 97% of the data.

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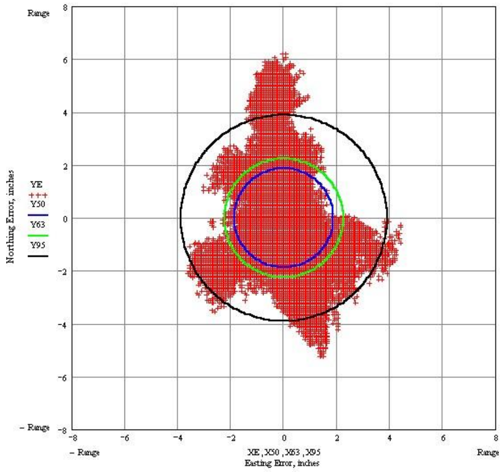
GPS Accuracy… *by the numbers*

Receiver	68%	95%
SF2	4.33	6.29
252 OmniStar	2.76	5.51



Make Sure Your Comparing Apples to Applies!
4” at 68% is *NOT* the same as 4” at 95%

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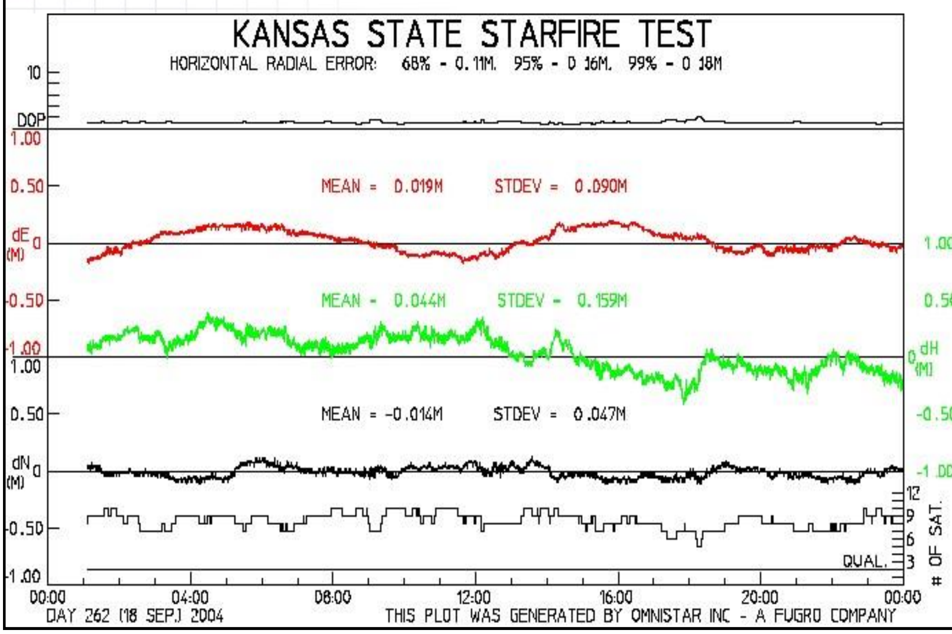
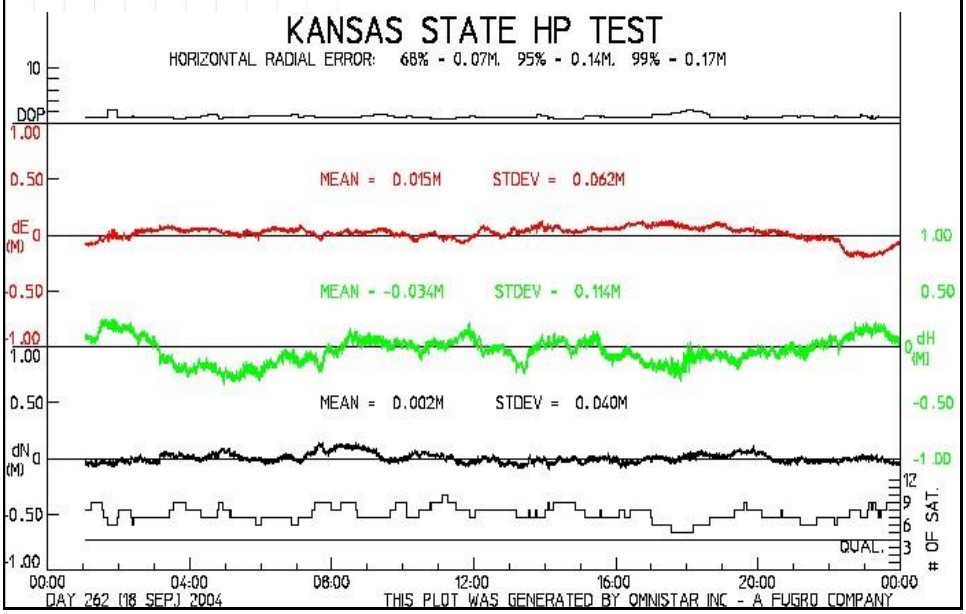
GPS Accuracy… *by the numbers*



GPS Accuracy… *by the numbers*



GPS Accuracy Tech Info

- When buying GPS units, the accuracy is often given in several different ways. Typically it is a value
- 1dRMS (or RMS) - Approximately 68 percent of the data points occur within this distance of truth.
- 2dRMS - Approximately 95 percent of the data points occur with this distance of truth.
- 3dRMS - Approximately 99.7 percent of the data points occur with this distance of truth.

Position accuracy
Static (year-to-year) .... submeter differential
Dynamic (pass-to-pass) .... 4-12 inch (10-30 cm) RMS 15 min pass-to-pass accuracy
Time to first fix .... <30 seconds, typical
NMEA messages .... GGA, GGL, GRS, GST, VTG, RMC, GSA, GSV, XTE, ZDA, ALM, MSS
Communication Ports .... 2 × RS-232, 2 × J1939 (CAN 2.0B)

Ordering information

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Flow Control Systems

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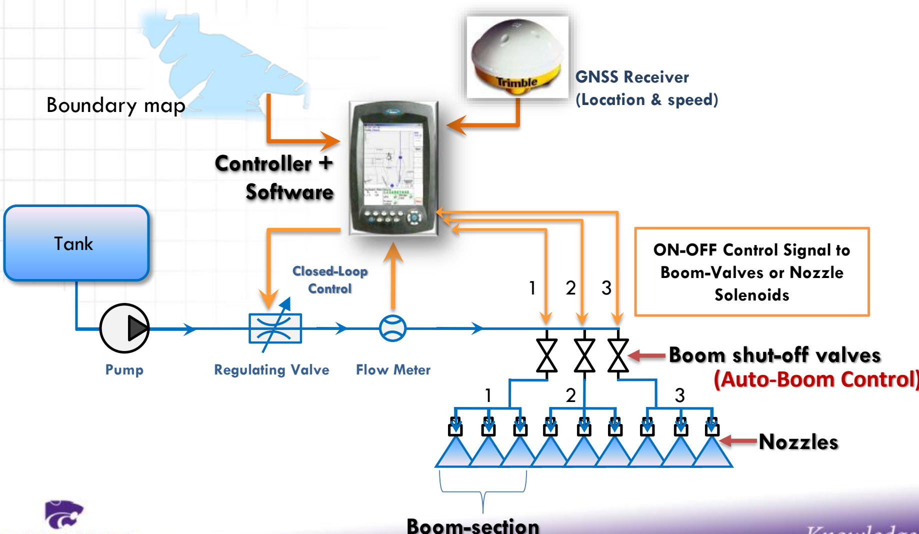
Controller with Automatic Section Control



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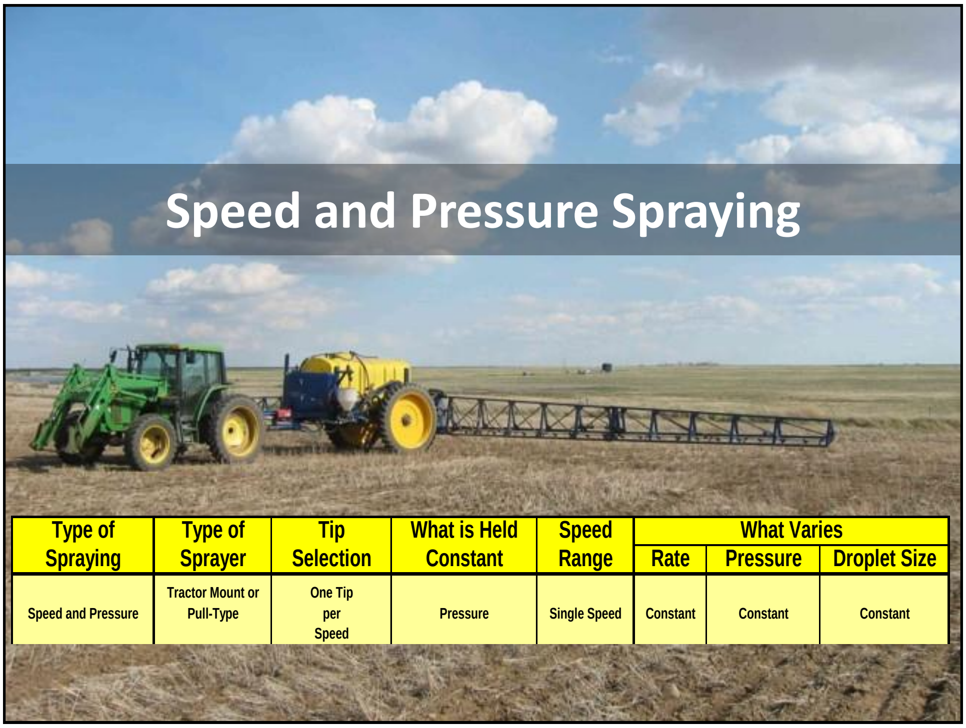
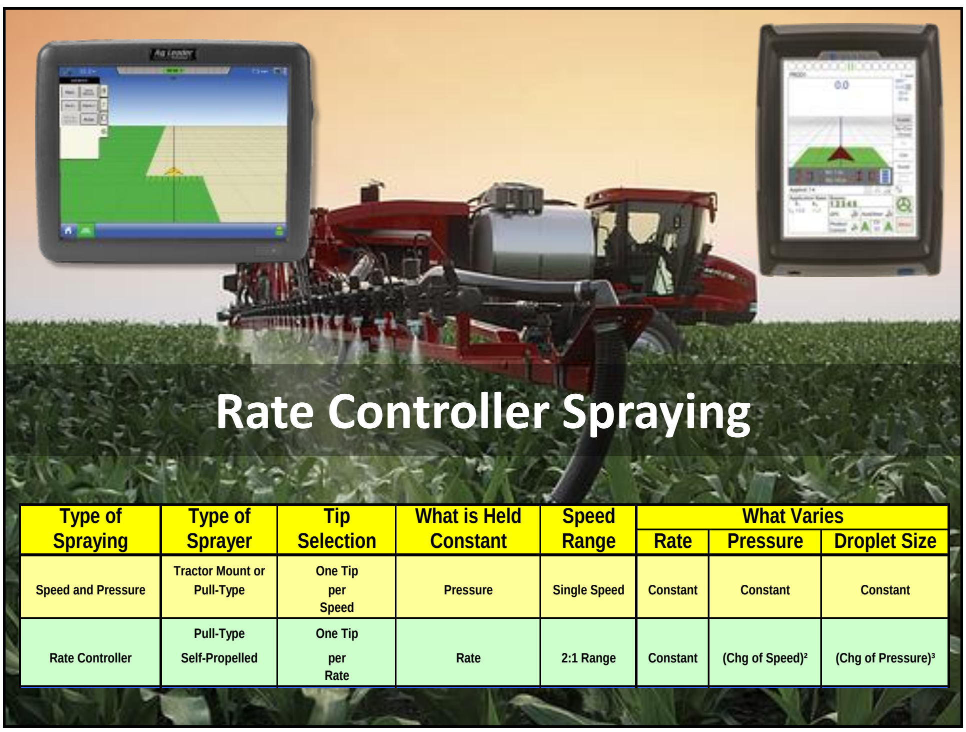
Speed and Pressure Spraying



Type of Spraying	Type of Sprayer	Tip Selection	What is Held Constant	Speed Range	What Varies		
					Rate	Pressure	Droplet Size
Speed and Pressure	Tractor Mount or Pull-Type	One Tip per Speed	Pressure	Single Speed	Constant	Constant	Constant

Rate Controller Spraying



Type of Spraying	Type of Sprayer	Tip Selection	What is Held Constant	Speed Range	What Varies		
					Rate	Pressure	Droplet Size
Speed and Pressure	Tractor Mount or Pull-Type	One Tip per Speed	Pressure	Single Speed	Constant	Constant	Constant
Rate Controller	Pull-Type Self-Propelled	One Tip per Rate	Rate	2:1 Range	Constant	(Chg of Speed)^2	(Chg of Pressure)^3

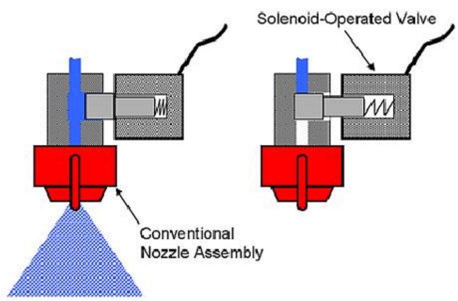
PWM Spraying

Rate Controller with Blended Pulse

Type of Spraying	Type of Sprayer	Tip Selection	What is Held Constant	Speed Range	What Varies		
					Rate	Pressure	Droplet Size
Speed and Pressure	Tractor Mount or Pull-Type	One Tip per Speed	Pressure	Single Speed	Constant	Constant	Constant
Rate Controller	Pull-Type Self-Propelled	One Tip per Rate	Rate	2:1 Range	Constant	(Chg of Speed)^2	(Chg of Pressure)^3
AIM Command	Self-Propelled	One Tip per Chemical Mode of Action	Rate and Pressure	8:1 Range	Constant	Constant	Constant

How it Works

- Uses high speed solenoid valves to regulate flow
- Varies application rate with duty cycle: independently of pressure



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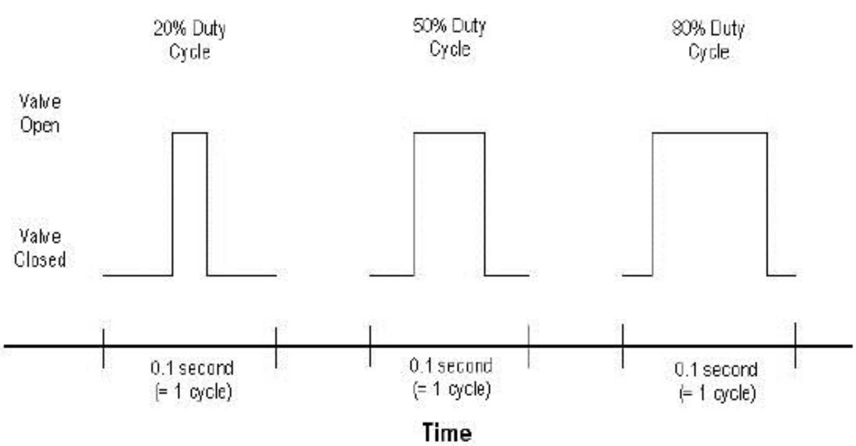
Pulse compared to conventional:

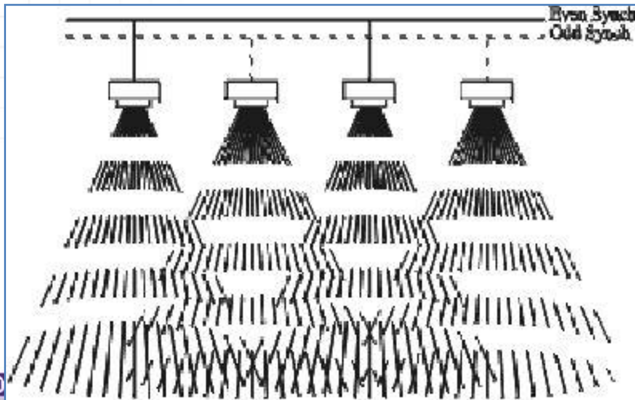
What is Pulse Width?

- Type of control system
- Modulates a DC square wave signal



Synchro® Blended Pulse

Each Synchro® nozzle emits 10 pulses per second, with adjacent nozzles having alternating timing. The alternating pulses, combined with overlapping spray patterns and the natural dispersion of droplets traveling in air, blend together to provide consistent coverage.



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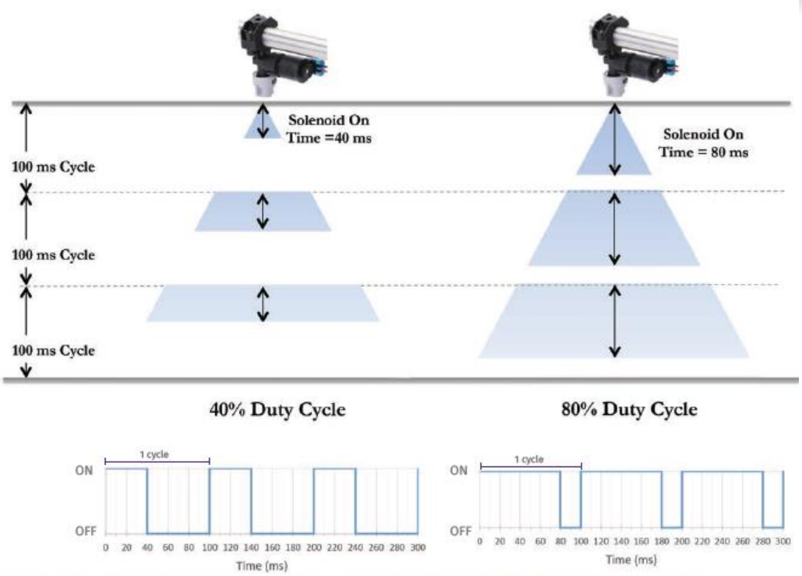

Figure 2. Nozzle on-state time variation during 40% (left) and 80% (right) duty cycle with a 10Hz (100ms cycle) PWM system.

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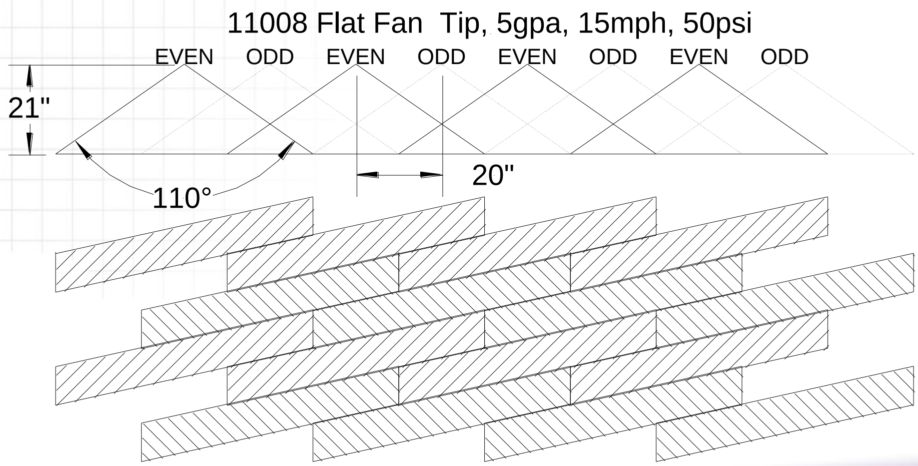
Spray pattern quality not sacrificed:



Good Pulse Blending

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Figure 1.
Conventional Application: Pressure varies with changing speeds

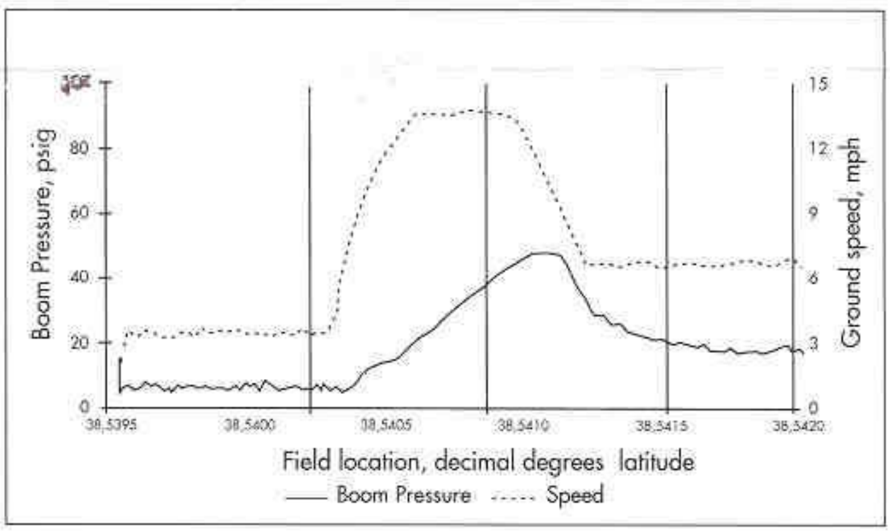

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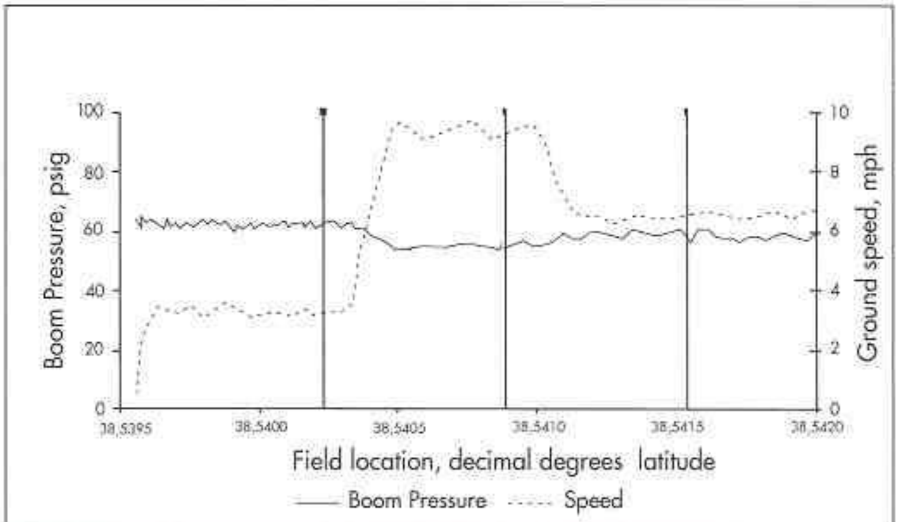
Figure 2.
AIM Command Application: Pressure stable as speed varies



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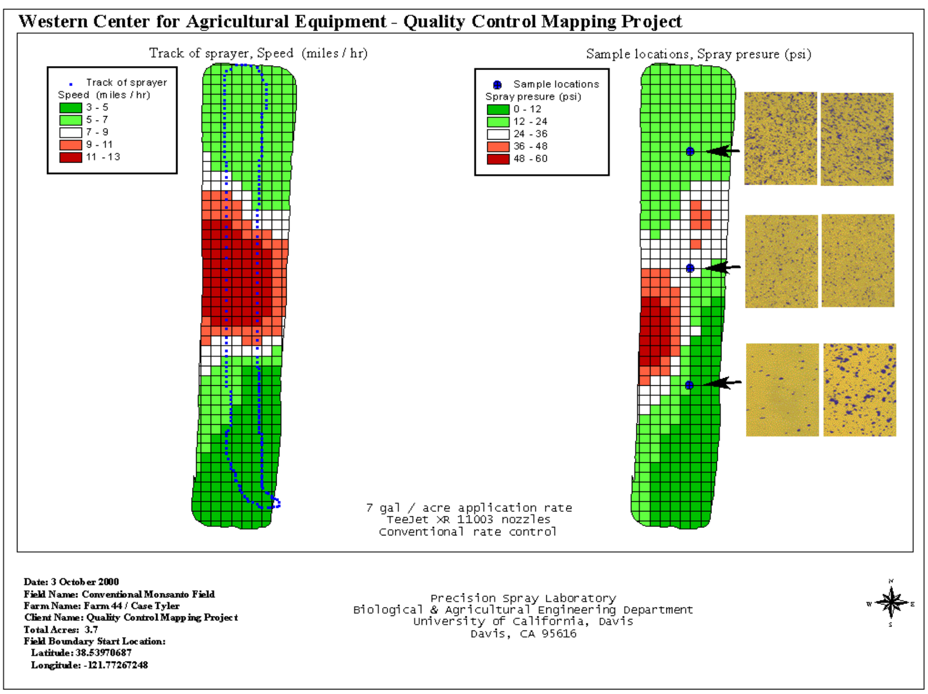
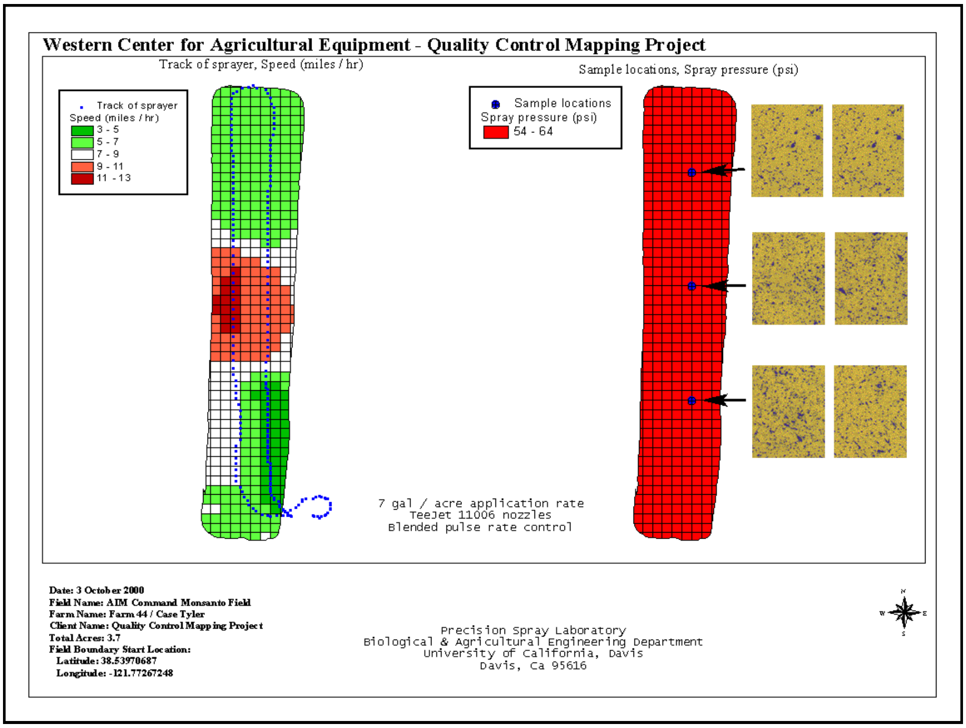
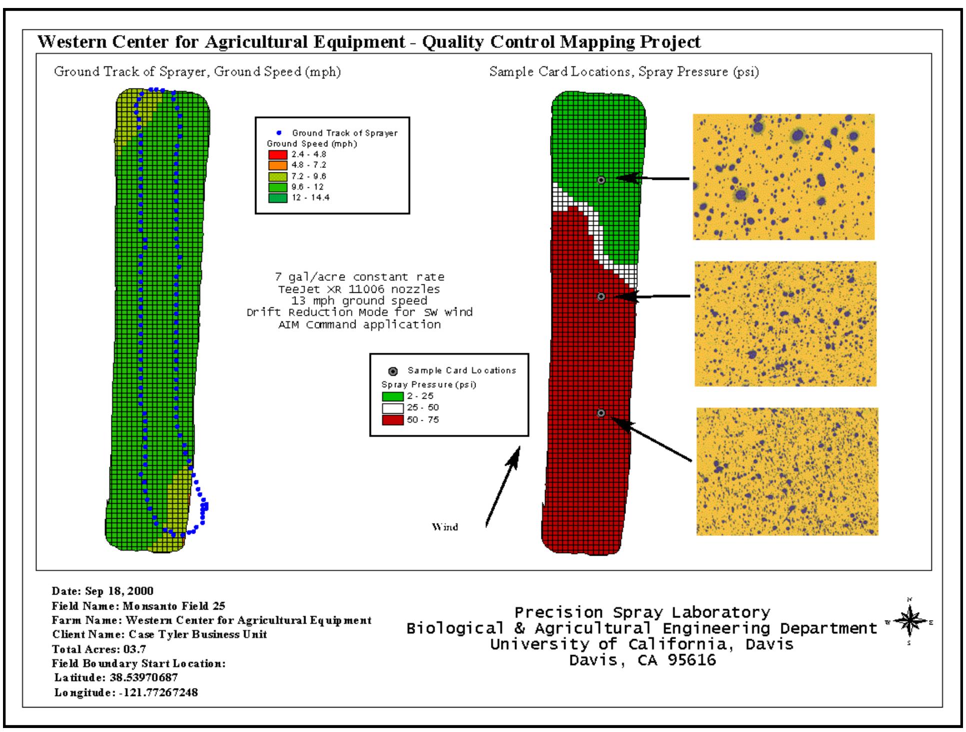



Western Center for Agricultural Equipment - Quality Control Mapping Project
Track of sprayer, Speed (miles / hr)
Sample locations, Spray pressure (psi)
Track of sprayer
Speed (miles / hr)
3 - 5
5 - 7
7 - 9
9 - 11
11 - 13
Sample locations
Spray pressure (psi)
54 - 64
7 gal / acre application rate
TeeJet 11006 nozzles
Blended pulse rate control
Date: 3 October 2000
Field Name: AIM Command Monsanto Field
Farm Name: Farm 44 / Case Tyler
Client Name: Quality Control Mapping Project
Total Acres: 3.7
Field Boundary Start Location:
Latitude: 38.53970687
Longitude: -121.77267248
Precision Spray Laboratory
Biological & Agricultural Engineering Department
University of California, Davis
Davis, Ca 95616


Western Center for Agricultural Equipment - Quality Control Mapping Project
Ground Track of Sprayer, Ground Speed (mph)
Sample Card Locations, Spray Pressure (psi)
Ground Track of Sprayer
Ground Speed (mph)
2.4 - 4.8
4.8 - 7.2
7.2 - 9.6
9.6 - 12
12 - 14.4
7 gal/acre constant rate
TeeJet XR 11006 nozzles
13 mph ground speed
Drift Reduction Mode for SW wind
AIM Command application
Sample Card Locations
Spray Pressure (psi)
2 - 25
25 - 50
50 - 75
Wind
Date: Sep 18, 2000
Field Name: Monsanto Field 25
Farm Name: Western Center for Agricultural Equipment
Client Name: Case Tyler Business Unit
Total Acres: 03.7
Field Boundary Start Location:
Latitude: 38.53970687
Longitude: -121.77267248
Precision Spray Laboratory
Biological & Agricultural Engineering Department
University of California, Davis
Davis, CA 95616

Procedures:

- Treatment 1
  - Conventional, 20 psi, 5 mph, tt11002, 8 GPA
- Treatment 2
  - Conventional, 75 psi, 10 mph, tt11002, 8 GPA
- Treatment 3
  - PWM, 40 psi, 5 mph, tt11004, 8 GPA
- Treatment 4
  - PWM, 40 psi, 10 mph, tt11004, 8 GPA

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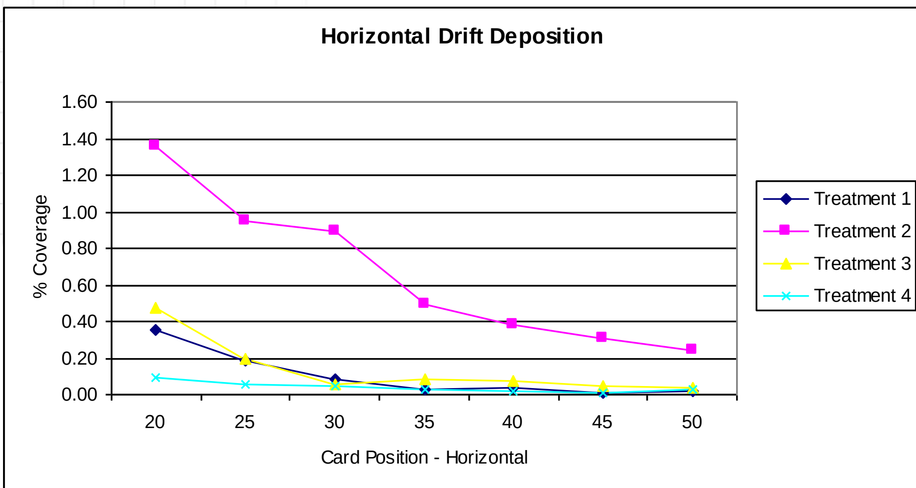
Drift



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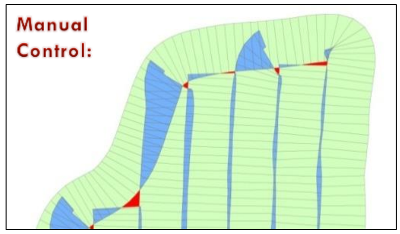
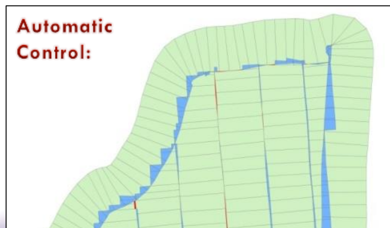
Benefits

- Operator dependent
- Application error
  - Skips (Red)
  - Overlap (Blue)

- Consistent
- Product savings
  - Reduced overlap
  - No skips





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Turn Compensation

More accurate application when spraying contours or center pivots:

Reduces weed resistance from non-lethal doses
Prevents crop damage from chemical overdoes

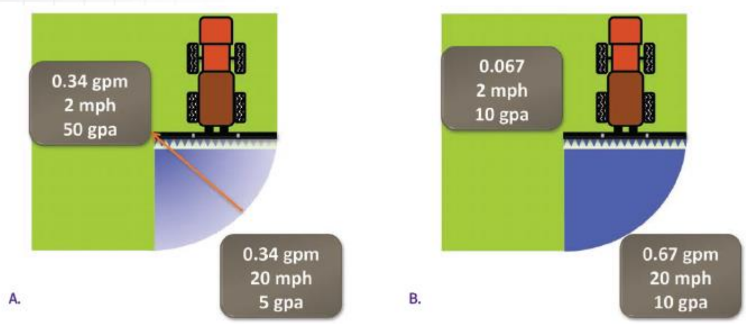

Figure 6. The turn compensation feature for a PWM spray system modulates individual nozzles in order to maintain the target rate across the boom regardless of velocity between the inside and outside boom during curvilinear travel such as turning at field headlands or maneuvering around other obstacles. Off-rate application occurs without turn compensation technology (A.) whereas uniform rate across the boom is maintain with the technology (B.)

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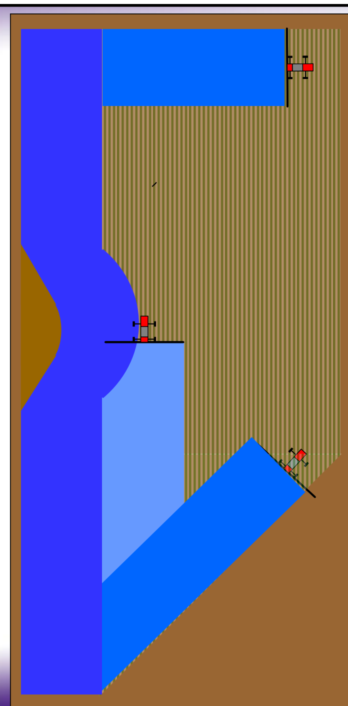
Individual Nozzle Swath Overlap Control

Minimize skips, over-spray, over-laps
Prevents over-application crop damage
Up to 15% Chemical Savings
Adjustable from 0% to 100% overlap.
Modifies the flow meter signal to satisfy the rate controller.



CAPSTAN AG SYSTEMS, INC. PinPoint

Follow Manufacturers' Recommendations

- Low Duty Cycles Can Cause Differences in Effective Application Rate
- Typically wish to maintain duty cycles in the 50-100% range

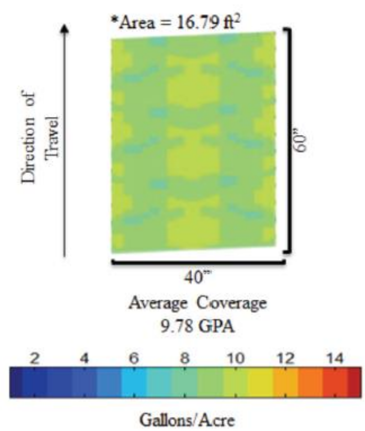


Figure 9. Simulated application coverage of three complete pulses at a duty pace of 80%, 50psi target pressure and 10 GPA target application rate (Mangus et al., 2015).

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Market Players

- SharpShooter (Capstan/Case IH "Aim")
- Pinpont II (Capstan Ag/Case IH Aim Command PRO)
- ExactApply (Deere in MY18)
- Hawkeye (Raven/Case IH AIM Command FLEX)
- DynaJet (TeeJet)

K-State Extension Publication MF3314


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Pulse Width Modulated (PWM) Technology for Liquid Application

Ajay Sharda, Terry Griffin, Lucas Haag, Devin Mangus, John Fulton, John Slocombe

Introduction

Liquid application systems are used for a variety of pesticide and liquid fertilizer applications. Self-propelled sprayers commonly use flow-based liquid control systems to implement application rates. Sprayers are also fitted with automated guidance and automatic section control (ASC) for individual boom and nozzle control.

Flow-based control systems regulate product flow rate in the plumbing system to account for changes in ground speed (acceleration and deceleration) and spray swath width (ASC actuation) during field operation. These systems use fixed-orifice nozzles as selected based on product label specification including recommendations on application rate, travel speed, and droplet-size classification. However, typical field application speeds vary from 6 to 20 mph, depending on factors such as field shape, obstacles, and operator driving

Both droplet size distribution and spray fan angle consistency are critical to achieve desired overlap from adjacent nozzles and maintain uniform coverage.

Technology Basics

A Pulse Width Modulation (PWM) system uses solenoids mounted at each individual nozzle to the existing nozzle body drip check to provide automatic proportional flow compensation based on the speed of the sprayer (Figure 1).

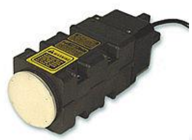
The solenoid is an

Figure 1. Solenoid operated mounted

Electronics/Rate Controllers

- How does your system work when speed changes?
- Is it pressure based?
- What is the effect of going slower?
- What is the effect of going faster?

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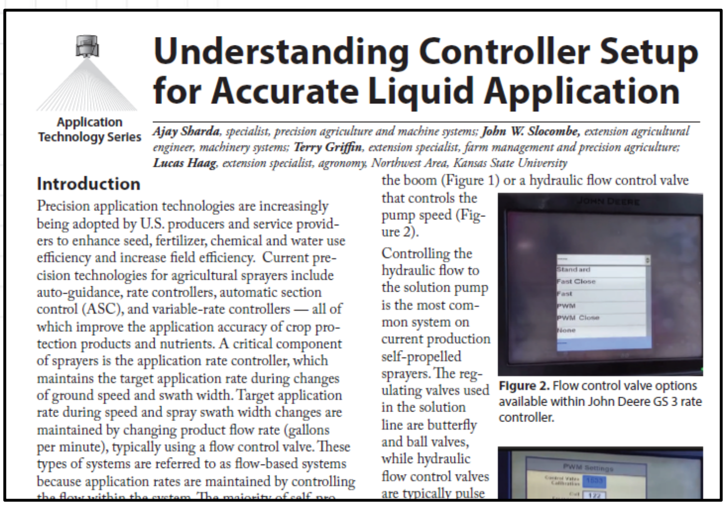

Understanding Controller Setup for Accurate Liquid Application

Application Technology Series

Ajay Sharda, specialist, precision agriculture and machine systems; John W. Slocombe, extension agricultural engineer, machinery systems; Terry Griffin, extension specialist, farm management and precision agriculture; Lucas Haag, extension specialist, agronomy, Northwest Area, Kansas State University

Introduction

Precision application technologies are increasingly being adopted by U.S. producers and service providers to enhance seed, fertilizer, chemical and water use efficiency and increase field efficiency. Current precision technologies for agricultural sprayers include auto-guidance, rate controllers, automatic section control (ASC), and variable-rate controllers — all of which improve the application accuracy of crop protection products and nutrients. A critical component of sprayers is the application rate controller, which maintains the target application rate during changes of ground speed and swath width. Target application rate during speed and spray swath width changes are maintained by changing product flow rate (gallons per minute), typically using a flow control valve. These types of systems are referred to as flow-based systems because application rates are maintained by controlling the flow within the system. The majority of self-pro-

the boom (Figure 1) or a hydraulic flow control valve that controls the pump speed (Figure 2).

Controlling the hydraulic flow to the solution pump is the most common system on current production self-propelled sprayers. The regulating valves used in the solution line are butterfly and ball valves, while hydraulic flow control valves are typically pulse

Figure 2. Flow control valve options available within John Deere GS 3 rate controller.

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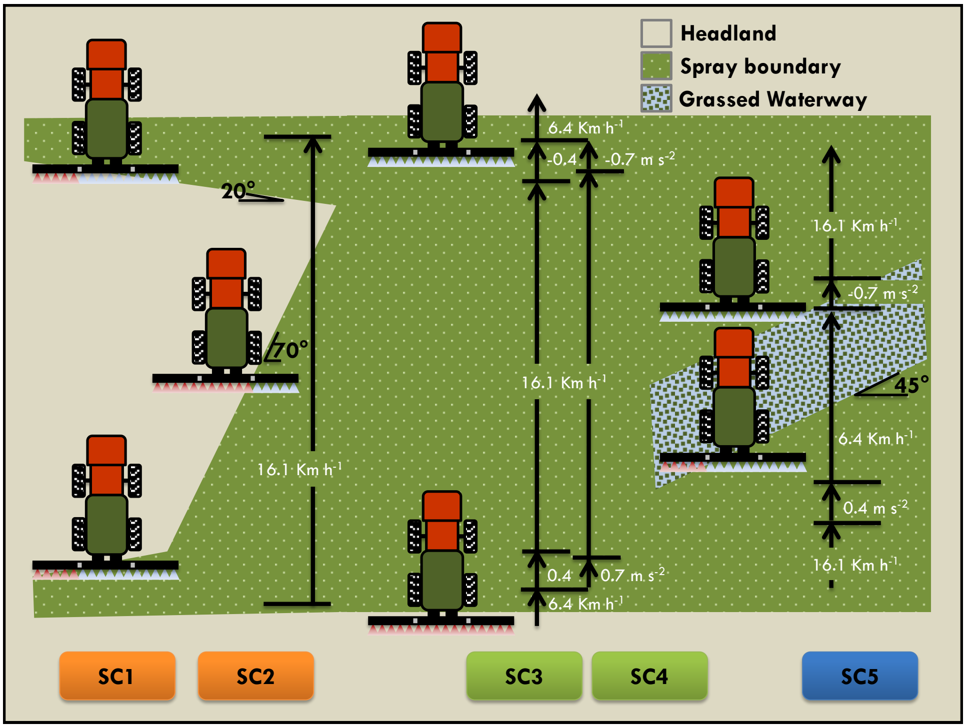

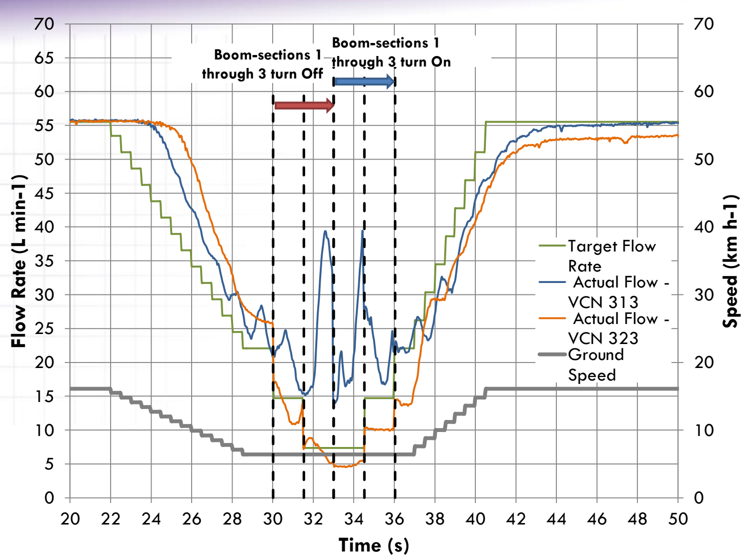

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Flow oscillation and instability

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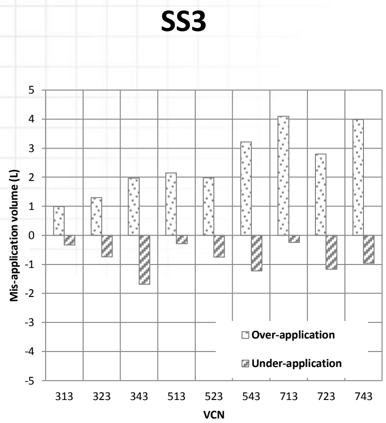
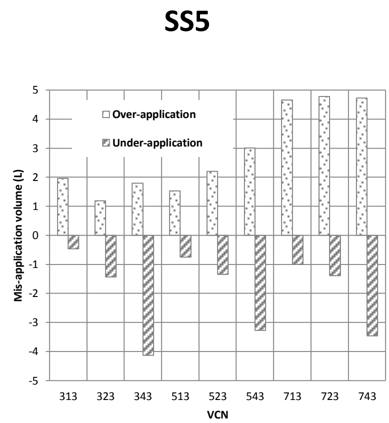
What does it mean on volume basis?





Automatic Boom Height

- Maintain uniform boom height
- Increase application uniformity and therby effectiveness
- Reduces wear on sprayer boom
- Avoid contact between the boom or nozzles with the ground
- Increase field efficiency as the operator is not responsible for constant adjustment
- Potential to reduce drift and provide uniform droplet deposition

Automatic Boom Height

Options

- Sonar Based
- Physical Based (ground engaging wheel)
- Roll Sensors

Figure 2. Gauge wheels measure pressure between the wheel and the ground to determine boom height.

Figure 5. Raven Ultraglide ultra-sonic sensor.

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Ajay Sharda
Terry Griffin
Lucas Haag
John W. Slocombe

Automatic Boom Height Control Technology for Agricultural Sprayers

Introduction

Advancements in liquid application equipment make operation of large self-propelled machines easier. Current agricultural sprayers have spray boom widths of up to 120 feet. Because of a combination of increased machinery size, technology, and growing environmental concerns, more is being demanded from chemical applicators.

One critical technology to meeting these demands is automatic boom height control (ABHC). This technology automatically maintains the boom at a target height from the top of the crop canopy; and is especially useful when operating in fields with varying terrain attributes or uneven crop canopy heights. In the case where the sprayer is traveling along uneven terrain, ABHC technology aligns left and right wings of the boom with respect to the terrain. During a typical field application, boom height of greater than the targeted plant can increase the potential for drift, loss of droplets to volatilization, and non-uniform spray coverage; whereas a boom closer than intended to the actual

Automatic Boom Height Control Technology

ABHC technology uses boom-mounted ultrasonic sensors to continuously monitor instantaneous boom height. Ultrasonic sensors (Figure 1) emit a sound pulse that reflects off of objects within the wave field, to be received by the sensor. The sensor measures the amount of time it takes for the pulse to return. Since sound travels at almost a constant velocity, the in-cab controller calculates how high the sensor is above the sensed

Figure 1. Ultrasonic sensor mounted on the sprayer boom.

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Nozzles are important because:

- Control the amount – GPA.
- Determine uniformity of application.
- Affects the coverage.
- Influences the drift potential.

Nozzle Controls amount applied:

Nozzle Flow Rate is affected by:

- **Orifice size**
- **Pressure**
- **Solution characteristics**

Weight of Solution	Specific Gravity	Conversion Factors
7.0 lbs./gal.	.84	.92
8.0 lbs./gal.	.96	.98
8.34 lbs./gal.	1.00–WATER	1.00
9.0 lbs./gal.	1.08	1.04
10.0 lbs./gal.	1.20	1.10
10.65 lbs./gal.	1.28–28% nitrogen	1.13
11.0 lbs./gal.	1.32	1.15
12.0 lbs./gal.	1.44	1.20
14.0 lbs./gal.	1.68	1.30

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	PSI	DROP SIZE	CAPACITY ONE NOZZLE IN GPM	CAPACITY ONE NOZZLE IN OZ/MIN.	20" GPA 4 MPH	5 MPH	6 MPH	8 MPH	10 MPH	12 MPH	15 MPH	20 MPH	GALLONS PER 1000 SQ. FT. 2 MPH	3 MPH	4 MPH	5 MPH
TT11001 (100)	15	C	0.061	7.8	4.5	3.6	3.0	2.3	1.8	1.5	1.2	0.91	0.21	0.14	0.10	0.08
	20	M	0.071	9.1	5.3	4.2	3.5	2.6	2.1	1.8	1.4	1.1	0.24	0.16	0.12	0.10
	30	M	0.087	[illegible]	6.5	5.2	4.3	3.2	2.6	2.2	1.7	1.3	0.30	0.20	0.15	0.12
	40	M	0.10	[illegible]	7.4	5.9	5.0	3.7	3.0	2.5	2.0	1.5	0.34	0.23	0.17	0.14
	50	F	0.11	14	8.2	6.5	5.4	4.1	3.3	2.7	2.2	1.6	0.37	0.25	0.19	0.15
	60	F	0.12	15	8.9	7.1	5.9	4.5	3.6	3.0	2.4	1.8	0.41	0.27	0.20	0.16
	75	F	0.14	18	10.4	8.3	6.9	5.2	4.2	3.5	2.8	2.1	0.48	0.32	0.24	0.19
	90	F	0.15	19	11.1	8.9	7.4	5.6	4.5	3.7	3.0	2.2	0.51	0.34	0.26	0.20
TT110015 (100)	15	C	0.092	12	6.8	5.5	4.6	3.4	2.7	2.3	1.8	1.4	0.31	0.21	0.16	0.13
	20	C	0.11	14	8.2	6.5	5.4	4.1	3.3	2.7	2.2	1.6	0.37	0.25	0.19	0.15
	30	M	0.13	17	9.7	7.7	6.4	4.8	3.9	3.2	2.6	1.9	0.44	0.29	0.22	0.18
	40	M	0.15	19	11.1	8.9	7.4	5.6	4.5	3.7	3.0	2.2	0.51	0.34	0.26	0.20
	50	M	0.17	22	12.6	10.1	8.4	6.3	5.0	4.2	3.4	2.5	0.58	0.39	0.29	0.23
	60	M	0.18	23	13.4	10.7	8.9	6.7	5.3	4.5	3.6	2.7	0.61	0.41	0.31	0.24
	75	F	0.21	27	15.6	12.5	10.4	7.8	6.2	5.2	4.2	3.1	0.71	0.48	0.36	0.29
	90	F	0.23	29	17.1	13.7	11.4	8.5	6.8	5.7	4.6	3.4	0.78	0.52	0.39	0.31
TT11002 (50)	15	C	0.12	15	8.9	7.1	5.9	4.5	3.6	3.0	2.4	1.8	0.41	0.27	0.20	0.16
	20	C	0.14	18	10.4	8.3	6.9	5.2	4.2	3.5	2.8	2.1	0.48	0.32	0.24	0.19
	30	M	0.17	22	12.6	10.1	8.4	6.3	5.0	4.2	3.4	2.5	0.58	0.39	0.29	0.23
	40	M	0.20	26	14.9	11.9	9.9	7.4	5.9	5.0	4.0	3.0	0.68	0.45	0.34	0.27
	50	M	0.22	28	16.3	13.1	10.9	8.2	6.5	5.4	4.4	3.3	0.75	0.50	0.37	0.30
	60	M	0.24	31	17.8	14.3	11.9	8.9	7.1	5.9	4.8	3.6	0.82	0.54	0.41	0.33
	75	M	0.27	35	20	16.0	13.4	10.0	8.0	6.7	5.3	4.0	0.92	0.61	0.46	0.37
	90	F	0.30	38	22	17.8	14.9	11.1	8.9	7.4	5.9	4.5	1.0	0.68	0.51	0.41
TT110025 (50)	15	VC	0.15	19	11.1	8.9	7.4	5.6	4.5	3.7	3.0	2.2	0.51	0.34	0.26	0.20
	20	C	0.18	23	13.4	10.7	8.9	6.7	5.3	4.5	3.6	2.7	0.61	0.41	0.31	0.24
	30	C	0.22	28	16.3	13.1	10.9	8.2	6.5	5.4	4.4	3.3	0.75	0.50	0.37	0.30
	40	M	0.25	32	18.6	14.9	12.4	9.3	7.4	6.2	5.0	3.7	0.85	0.57	0.43	0.34
	50	M	0.28	36	21	16.6	13.9	10.4	8.3	6.9	5.5	4.2	0.95	0.63	0.48	0.38
	60	M	0.31	40	23	18.4	15.3	11.5	9.2	7.7	6.1	4.6	1.1	0.70	0.53	0.42
	75	M	0.34	44	25	20	16.8	12.6	10.1	8.4	6.7	5.0	1.2	0.77	0.58	0.46
	90	F	0.38	49	28	23	18.8	14.1	11.3	9.4	7.5	5.6	1.3	0.86	0.65	0.52
TT11003 (50)	15	VC	0.18	23	13.4	10.7	8.9	6.7	5.3	4.5	3.6	2.7	0.61	0.41	0.31	0.24
	20	VC	0.21	27	15.6	12.5	10.4	7.8	6.2	5.2	4.2	3.1	0.71	0.48	0.36	0.29
	30	C	0.26	33	19.3	15.4	12.9	9.7	7.7	6.4	5.1	3.9	0.88	0.59	0.44	0.35
	40	C	0.30	[illegible]	22	17.8	14.9	11.1	8.9	7.4	5.9	4.5	1.0	0.68	0.51	0.41
	50	M	0.34	44	25	20	16.8	12.6	10.1	8.4	6.7	5.0	1.2	0.77	0.58	0.46
	60	M	0.37	47	27	22	18.3	13.7	11.0	9.2	7.3	5.5	1.3	0.84	0.63	0.50
	75	M	0.41	52	30	24	20	15.2	12.2	10.1	8.1	6.1	1.4	0.93	0.70	0.56
	90	M	0.45	58	33	27	22	16.7	13.4	11.1	8.9	6.7	1.5	1.0	0.77	0.61
TT11004 (50)	15	XC	0.24	31	17.8	14.3	11.9	8.9	7.1	5.9	4.8	3.6	0.82	0.54	0.41	0.33
	20	VC	0.28	36	21	16.6	13.9	10.4	8.3	6.9	5.5	4.2	0.95	0.63	0.48	0.38
	30	C	0.35	45	26	21	17.3	13.0	10.4	8.7	6.9	5.2	1.2	0.79	0.60	0.48
	40	C	0.40	51	30	24	19.8	14.9	11.9	9.9	7.9	5.9	1.4	0.91	0.68	0.54
	50	C	0.45	58	33	27	22	16.7	13.4	11.1	8.9	6.7	1.5	1.0	0.77	0.61
	60	C	0.49	63	36	29	24	18.2	14.6	12.1	9.7	7.3	1.7	1.1	0.83	0.67

Calibration!!!!

GPA

Ensuring that the spray output is what it is supposed to be!

2015 Chemical Weed Control

Calibrating Boom Sprayers – MF2894

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Knowledge for Life

GPM Example Solution:

$$\mathbf{GPM} = \frac{\mathbf{GPA \quad x \quad MPH \quad x \quad W}}{\mathbf{5940}}$$

$$GPM = \frac{7.5 \quad x \quad 12 \quad x \quad 20}{5940}$$

Answer **.30gpm**

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Knowledge for Life

Selecting the proper nozzle….

Page 9, 12, 14, 15

- Calculate GPM (formula)
- Look under GPM column
- Match to pressure-psi
- Choose the size needed
- Operate at given pressure and speed used in formula to achieve GPA

.30

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Tip No. (Strainer Screen Size)	Liquid Pressure in psi	Dropsize Category	Capacity 1 Nozzle in GPM	Gallons Per Acre - 20" Spacing 4 mph	5 mph	6 mph	8 mph	10 mph	12 mph	15 mph	20 mph
AIXR110015 (100 Mesh) Green	15	XC	0.092	6.8	5.5	4.6	3.4	2.7	2.3	1.8	1.4
	20	XC	0.11	8.2	6.5	5.4	4.1	3.3	2.7	2.2	1.6
	30	C	0.13	9.7	7.7	6.4	4.8	3.9	3.2	2.6	1.9
	40	C	0.15	11.1	8.9	7.4	5.6	4.5	3.7	3.0	2.2
	50	C	0.17	12.6	10.1	8.4	6.3	5.0	4.2	3.4	2.5
	60	M	0.18	13.4	10.7	8.9	6.7	5.3	4.5	3.6	2.7
	75	M	0.21	15.6	12.5	10.4	7.8	6.2	5.2	4.2	3.1
	90	M	0.23	17.1	13.7	11.4	8.5	6.8	5.7	4.6	3.4
AIXR11002 (50 Mesh) Yellow	15	XC	0.12	8.9	7.1	5.9	4.5	3.6	3.0	2.4	1.8
	20	XC	0.14	10.4	8.3	6.9	5.2	4.2	3.5	2.8	2.1
	30	VC	0.17	12.6	10.1	8.4	6.3	5.0	4.2	3.4	2.5
	40	C	0.20	14.9	11.9	9.9	7.4	5.9	5.0	4.0	3.0
	50	C	0.22	16.3							
	60	C	0.24	17.8							
	75	M	0.27	20							
	90	M	0.30	22							
AIXR110025 (50 Mesh) Violet	15	XC	0.15	11.1							
	20	XC	0.18	13.4							
	30	XC	0.22	16.3							
	40	VC	0.25	18.6							
	50	C	0.28	21							
	60	C	0.31	23							
	75	C	0.34	25							
	90	C	0.38	28							
AIXR11003 (50 Mesh) Blue	15	XC	0.18	13.4							
	20	XC	0.21	15.6							
	30	XC	0.26	19.3							
	40	VC	0.30	22							
	50	C	0.34	25							
	60	C	0.37	27							
	75	C	0.41	30	24	20	15.2	12.2	10.1	8.1	6.1
	90	C	0.45	33	27	22	16.7	13.4	11.1	8.9	6.7
AIXR11004 (50 Mesh) Red	15	XC	0.24	17.8	14.3	11.9	8.9	7.1	5.9	4.8	3.6
	20	XC	0.28	21	16.6	13.9	10.4	8.3	6.9	5.5	4.2
	30	XC	0.35	26	21	17.3	13.0	10.4	8.7	6.9	5.2
	40	XC	0.40	30	24	19.8	14.9	11.9	9.9	7.9	5.9
	50	VC	0.45	33	27	22	16.7	13.4	11.1	8.9	6.7
	60	VC	0.49	36	29	24	18.2	14.6	12.1	9.7	7.3
	75	C	0.55	41	33	27	20	16.3	13.6	10.9	8.2

Selecting the proper nozzle….

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- Calculate GPM (formula)
- Look under GPM column
- Match to pressure-psi
- Choose the size needed
- Operate at given pressure and speed used in formula to achieve GPA

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	PSI	DROP SIZE	CAPACITY ONE NOZZLE IN GPM	CAPACITY ONE NOZZLE IN OZ./MIN.	GPA 4 MPH	5 MPH	6 MPH	8 MPH	10 MPH	12 MPH
AIC110015 (100)	30	VC	0.13	17	9.7	7.7	6.4	4.8	3.9	3.2
	40	VC	0.15	19	11.1	8.9	7.4	5.6	4.5	3.7
	50	VC	0.17	22	12.6	10.1	8.4	6.3	5.0	4.2
	60	C	0.18	23	13.4	10.7	8.9	6.7	5.3	4.5
	70	C	0.20	26	14.9	11.9	9.9	7.4	5.9	5.0
	80	C	0.21	27	15.6	12.5	10.4	7.8	6.2	5.2
	90	C	0.23	29	17.1	13.7	11.4	8.5	6.8	5.7
	100	C	0.24	31	17.8	14.3	11.9	8.9	7.1	5.9
AIC11002 (50)	30	VC	0.17	22	12.6	10.1	8.4	6.3	5.0	4.2
	40	VC	0.20	26	14.9	11.9	9.9	7.4	5.9	5.0
	50	VC	0.22	28	16.3	13.1	10.9	8.2	6.5	5.4
	60	VC	0.24	31	17.8	14.3	11.9	8.9	7.1	5.9
	70	C	0.26	33	19.3	15.4	12.9	9.7	7.7	6.4
	80	C	0.28	36	21	16.6	13.9	10.4	8.3	6.9
	90	C	0.30	38	22	17.8	14.9	11.1	8.9	7.4
	100	C	0.32	41	24	19.0	15.8	11.9	9.5	7.9
AIC110025 (50)	30	VC	0.22	28	16.3	13.1	10.9	8.2	6.5	5.4
	40	VC	0.25	32	18.6	14.9	12.4	9.3	7.4	6.2
	50	VC	0.28	36	21	16.6	13.9	10.4	8.3	6.9
	60	VC	0.31	40	23	18.4	15.3	11.5	9.2	7.7
	70	VC	0.33	42	25	19.6	16.3	12.3	9.8	8.2
	80	C	0.35	45	26	21	17.3	13.0	10.4	8.7
	90	C	0.38	49	28	23	18.8	14.1	11.3	9.4
	100	C	0.40	51	30	24	19.8	14.9	11.9	9.9
AIC11003 (50)	30	XC	0.26	33	19.3	15.4	12.9	9.7	7.7	6.4
	40	VC	0.30	38	22	17.8	14.9	11.1	8.9	7.4
	50	VC	0.34	44	25	20	16.8	12.6	10.1	8.4
	60	VC	0.37	47	27	22	18.3	13.7	11.0	9.2
	70	VC	0.40	51	30	24	19.8	14.9	11.9	9.9
	80	VC	0.42	54	31	25	21	15.6	12.5	10.4
	90	C	0.45	58	33	27	22	16.7	13.4	11.1
	100	C	0.47	60	35	28	23	17.4	14.0	11.6

ASABE Standard

Symbol	Category	Code	Relative Size	Comparative Size	Atomization
VF	Very Fine	Red		Pe[illegible]eedle [illegible]s)	Fog
F	Fine	Orange		Human Hair (100 Microns)	Fine Mist
M	Medium	Yellow		Sewing Thread (150 Microns)	Fine Drizzle
C	Coarse	Blue			
VC	Very Coarse	Green		Staple (420 Microns)	Light Rain
EC	Extremely Coarse	White		#2 Pencil Lead (2000 Microns)	Thunderstorm

Comparative Size

Fungicides/Insecticides

Herbicides

Source: Crop Life – July 2002

Bayer CropScience

OLYMPUS™ FLEX Herbicide

For Post-emergence Control of Certain Grasses and Broadleaf Weeds in Fall-sown or Winter Wheat.

ACTIVE INGREDIENTS:

Propoxycarbazone-sodium (CAS No. 181274-15-7) 6.75%

Mesosulfuron-Methyl (CAS No. 208465-21-8) 4.50%

INERT INGREDIENTS 88.75%

Contains petroleum distillates.

Protected by U.S. Patent Nos. 5,648,315 and 5,688,745 **TOTAL :** 100.00%

This product is a water dispersible granule containing 6.75% Propoxycarbazone-sodium and 4.50% Mesosulfuron-methyl, by weight.

EPA Reg. No. 264-833 **EPA Est.**

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Knowledge for Life

GROUND APPLICATION

OLYMPUS™ FLEX Herbicide can be applied broadcast in 10 or more gallons of water per acre. For weed control in dense weed canopies, use 15 or more gallons of water per acre. Weed infestations should be treated before they become competitive with the crop.

The use of 80-degree or 110-degree flat-fan nozzles is highly recommended for optimum spray coverage and canopy penetration. To achieve uniform spray coverage, use nozzles and pressure that deliver MEDIUM spray droplets as indicated in nozzle manufacturer's catalogs and in accordance with ASAE standard S-572. Use screens that are 50 mesh or larger.

AERIAL APPLICATION

OLYMPUS™ FLEX Herbicide should be applied in a minimum of 5 gallons of water per broadcast acre. Weed infestations should be treated before they become competitive with the crop.

To achieve uniform spray coverage, use nozzles and pressure that deliver MEDIUM spray droplets as indicated in nozzle manufacturer's catalogs and in accordance with ASAE standard S-572. DO NOT use raindrop nozzles.

Aerial applications with this product should be made at a maximum height of 10 feet above the crop with low drift nozzles at a maximum pressure of 40 psi. Avoid application under conditions where uniform coverage cannot be obtained or where excessive spray drift may occur.

Flagmen and loaders should avoid inhalation of spray mist and prolonged contact with skin.

See the ***SPRAY DRIFT MANAGEMENT*** section of this label for additional information on proper application of OLYMPUS™ FLEX Herbicide.

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Knowledge for Life

Checking for accuracy

- Check several new nozzles
  - flow rate within 5-7% of desired output?
- Check flow rate frequently
  - adjust pressure to compensate for small changes output due to wear
- Replace nozzles & recalibrate when:
  - output > 7% change from new nozzle
  - when pattern becomes uneven

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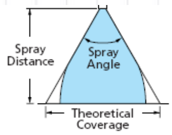
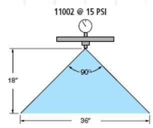
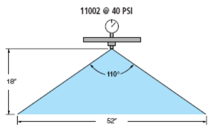
Knowledge for Life

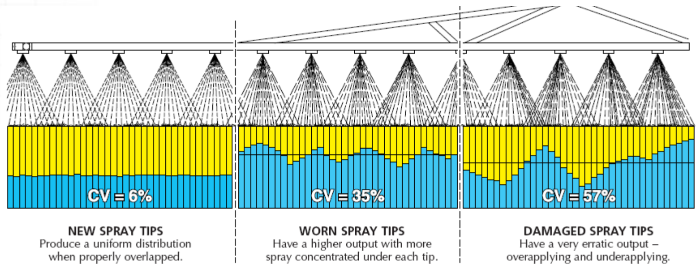
2. Set up for Uniformity:



Goal is to put the material on evenly from nozzle to nozzle, end of boom to end of boom, and across the entire field. A 20-inch spacing requires 17-19" above target for 50-60% overlap. Nozzle mount angle?







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Knowledge for Life

SpotOn Electronic Calibration Tool

Sponsored by Successful Farming
Sponsored

Scott Bretthauer - U of I
Jim Wilson - SDSU
Randy Taylor - OSU
Bobby Grisso & Pat Hipkins - VTU
Mark Hanna – ISU
Bob Wolf – KSU

for Life

Accuracy of SpotOn Tester by Nozzle Type

Average by Nozzle Type

Nozzle Type*	SpotOn gpm	Scale gpm	Visual gpm
AIXR	0.34	0.34	0.35
TT	0.34	0.34	0.35
TTJ60	0.34	0.35	0.36
ULD	0.37	0.37	0.38
XR	0.34	0.34	0.35

*Nozzles tested included the TeeJet Air Induction XR (AIXR); the Turbo TeeJet VP nozzle (TT); TTJ60-VP TeeJet Turbo Twin Jet (TTJ60); Hypro Ultra LoDrift (ULD); and the TeeJet XR (XR).

Agricultural engineers tested readings in a comparison of the SpotOn calibrator, actual scale measurements, and a visual evaluation across five nozzle types. There was little difference between the three readings across all five nozzle types. The SpotOn calibrator provides an accurate and quick calibration reading, says Bob Wolf of Wolf Consulting & Research.

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Accuracy of SpotOn Tester by Nozzle Size and Pressure

Calibration Comparison

Flow by orifice, pressure, and measurement type compared to manufacturer's standard

Orifice/psi	SpotOn gpm	Scale gpm	Visual gpm	Mfr's standard gpm
11002				
15	0.12	0.13	0.14	0.12
30	0.19	0.19	0.20	0.17
45	0.21	0.22	0.22	0.21
11004				
15	0.25	0.26	0.26	0.24
30	0.35	0.25	0.36	0.35
45	0.43	0.43	0.44	0.43
11006				
15	0.38	0.39	0.39	0.37
30	0.53	0.53	0.54	0.52
45	0.66	0.64	0.65	0.64

Testing by scientists at six universities compared SpotOn gpm readings with actual scale measurements taken of a given nozzle flow along with a visual evaluation and the manufacturer's standard gpm. It was tested under three nozzle orifice sizes: 11002, 11004, and 11006. The SpotOn readings compared favorably with all other measurements, says Bob Wolf of Wolf Consulting & Research.

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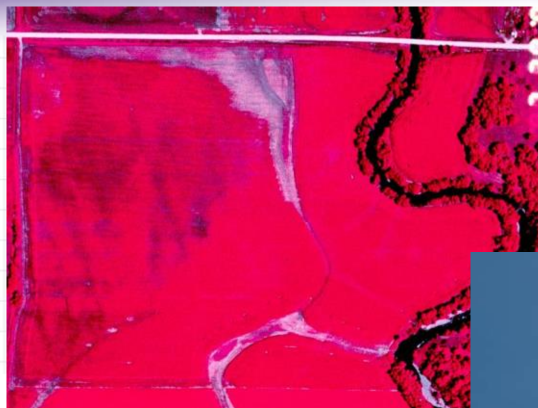
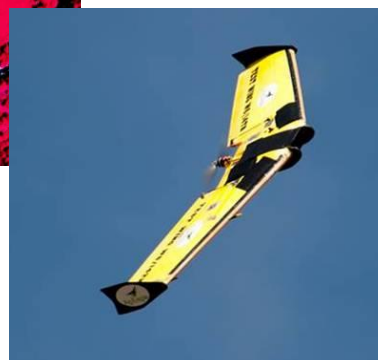
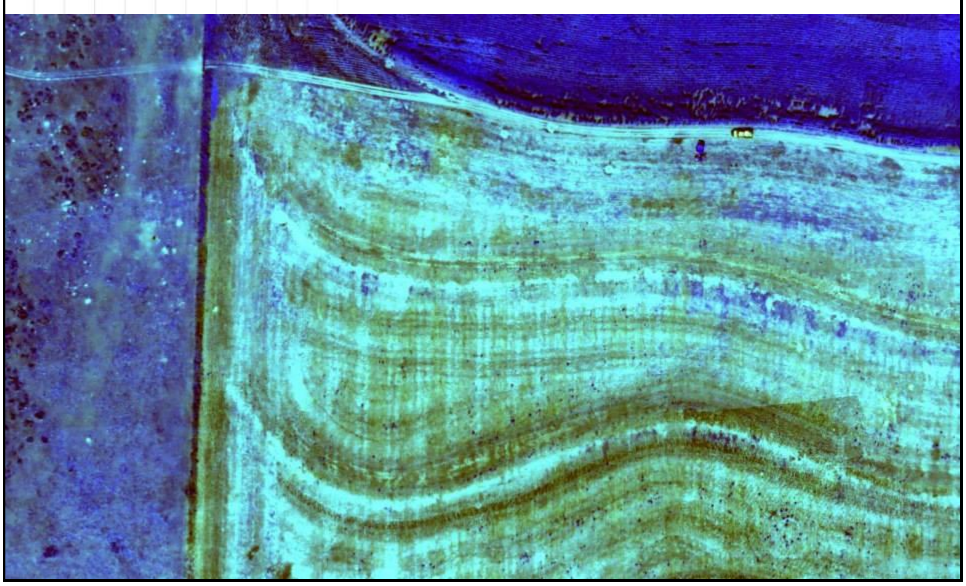




UAV Imagery – Rawlins County 2013



UAV Imagery – Rawlins County 2013