Effective Pesticide Spraying

Tom Wolf
Agrimetrix Research & Training
Saskatoon, SK

Sprayers101

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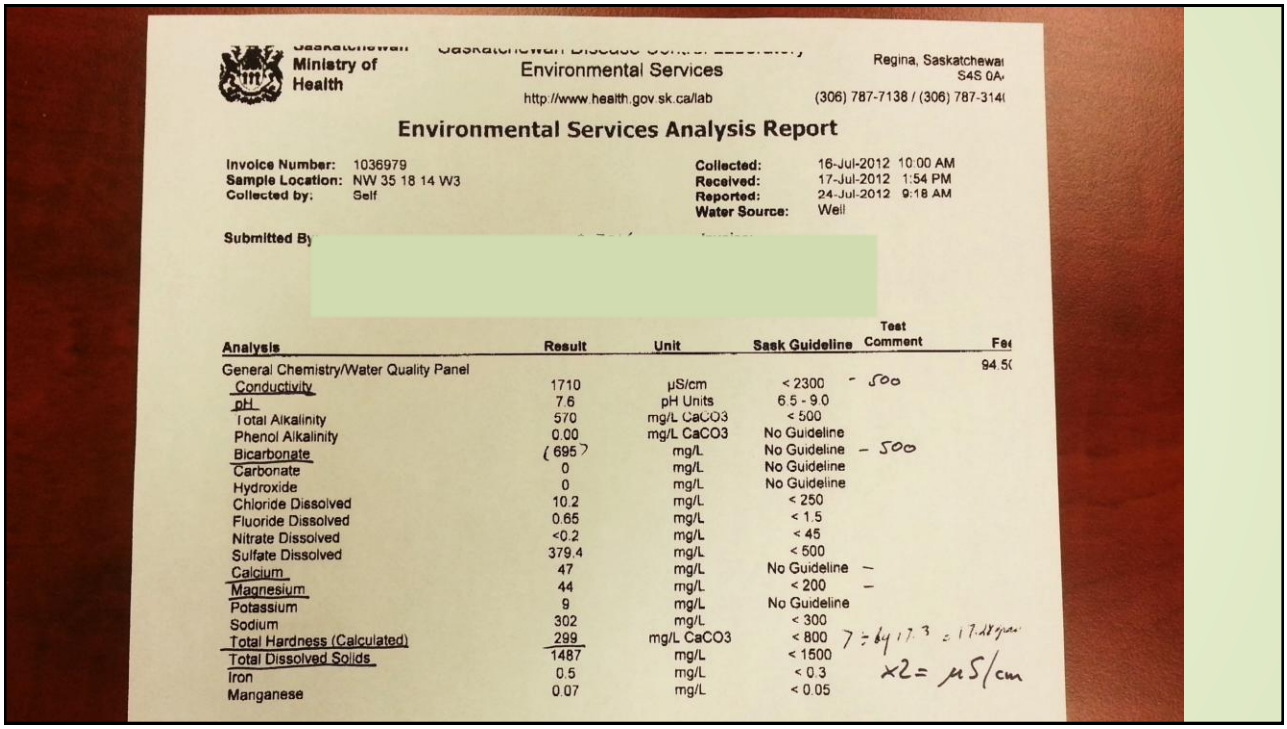
InterLock
Cimmer NG
ERICKSON
CREDIT XTREME
DO NOT SALE OR USE IN UNITED STATES

4



Ministry of Health

Environmental Services

http://www.health.gov.sk.ca/lab

Regina, Saskatchewan S4S 0A

(306) 787-7138 / (306) 787-3140

Environmental Services Analysis Report

Invoice Number: 1036979
Sample Location: NW 35 18 14 W3
Collected by: Self

Collected: 16-Jul-2012 10:00 AM
Received: 17-Jul-2012 1:54 PM
Reported: 24-Jul-2012 9:18 AM
Water Source: Well

Submitted By

Analysis	Result	Unit	Sask Guideline	Test Comment	Fee
General Chemistry/Water Quality Panel					94.50
Conductivity	1710	µS/cm	< 2300	- 500	
pH	7.6	pH Units	6.5 - 9.0		
Total Alkalinity	570	mg/L CaCO3	< 500		
Phenol Alkalinity	0.00	mg/L CaCO3	No Guideline		
Bicarbonate	(695)	mg/L	No Guideline	- 500	
Carbonate	0	mg/L	No Guideline		
Hydroxide	0	mg/L	No Guideline		
Chloride Dissolved	10.2	mg/L	< 250		
Fluoride Dissolved	0.65	mg/L	< 1.5		
Nitrate Dissolved	<0.2	mg/L	< 45		
Sulfate Dissolved	379.4	mg/L	< 500		
Calcium	47	mg/L	No Guideline	–	
Magnesium	44	mg/L	< 200	–	
Potassium	9	mg/L	No Guideline		
Sodium	302	mg/L	< 300		
Total Hardness (Calculated)	299	mg/L CaCO3	< 800	7 × 17.3 = 121.1 ppm	
Total Dissolved Solids	1487	mg/L	< 1500	x2 = µS/cm	
Iron	0.5	mg/L	< 0.3		
Manganese	0.07	mg/L	< 0.05		

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Turbidity

Contains suspended solids such as Clay, Silt, Organic Matter

	Mixing	Spraying	Efficacy
Turbidity	0	0	negative

- Can bind (neutralize) glyphosate and diquat (Reglone)
- Not usually tested for, but easy to see
- Treat with Aluminum Sulphate (coagulating agent)

Adapted from Jim Reiss, Precision Labs

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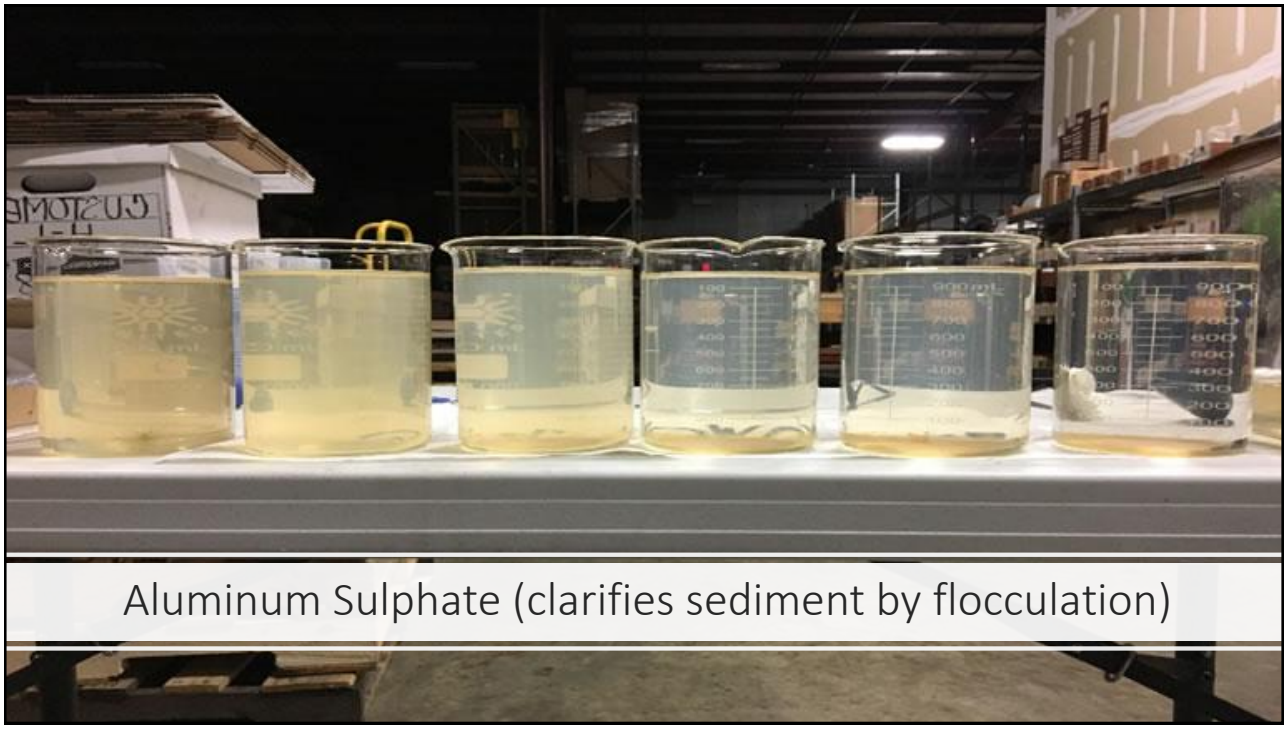

Aluminum Sulphate (clarifies sediment by flocculation)

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Conductivity / Total Dissolved Solids (TDS)

Sum of charged particles (Ca^{++}, Mg^{++}, Fe^{+++}, Na^{+}, K^{+}, Cl^{-}, nitrates, sulphates, bicarbonates, etc.)

	Mixing	Spraying	Efficacy
Conductivity	~neg	0	neg

- Big picture, no detail
- TDS <500 ppm, no problem
- TDS >500 ppm, need more info
- Conductivity (µS/cm) * ~0.6 = TDS (ppm)

Adapted from Jim Reiss, Precision Labs

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pH

A measure of how acidic or basic the carrier water is. Target 6 to 8.

	Mixing	Spraying	Efficacy
pH	NEG	0	Neg

- 1. Improve solubility and ease of cleanout
- 2. Prevent alkaline hydrolysis
- 3. Wrong pH can be catastrophic for tank mixes

Adapted from Jim Reiss, Precision Labs

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Herbicide Half-Life and pH

Product	Active ingredient	Half Life
Atrazine	atrazine	More stable at high pH
Banvel	dicamba	Stable at pH 5 - 6
Bromoxynil	bromoxynil	pH 5 = 34 days; pH 9 = 1.7 days
Fusilade	fluazifop-p	pH 4.5 = 455 days; pH 9 = 17 days
Liberty	glufosinate-ammonium	Very stable over a wide range of pH values
Gramoxone	paraquat	Not stable at pH above 7
MCPA	MCPA	pH 9 = < 5 days
Poast	sethoxydim	Stable at pH 4.0 to 10
Princep	simazine	pH 4.5 = 20 days; pH 5 = 96 days; pH 9 = 24 days
Prowl	pendimethalin	Stable over a wide range of pH values
Roundup	glyphosate	Stable over a wide range of pH values
Treflan	triflularin	Stable over a wide range of pH values
Weedar	2,4-D	Stable at pH 4.5 to 7

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pH and Water Solubility

Brand Name	Active Ingredient	MOA Group	Solubility (ppm) pH 5	pH 7	pH 9
Achieve	tralkoxydim	1	6	7	9,800
Muster	ethametsulfuron	2	2	50	410
Ally	metsulfuron	2	550	2,800	313,000
Express	tribenuron	2	48	2,040	18,300
Pinnacle	thifensulfuron	2	223	2,240	8,830
Everest	flucarbazone	2	3,000	44,000	44,000
Simplicity	pyroxsulam	2	16	32,000	13,700
Frontline	florasulam	2	0.1	6	94
Varro	thiencarbazone	2	172	436	417
Raptor	imazamox	2	116,000	>626,000	>628,000
Pursuit	imazethapyr	2	2,570	12,870	7,500
2,4-D acid	2,4-D	4	29,934	44,558	43,134
Heat	saflufenacil	14	30	2,100	>5,000
Distinct	diflufenzopyr	19	63	5,900	10,550
Infinity	pyrasulfatole	27	4,200	69,100	49,000

Adapted from Jim Reiss, Precision Labs

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Bicarbonates / Alkalinity

A measure of water's ability to resist a change in pH (buffering capacity). Bicarbonates are associated with hard water.

	Mixing	Spraying	Efficacy
Bicarbonates	neg	neg	NEG

- >500 ppm inhibits 2,4-D amine, MCPA amine, tralkoxydim, sethoxydim, clethodim
- May cause high pH
- AMS and UAN (and some acids) can combat bicarbonates

Adapted from Jim Reiss, Precision Labs

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Total Hardness

Calculated from Ca^{++} and Mg^{++} ppm, but Fe^{+++}, Na^{+}, and K^{+} also antagonize.

	Mixing	Spraying	Efficacy
Hardness	neg	0	NEG

- Affects primarily glyphosate and glufosinate
- Also 2,4-D amine & dicamba
- Commonly treated with Ammonium Sulphate (AMS, 21-0-0-24)

Adapted from Jim Reiss, Precision Labs

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Ca^{++}
(Hard water cation)

$Herbicide^{-}$

$NH_4^{+}SO_4^{--}$
(AMS)

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Insoluble precipitate

$Ca^{++}SO_4^{--}$

$Herbicide^{-}NH_4^{+}$

Improved herbicide translocation

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Temperature

Low water temperature can affect emulsifier performance in pesticides or adjuvants

	Mixing	Spraying	Efficacy
Temperature	neg	neg	neg

- Requires longer mix times and intervals between tank mix partners
- Viscous films can inhibit PWM plunger movement
- High bicarbonates can make this effect worse

Adapted from Jim Reiss, Precision Labs

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Analyte	Result	Guidelines for Canadian Drinking Water Quality (2022)	RDL	Units	Analyzed	Notes
Sample ID: SAMPLE 2 (C512128-02) [Water] Sampled: 2025-12-11 07:15						
Anions						
Chloride	93.0	AO ≤ 250	5.00	mg/L	2025-12-15	
Fluoride	0.10	MAC = 1.5	0.10	mg/L	2025-12-15	
Nitrate-N	3.96	MAC = 10	0.500	mg/L	2025-12-15	
Nitrite-N	<0.050	MAC = 1	0.050	mg/L	2025-12-15	
Sulfate	33.7	N/A	1.0	mg/L	2025-12-15	
Calculated Parameters						
Hardness, Dissolved (as CaCO3)	528	N/A	1.24	mg/L	N/A	
Nitrate+Nitrite (as N)	3.96	N/A	0.500	mg/L	N/A	
Total Dissolved Solids	552	AO ≤ 500	5.00	mg/L	N/A	
Sodium Adsorption Ratio	0.2	N/A	0.1	-	2025-12-15	
Ion Balance	104	N/A	1.0	%	2025-12-18	
Dissolved Metals						
Calcium	132	N/A	0.050	mg/L	2025-12-15	
Iron	<0.100	AO ≤ 0.3	0.100	mg/L	2025-12-15	
Magnesium	48.2	N/A	0.300	mg/L	2025-12-15	
Manganese	<0.010	AO ≤ 0.02	0.010	mg/L	2025-12-15	
Potassium	3.68	N/A	0.200	mg/L	2025-12-15	
Sodium	10.3	AO ≤ 200	0.050	mg/L	2025-12-15	
General Parameters						
Alkalinity, Total (as CaCO3)	351	N/A	2.0	mg/L	2025-12-17	
Bicarbonate (HCO3)	428	N/A	2.5	mg/L	2025-12-17	
Carbonate (CO3)	<2.0	N/A	2.0	mg/L	2025-12-17	
Hydroxide (OH)	<2.0	N/A	2.0	mg/L	2025-12-17	
Conductivity (EC)	1060	N/A	2.0	uS/cm	2025-12-17	
pH @ 25C	7.59	AO = 7.0-10.5	0.10	pH units	2025-12-17	
Turbidity	0.24	NTU0.1	0.10	NTU	2025-12-12	

17

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Dissolved M						
Calcium						5
Iron						5
Magnesium						5
Manganese						5
Potassium	3.68	N/A	0.200	mg/L	2025-12-15	
Sodium	10.3	AO ≤ 200	0.050	mg/L	2025-12-15	
General Parameters						
Alkalinity, Total (as CaCO3)	351	N/A	2.0	mg/L	2025-12-17	
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Water is hard but otherwise OK. Add AMS and use for spraying.

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PROJECT NO:
PO#:
LAB NUMBER: 174603
SAMPLE ID: FERTILIZER

SAMPLE MATRIX:WATER
DATE RECEIVED:NONE GIVEN
DATE REPORTED:07/07/2011
PAGE:3

PARAMETER	RESULT	UNIT	DETECTION LIMIT	METHOD REFERENCE
Total Alkalinity	349.3	ug/ml	10.0	Titration
Bicarbonate	349.3	ug/ml	10.0	Colourimetric
Carbonate	BDL*	ug/ml	10.00	Colourimetric
Calcium	155.23	ug/ml	0.10	ICP
Copper	BDL*	ug/ml	0.02	ICP
Magnesium	69.00	ug/ml	0.10	ICP
Manganese	0.15	ug/ml	0.02	ICP
Phosphorus	BDL*	ug/ml	0.10	ICP
Potassium	15882.53	ug/ml	0.10	ICP
Sodium	498.43	ug/ml	0.10	ICP
Sulphur (as SO4)	954.15	ug/ml	0.10	ICP
Zinc	0.21	ug/ml	0.02	ICP
Conductivity (@ 25 deg C)	41.06	ms/cm	0.02	Conductivity Meter
Total Dissolved Solids	26692.5	ug/ml	10.0	TDS Meter
pH	7.75	---	-.--	pH Meter
Nitrate - N	2.3	ug/ml	1.0	Automated Colourimetric
Hardness	671.0	ug/ml	1.0	ICP/Calculation
Chloride	16013.8	ug/ml	1.0	ISE

22

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24

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SAMPLE ID: FERTILIZER

SAMPLE MATRIX:WATER
DATE RECEIVED:NONE GIVEN
DATE REPORTED:07/07/2011
PAGE:3

PARAMETER	RESULT	UNIT	DETECTION LIMIT	METHOD REFERENCE
Total Alkalinity	349.3	ug/ml	10.0	Titration
Bicarbonate	349.3	ug/ml	10.0	Colourimetric
Carbonate	BDL*	ug/ml	10.00	Colourimetric
Calcium	155.23	ug/ml	0.10	ICP
Copper	BDL*	ug/ml	0.02	ICP
Magnesium	69.00	ug/ml	0.10	ICP
Manganese	0.15	ug/ml	0.02	ICP
Phosphorus	BDL*	ug/ml	0.10	ICP
Potassium	15882.53	ug/ml	0.10	ICP
Sodium	498.43	ug/ml	0.10	ICP
Sulphur (as SO4)	954.15	ug/ml	0.10	ICP
Zinc	0.21	ug/ml	0.02	ICP
Conductivity (@ 25 deg C)	41.06	ms/cm	0.02	Conductivity Meter
Total Dissolved Solids	26692.5	ug/ml	10.0	TDS Meter
pH	7.75	---	-.--	pH Meter
Nitrate - N	2.3	ug/ml	1.0	Automated Colourimetric
Hardness	671.0	ug/ml	1.0	ICP/Calculation
Chloride	16013.8	ug/ml	1.0	ISE

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PROJECT NO:
PO#:
LAB NUMBER: 174603
SAMPLE ID: FERTILIZER

SAMPLE MATRIX:WATER
DATE RECEIVED:NONE GIVEN
DATE REPORTED:07/07/2011
PAGE:3

PARAMETER	RESULT	UNIT	DETECTION LIMIT	METHOD REFERENCE
Total Alkalinity	349.3	ug/ml	10.0	Titration
Bicarbonate	349.3	ug/ml	10.0	Colourimetric
Carbonate	BDL*	ug/ml	10.00	Colourimetric
Calcium	155.23	ug/ml	0.10	ICP
Copper	BDL*	ug/ml	0.02	ICP
Magnesium	69.00	ug/ml	0.10	ICP
Manganese	0.15	ug/ml	0.02	ICP
Phosphorus	BDL*	ug/ml	0.10	ICP
Potassium	15882.53	ug/ml	0.10	ICP
Sodium	498.43	ug/ml	0.10	ICP
Sulphur (as SO4)	954.15	ug/ml	0.10	ICP
Zinc	0.21	ug/ml	0.02	ICP
Conductivity (@ 25 deg C)	41.06	ms/cm	0.02	Conductivity Meter
Total Dissolved Solids	26692.5	ug/ml	10.0	TDS Meter
pH	7.75	---	-.--	pH Meter
Nitrate - N	2.3	ug/ml	1.0	Automated Colourimetric
Hardness	671.0	ug/ml	1.0	ICP/Calculation
Chloride	16013.8	ug/ml	1.0	ISE

27

PROJECT NO:
PO#:
LAB NUMBER: 174603
SAMPLE ID: FERTILIZER

SAMPLE MATRIX:WATER
DATE RECEIVED:NONE GIVEN
DATE REPORTED:07/07/2011
PAGE:3

PARAMETER	RESULT	UNIT	DETECTION LIMIT	METHOD REFERENCE
Total Alkalinity	349.3	ug/ml	10.0	Titration
Bicarbonate	349.3	ug/ml	10.0	Colourimetric
Carbonate	BDL*	ug/ml	10.00	Colourimetric
Calcium	155.23	ug/ml	0.10	ICP
Copper	BDL*	ug/ml	0.02	ICP
Magnesium				
Manganese				
Phosphorus				
Potassium				
Sodium				
Sulphur (as SO4)				
Zinc	0.21	ug/ml	0.02	ICP
Conductivity (@ 25 deg C)	41.06	ms/cm	0.02	Conductivity Meter
Total Dissolved Solids	26692.5	ug/ml	10.0	TDS Meter
pH	7.75	---	-.--	pH Meter
Nitrate - N	2.3	ug/ml	1.0	Automated Colourimetric
Hardness	671.0	ug/ml	1.0	ICP/Calculation
Chloride	16013.8	ug/ml	1.0	ISE

Very hard water that is also very high in Potassium Chloride. Potassium is antagonistic. Do not use for spraying.

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Analyte	Result	Guidelines for Canadian Drinking Water Quality (2022)	RDL	Units	Analyzed	Notes
Sample ID: SAMPLE 4 (C512128-04) [Water] Sampled: 2025-12-08 13:53						
Anions						
Chloride	2.32	AO ≤ 250	0.50	mg/L	2025-12-15	
Fluoride	0.94	MAC = 1.5	0.10	mg/L	2025-12-15	
Nitrate-N	<0.050	MAC = 10	0.050	mg/L	2025-12-15	
Nitrite-N	<0.050	MAC = 1	0.050	mg/L	2025-12-15	
Sulfate	390	N/A	10.0	mg/L	2025-12-15	
Calculated Parameters						
Hardness, Dissolved (as CaCO3)	24.8	N/A	0.125	mg/L	N/A	
Nitrate+Nitrite (as N)	<0.0500	N/A	0.0500	mg/L	N/A	
Total Dissolved Solids	1130	AO ≤ 500	10.0	mg/L	N/A	
Sodium Adsorption Ratio	37.0	N/A	0.1	-	2025-12-15	
Ion Balance	104	N/A	1.0	%	2025-12-18	
Dissolved Metals						
Calcium	7.46	N/A	0.050	mg/L	2025-12-15	
Iron	<0.100	AO ≤ 0.3	0.100	mg/L	2025-12-15	
Magnesium	1.49	N/A	0.030	mg/L	2025-12-15	
Manganese	0.022	AO ≤ 0.02	0.010	mg/L	2025-12-15	
Potassium	1.55	N/A	0.200	mg/L	2025-12-15	
Sodium	423	AO ≤ 200	0.500	mg/L	2025-12-15	
General Parameters						
Alkalinity, Total (as CaCO3)	498	N/A	2.0	mg/L	2025-12-17	
Bicarbonate (HCO3)	608	N/A	2.5	mg/L	2025-12-17	
Carbonate (CO3)	<2.0	N/A	2.0	mg/L	2025-12-17	
Hydroxide (OH)	<2.0	N/A	2.0	mg/L	2025-12-17	
Conductivity (EC)	1810	N/A	2.0	uS/cm	2025-12-17	
pH @ 25C	8.28	AO = 7.0-10.5	0.10	pH units	2025-12-17	
Turbidity	0.31	NTU0.1	0.10	NTU	2025-12-12	

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Analyte	Result	Guidelines for Canadian Drinking Water Quality (2022)	RDL	Units	Analyzed	Notes
Sample ID: SAMPLE 4 (C512128-04) [Water] Sampled: 2025-12-08 13:53						
Anions						
Chloride	2.32	AO ≤ 250	0.50	mg/L	2025-12-15	
Fluoride	0.94	MAC = 1.5	0.10	mg/L	2025-12-15	
Nitrate-N	<0.050	MAC = 10	0.050	mg/L	2025-12-15	
Nitrite-N	<0.050	MAC = 1	0.050	mg/L	2025-12-15	
Sulfate	390	N/A	10.0	mg/L	2025-12-15	
Calculated Parameters						
Hardness, Dissolved (as CaCO3)	24.8	N/A	0.125	mg/L	N/A	
Nitrate+Nitrite (as N)	<0.0500	N/A	0.0500	mg/L	N/A	
Total Dissolved Solids	1130	AO ≤ 500	10.0	mg/L	N/A	
Sodium Adsorption Ratio	37.0	N/A	0.1	-	2025-12-15	
Ion Balance	104	N/A	1.0	%	2025-12-18	
Dissolved Metals						
Calcium	7.46	N/A	0.050	mg/L	2025-12-15	
Iron	<0.100	AO ≤ 0.3	0.100	mg/L	2025-12-15	
Magnesium	1.49	N/A	0.030	mg/L	2025-12-15	
Manganese	0.022	AO ≤ 0.02	0.010	mg/L	2025-12-15	
Potassium	1.55	N/A	0.200	mg/L	2025-12-15	
Sodium	423	AO ≤ 200	0.500	mg/L	2025-12-15	
General Parameters						
Alkalinity, Total (as CaCO3)	498	N/A	2.0	mg/L	2025-12-17	
Bicarbonate (HCO3)	608	N/A	2.5	mg/L	2025-12-17	
Carbonate (CO3)	<2.0	N/A	2.0	mg/L	2025-12-17	
Hydroxide (OH)	<2.0	N/A	2.0	mg/L	2025-12-17	
Conductivity (EC)	1810	N/A	2.0	uS/cm	2025-12-17	
pH @ 25C	8.28	AO = 7.0-10.5	0.10	pH units	2025-12-17	
Turbidity	0.31	NTU0.1	0.10	NTU	2025-12-12	

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Analyte	Result	Guidelines for Canadian Drinking Water Quality (2022)	RDL	Units	Analyzed	Notes
Sample ID: SAMPLE 4 (C512128-04) [Water] Sampled: 2025-12-08 13:53						
Anions						
Chloride	2.32	AO ≤ 250	0.50	mg/L	2025-12-15	
Fluoride	0.94	MAC = 1.5	0.10	mg/L	2025-12-15	
Nitrate-N	<0.050	MAC = 10	0.050	mg/L	2025-12-15	
Nitrite-N	<0.050	MAC = 1	0.050	mg/L	2025-12-15	
Sulfate	390	N/A	10.0	mg/L	2025-12-15	
Calculated Parameters						
Hardness, Dissolved (as CaCO3)	24.8	N/A	0.125	mg/L	N/A	
Nitrate+Nitrite (as N)	<0.0500	N/A	0.0500	mg/L	N/A	
Total Dissolved Solids	1130	AO ≤ 500	10.0	mg/L	N/A	
Sodium Adsorption Ratio	37.0	N/A	0.1	-	2025-12-15	
Ion Balance	104	N/A	1.0	%	2025-12-18	
Dissolved Metals						
Calcium	7.46	N/A	0.050	mg/L	2025-12-15	
Iron	<0.100	AO ≤ 0.3	0.100	mg/L	2025-12-15	
Magnesium	1.49	N/A	0.030	mg/L	2025-12-15	
Manganese	0.022	AO ≤ 0.02	0.010	mg/L	2025-12-15	
Potassium	1.55	N/A	0.200	mg/L	2025-12-15	
Sodium	423	AO ≤ 200	0.500	mg/L	2025-12-15	
General Parameters						
Alkalinity, Total (as CaCO3)	498	N/A	2.0	mg/L	2025-12-17	
Bicarbonate (HCO3)	608	N/A	2.5	mg/L	2025-12-17	
Carbonate (CO3)	<2.0	N/A	2.0	mg/L	2025-12-17	
Hydroxide (OH)	<2.0	N/A	2.0	mg/L	2025-12-17	
Conductivity (EC)	1810	N/A	2.0	uS/cm	2025-12-17	
pH @ 25C	8.28	AO = 7.0-10.5	0.10	pH units	2025-12-17	
Turbidity	0.31	NTU0.1	0.10	NTU	2025-12-12	

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Analyte	Result	Guidelines for Canadian Drinking Water Quality (2022)	RDL	Units	Analyzed	Notes
Sample ID: SAMPLE 4 (C512128-04) [Water] Sampled: 2025-12-08 13:53						
Anions						
Chloride	2.32	AO ≤ 250	0.50	mg/L	2025-12-15	
Fluoride	0.94	MAC = 1.5	0.10	mg/L	2025-12-15	
Nitrate-N	<0.050	MAC = 10	0.050	mg/L	2025-12-15	
Nitrite-N	<0.050	MAC = 1	0.050	mg/L	2025-12-15	
Sulfate	390	N/A	10.0	mg/L	2025-12-15	
Calculated Parameters						
Hardness, Dissolved (as CaCO3)	24.8	N/A	0.125	mg/L	N/A	
Nitrate+Nitrite (as N)	<0.0500	N/A	0.0500	mg/L	N/A	
Total Dissolved Solids	1130	AO ≤ 500	10.0	mg/L	N/A	
Sodium Adsorption Ratio	37.0	N/A	0.1	-	2025-12-15	
Ion Balance	104	N/A	1.0	%	2025-12-18	
Dissolved Metals						
Calcium	7.46	N/A	0.050	mg/L	2025-12-15	
Iron	<0.100	AO ≤ 0.3	0.100	mg/L	2025-12-15	
Magnesium	1.49	N/A	0.030	mg/L	2025-12-15	
Manganese	0.022	AO ≤ 0.02	0.010	mg/L	2025-12-15	
Potassium	1.55	N/A	0.200	mg/L	2025-12-15	
Sodium	423	AO ≤ 200	0.500	mg/L	2025-12-15	
General Parameters						
Alkalinity, Total (as CaCO3)	498	N/A	2.0	mg/L	2025-12-17	
Bicarbonate (HCO3)	608	N/A	2.5	mg/L	2025-12-17	
Carbonate (CO3)	<2.0	N/A	2.0	mg/L	2025-12-17	
Hydroxide (OH)	<2.0	N/A	2.0	mg/L	2025-12-17	
Conductivity (EC)	1810	N/A	2.0	uS/cm	2025-12-17	
pH @ 25C	8.28	AO = 7.0-10.5	0.10	pH units	2025-12-17	
Turbidity	0.31	NTU0.1	0.10	NTU	2025-12-12	

32

Analyte	Result	Guidelines for Canadian Drinking Water Quality (2022)	RDL	Units	Analyzed	Notes
Sample ID: SAMPLE 4 (C512128-04) [Water] Sampled: 2025-12-08 13:53						
Anions						
Chloride	2.32	AO ≤ 250	0.50	mg/L	2025-12-15	
Fluoride	0.94	MAC = 1.5	0.10	mg/L	2025-12-15	
Nitrate-N	<0.050	MAC = 10	0.050	mg/L	2025-12-15	
Nitrite-N	<0.050	MAC = 1	0.050	mg/L	2025-12-15	
Sulfate	390	N/A	10.0	mg/L	2025-12-15	
Calculated Parameters						
Hardness, Dissolved (as CaCO3)	24.8	N/A	0.125	mg/L	N/A	
Nitrate+Nitrite (as N)	<0.0500	N/A	0.0500	mg/L	N/A	
Total Dissolved Solids	1130	AO ≤ 500	10.0	mg/L	N/A	
Sodium Adsorption Ratio	37.0	N/A	0.1	-	2025-12-15	
Ion Balance	104	N/A	1.0	%	2025-12-18	
Dissolved Metals						
Calcium	7.46	N/A	0.050	mg/L	2025-12-15	
Iron	<0.100	AO ≤ 0.3	0.100	mg/L	2025-12-15	
Magnesium	1.49	N/A	0.030	mg/L	2025-12-15	
Manganese	0.022	AO ≤ 0.02	0.010	mg/L	2025-12-15	
Potassium	1.55	N/A	0.200	mg/L	2025-12-15	
Sodium	423	AO ≤ 200	0.500	mg/L	2025-12-15	
General Parameters						
Alkalinity, Total (as CaCO3)	498	N/A	2.0	mg/L	2025-12-17	
Bicarbonate (HCO3)	608	N/A	2.5	mg/L	2025-12-17	
Carbonate (CO3)	<2.0	N/A	2.0	mg/L	2025-12-17	
Hydroxide (OH)	<2.0	N/A	2.0	mg/L	2025-12-17	
Conductivity (EC)	1810	N/A	2.0	uS/cm	2025-12-17	
pH @ 25C	8.28	AO = 7.0-10.5	0.10	pH units	2025-12-17	
Turbidity	0.31	NTU0.1	0.10	NTU	2025-12-12	

33

Analyte	Result	Guidelines for Canadian Drinking Water Quality (2022)	RDL	Units	Analyzed	Notes
Sample ID: SAMPLE 4 (C512128-04) [Water] Sampled: 2025-12-08 13:53						
Anions						
Chloride	2.32	AO ≤ 250	0.50	mg/L	2025-12-15	
Fluoride	0.94	MAC = 1.5	0.10	mg/L	2025-12-15	
Nitrate-N	<0.050	MAC = 10	0.050	mg/L	2025-12-15	
Nitrite-N	<0.050	MAC = 1	0.050	mg/L	2025-12-15	
Sulfate	390	N/A	10.0	mg/L	2025-12-15	
Calculated Parameters						
Hardness, Dissolved (as CaCO3)	24.8	N/A	0.125	mg/L	N/A	
Nitrate+Nitrite (as N)						
Total Dissolved						
Sodium Adsorp						
Ion Balance						
Dissolved Meta						
Calcium						
Iron						
Magnesium						
Manganese						
Potassium						
Sodium						
General Parameters						
Alkalinity, Total (as CaCO3)	498	N/A	2.0	mg/L	2025-12-17	
Bicarbonate (HCO3)	608	N/A	2.5	mg/L	2025-12-17	
Carbonate (CO3)	<2.0	N/A	2.0	mg/L	2025-12-17	
Hydroxide (OH)	<2.0	N/A	2.0	mg/L	2025-12-17	
Conductivity (EC)	1810	N/A	2.0	uS/cm	2025-12-17	
pH @ 25C	8.28	AO = 7.0-10.5	0.10	pH units	2025-12-17	
Turbidity	0.31	NTU0.1	0.10	NTU	2025-12-12	

Water is high in TDS from sodium and bicarbonates. Although not hard, sodium can be antagonistic. Consider using AMS.

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PROJECT NO:
PO#:
LAB NUMBER: 174601
SAMPLE ID: MARCHWELL WELL

SAMPLE MATRIX:WATER
DATE RECEIVED:NONE GIVEN
DATE REPORTED:07/07/2011
PAGE:1

PARAMETER	RESULT	UNIT	DETECTION LIMIT	METHOD REFERENCE
Total Alkalinity	203.7	ug/ml	10.0	Titration
Bicarbonate	203.7	ug/ml	10.0	Colourimetric
Carbonate	BDL*	ug/ml	10.00	Colourimetric
Calcium	83.00	ug/ml	0.10	ICP
Copper	BDL*	ug/ml	0.02	ICP
Magnesium	58.36	ug/ml	0.10	ICP
Manganese	BDL*	ug/ml	0.02	ICP
Phosphorus	BDL*	ug/ml	0.10	ICP
Potassium	16.84	ug/ml	0.10	ICP
Sodium	19.70	ug/ml	0.10	ICP
Sulphur (as SO4)	239.49	ug/ml	0.10	ICP
Zinc	0.04	ug/ml	0.02	ICP
Conductivity (@ 25 deg C)	0.75	ms/cm	0.02	Conductivity Meter
Total Dissolved Solids	485.9	ug/ml	10.0	TDS Meter
pH	7.97	---	-.--	pH Meter
Nitrate - N	BDL*	ug/ml	1.0	Automated Colourimetric
Hardness	446.8	ug/ml	1.0	ICP/Calculation
Chloride	17.8	ug/ml	1.0	ISE

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PROJECT NO:
PO#:
LAB NUMBER: 174601
SAMPLE ID: MARCHWELL WELL

SAMPLE MATRIX:WATER
DATE RECEIVED:NONE GIVEN
DATE REPORTED:07/07/2011
PAGE:1

PARAMETER	RESULT	UNIT	DETECTION LIMIT	METHOD REFERENCE
Total Alkalinity	203.7	ug/ml	10.0	Titration
Bicarbonate	203.7	ug/ml	10.0	Colourimetric
Carbonate	BDL*	ug/ml	10.00	Colourimetric
Calcium	83.00	ug/ml	0.10	ICP
Copper	BDL*	ug/ml	0.02	ICP
Magnesium	58.36	ug/ml	0.10	ICP
Manganese	BDL*	ug/ml	0.02	ICP
Phosphorus	BDL*	ug/ml	0.10	ICP
Potassium	16.84	ug/ml	0.10	ICP
Sodium	19.70	ug/ml	0.10	ICP
Sulphur (as SO4)	239.49	ug/ml	0.10	ICP
Zinc	0.04	ug/ml	0.02	ICP
Conductivity (@ 25 deg C)	0.75	ms/cm	0.02	Conductivity Meter
Total Dissolved Solids	485.9	ug/ml	10.0	TDS Meter
pH	7.97	---	-.--	pH Meter
Nitrate - N	BDL*	ug/ml	1.0	Automated Colourimetric
Hardness	446.8	ug/ml	1.0	ICP/Calculation
Chloride	17.8	ug/ml	1.0	ISE

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PROJECT NO:
PO#:
LAB NUMBER: 174601
SAMPLE ID: MARCHWELL WELL

SAMPLE MATRIX:WATER
DATE RECEIVED:NONE GIVEN
DATE REPORTED:07/07/2011
PAGE:1

PARAMETER	RESULT	UNIT	DETECTION LIMIT	METHOD REFERENCE
Total Alkalinity	203.7	ug/ml	10.0	Titration
Bicarbonate	203.7	ug/ml	10.0	Colourimetric
Carbonate	BDL*	ug/ml	10.00	Colourimetric
Calcium	83.00	ug/ml	0.10	ICP
Copper	BDL*	ug/ml	0.02	ICP
Magnesium	58.36	ug/ml	0.10	ICP
Manganese	BDL*	ug/ml	0.02	ICP
Phosphorus	BDL*	ug/ml	0.10	ICP
Potassium	16.84	ug/ml	0.10	ICP
Sodium	19.70	ug/ml	0.10	ICP
Sulphur (as SO4)	239.49	ug/ml	0.10	ICP
Zinc	0.04	ug/ml	0.02	ICP
Conductivity (@ 25 deg C)	0.75	ms/cm	0.02	Conductivity Meter
Total Dissolved Solids	485.9	ug/ml	10.0	TDS Meter
pH	7.97	---	-.--	pH Meter
Nitrate - N	BDL*	ug/ml	1.0	Automated Colourimetric
Hardness	446.8	ug/ml	1.0	ICP/Calculation
Chloride	17.8	ug/ml	1.0	ISE

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PROJECT NO:
PO#:
LAB NUMBER: 174601
SAMPLE ID: MARCHWELL WELL

SAMPLE MATRIX:WATER
DATE RECEIVED:NONE GIVEN
DATE REPORTED:07/07/2011
PAGE:1

PARAMETER	RESULT	UNIT	DETECTION LIMIT	METHOD REFERENCE
Total Alkalinity	203.7	ug/ml	10.0	Titration
Bicarbonate	203.7	ug/ml	10.0	Colourimetric
Carbonate	BDL*	ug/ml	10.00	Colourimetric
Calcium	83.00	ug/ml	0.10	ICP
Copper	BDL*	ug/ml	0.02	ICP
Magnesium	58.36	ug/ml	0.10	ICP
Manganese	BDL*	ug/ml	0.02	ICP
Phosphorus	BDL*	ug/ml	0.10	ICP
Potassium	16.84	ug/ml	0.10	ICP
Sodium	19.70	ug/ml	0.10	ICP
Sulphur (as SO4)	239.49	ug/ml	0.10	ICP
Zinc	0.04	ug/ml	0.02	ICP
Conductivity (@ 25 deg C)	0.75	ms/cm	0.02	Conductivity Meter
Total Dissolved Solids	485.9	ug/ml	10.0	TDS Meter
pH	7.97	---	-.--	pH Meter
Nitrate - N	BDL*	ug/ml	1.0	Automated Colourimetric
Hardness	446.8	ug/ml	1.0	ICP/Calculation
Chloride	17.8	ug/ml	1.0	ISE

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PROJECT NO:
PO#:
LAB NUMBER: 174601
SAMPLE ID: MARCHWELL WELL

SAMPLE MATRIX:WATER
DATE RECEIVED:NONE GIVEN
DATE REPORTED:07/07/2011
PAGE:1

PARAMETER	RESULT	UNIT	DETECTION LIMIT	METHOD REFERENCE
Total Alkalinity	203.7	ug/ml	10.0	Titration
Bicarbonate	203.7	ug/ml	10.0	Colourimetric
Carbonate	BDL*	ug/ml	10.00	Colourimetric
Calcium	83.00	ug/ml	0.10	ICP
Copper	BDL*	ug/ml	0.02	ICP
Magnesium	58.36	ug/ml	0.10	ICP
Manganese	BDL*	ug/ml	0.02	ICP
Phosphorus	BDL*	ug/ml	0.10	ICP
Potassium	16.84	ug/ml	0.10	ICP
Sodium	19.70	ug/ml	0.10	ICP
Sulphur (as SO4)	239.49	ug/ml	0.10	ICP
Zinc	0.04	ug/ml	0.02	ICP
Conductivity (@ 25 deg C)	0.75	ms/cm	0.02	Conductivity Meter
Total Dissolved Solids	485.9	ug/ml	10.0	TDS Meter
pH	7.97	---	-.--	pH Meter
Nitrate - N	BDL*	ug/ml	1.0	Automated Colourimetric
Hardness	446.8	ug/ml	1.0	ICP/Calculation
Chloride	17.8	ug/ml	1.0	ISE

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PROJECT NO:
PO#:
LAB NUMBER: 174601
SAMPLE ID: MARCHWELL WELL

SAMPLE MATRIX:WATER
DATE RECEIVED:NONE GIVEN
DATE REPORTED:07/07/2011
PAGE:1

PARAMETER	RESULT	UNIT	DETECTION LIMIT	METHOD REFERENCE
Total Alkalinity	203.7	ug/ml	10.0	Titration
Bicarbonate	203.7	ug/ml	10.0	Colourimetric
Carbonate	BDL*	ug/ml	10.00	Colourimetric
Calcium	83.00	ug/ml	0.10	ICP
Copper	BDL*	ug/ml	0.02	ICP
Magnesium	58.36	ug/ml	0.10	ICP
Manganese	BDL*	ug/ml	0.02	ICP
Phosphorus	BDL*	ug/ml	0.10	ICP
Potassium	16.84	ug/ml	0.10	ICP
Sodium	19.70	ug/ml	0.10	ICP
Sulphur (as SO4)	239.49	ug/ml	0.10	ICP
Zinc	0.04	ug/ml	0.02	ICP
Conductivity (@ 25 deg C)	0.75	ms/cm	0.02	Conductivity Meter
Total Dissolved Solids	485.9	ug/ml	10.0	TDS Meter
pH	7.97	---	-.--	pH Meter
Nitrate - N	BDL*	ug/ml	1.0	Automated Colourimetric
Hardness	446.8	ug/ml	1.0	ICP/Calculation
Chloride	17.8	ug/ml	1.0	ISE

40

PROJECT NO:
PO#:
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PARAMETER	RESULT	UNIT	DETECTION LIMIT	METHOD REFERENCE
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Bicarbonate	203.7	ug/ml	10.0	Colourimetric
Carbonate	BDL*	ug/ml	10.00	Colourimetric
Calcium	83.00	ug/ml	0.10	ICP
Copper				
Magnesium				
Manganese				
Phosphorus				
Potassium				
Sodium				
Sulphur (as SO4)	239.49	ug/ml	0.10	ICP
Zinc	0.04	ug/ml	0.02	ICP
Conductivity (@ 25 deg C)	0.75	ms/cm	0.02	Conductivity Meter
Total Dissolved Solids	485.9	ug/ml	10.0	TDS Meter
pH	7.97	---	-.--	pH Meter
Nitrate - N	BDL*	ug/ml	1.0	Automated Colourimetric
Hardness	446.8	ug/ml	1.0	ICP/Calculation
Chloride	17.8	ug/ml	1.0	ISE

Hardness high from Mg and Ca, but otherwise this water is OK. Treat with AMS and use for spraying.

41

		Sample Description	Water Well / 15°C			
		Sample Matrix	Water			
Analyte		Units	Result	Nominal Detection Limit	Guideline Limit	Guideline Comments
Physical and Aggregate Properties						
Colour	Apparent, Potable	Colour units	>60	5	15	Above AO
Turbidity		NTU	11.0	0.1	0.1	Above OG
Routine Water						
pH			7.92		7.0-10.5	Within OG Range
Temperature of observed pH		°C	20.6			
Electrical Conductivity	at 25 °C	µS/cm	10200	1		
Calcium	Extractable	mg/L	59	0.2		
Magnesium	Extractable	mg/L	10	0.2		
Sodium	Extractable	mg/L	2080	0.4	200	Above AO
Potassium	Extractable	mg/L	9	0.4		
Iron	Extractable	mg/L	2.6	0.01	0.3	Above AO
Manganese	Extractable	mg/L	0.08	0.005	0.02 AO; 0.12 MAC	Above AO
Chloride	Dissolved	mg/L	3390	0.4	250	Above AO
Fluoride		mg/L	<1	0.05	1.5	Below MAC
Nitrate - N		mg/L	<0.2	0.01	10	Below MAC
Nitrite - N		mg/L	<0.1	0.005	1	Below MAC
Nitrate and Nitrite - N		mg/L	<0.3	0.01	10	Below MAC
Sulfate (SO4)	Extractable	mg/L	<9	0.9	500	Below AO
Hydroxide		mg/L	<5			
Carbonate		mg/L	<6			
Bicarbonate		mg/L	247			
P-Alkalinity	as CaCO3	mg/L	<5	5		
T-Alkalinity	as CaCO3	mg/L	202	5		
Total Dissolved Solids		mg/L	5660	1	500	Above AO
Hardness	as CaCO3	mg/L	190			
Ionic Balance		%	94			

42

		Sample Description	Water Well / 15°C			
		Sample Matrix	Water			
Analyte		Units	Result	Nominal Detection Limit	Guideline Limit	Guideline Comments
Physical and Aggregate Properties						
Colour	Apparent, Potable	Colour units	>60	5	15	Above AO
Turbidity		NTU	11.0	0.1	0.1	Above OG
Routine Water						
pH			7.92		7.0-10.5	Within OG Range
Temperature of observed pH		°C	20.6			
Electrical Conductivity						
Calcium						
Magnesium						
Sodium						Above AO
Potassium						
Iron						Above AO
Manganese						Above AO
Chloride						Above AO
Fluoride						Below MAC
Nitrate - N		mg/L	<0.2	0.01	10	Below MAC
Nitrite - N		mg/L	<0.1	0.005	1	Below MAC
Nitrate and Nitrite - N		mg/L	<0.3	0.01	10	Below MAC
Sulfate (SO4)	Extractable	mg/L	<9	0.9	500	Below AO
Hydroxide		mg/L	<5			
Carbonate		mg/L	<6			
Bicarbonate		mg/L	247			
P-Alkalinity	as CaCO3	mg/L	<5	5		
T-Alkalinity	as CaCO3	mg/L	202	5		
Total Dissolved Solids		mg/L	5660	1	500	Above AO
Hardness	as CaCO3	mg/L	190			
Ionic Balance		%	94			

Water is high in TDS from sodium and chloride. Although not hard, sodium can be antagonistic. Avoid using this water.

43

	Enter value water test		NDSU Antagonism Coefficient	AMS Requirement	
Iron	0.01	ppm	x 0.042 =	0.00	lbs/100 gal
Magnesium	19.9	ppm	x 0.014 =	0.28	lbs/100 gal
Calcium	58.3	ppm	x 0.009 =	0.53	lbs/100 gal
Sodium	10.4	ppm	X 0.005 =	0.05	lbs/100 gal
Potassium	0	ppm	X 0.002 =	0.00	lbs/100 gal
Hardness ($CaCO_3$ equivalent)	**229**	ppm		**0.86**	
Recommended AMS:					
Dry Product: lbs of AMS for 100 gallons of water=				**0.86**	lbs 21-0-0-24
34% Liquid: Litres of 34% AMS for 100 gallons of water=				**0.95**	Litres

44

	Enter value water test		NDSU Antagonism Coefficient	AMS Requirement	
Iron	20.0	ppm	x 0.042 =	0.84	lbs/100 gal
Magnesium	19.9	ppm	x 0.014 =	0.28	lbs/100 gal
Calcium	58.3	ppm	x 0.009 =	0.53	lbs/100 gal
Sodium	10.4	ppm	X 0.005 =	0.05	lbs/100 gal
Potassium	0	ppm	X 0.002 =	0.00	lbs/100 gal
Hardness ($CaCO_3$ equivalent)	**229**	ppm		**1.70**	
Recommended AMS:					
Dry Product: lbs of AMS for 100 gallons of water=				**1.70**	lbs 21-0-0-24
34% Liquid: Litres of 34% AMS for 100 gallons of water=				**1.89**	Litres

45

	Enter value water test		NDSU Antagonism Coefficient	AMS Requirement	
Iron	20.0	ppm	x 0.042 =	0.84	lbs/100 gal
Magnesium	19.9	ppm	x 0.014 =	0.28	lbs/100 gal
Calcium	58.3	ppm	x 0.009 =	0.53	lbs/100 gal
Sodium	10.4	ppm	X 0.005 =	0.05	lbs/100 gal
Potassium	0	ppm	X 0.002 =	0.00	lbs/100 gal
Hardness ($CaCO_3$ equivalent)	**229**	ppm		**1.70**	
Recommended AMS:					
Dry Product: lbs of AMS for 100 gallons of water=				**1.70**	lbs 21-0-0-24
34% Liquid: Litres of 34% AMS for 100 gallons of water=				**1.89**	Litres

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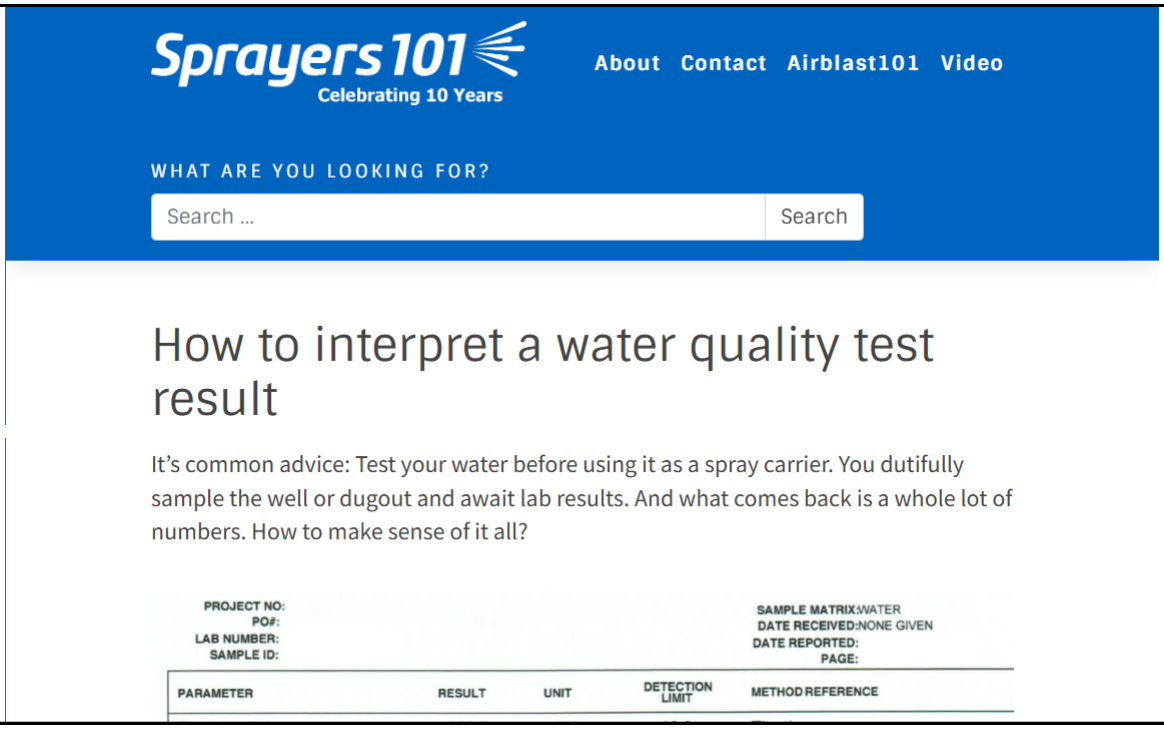
Parameter	Units	Glyphosate Guidelines	2,4-D Amine Guidelines
Conductivity	µS/cm	<500	<500
Hardness	mg/L	<350 for annual weeds <20 grains per U.S. gallon	<600
		<700 for perennial weeds <40 grains per U.S. gallon	
Bicarbonate	mg/L	No guidelines	<500

Source: adapted from Holm, F.A., J.L. Henry, and D. Billet. 1994. Farm Facts: Water quality and herbicides.

47



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What are the Options?

- Source from a different well
- Use surface water
- Use municipal water
- Treat with Ammonium Sulphate (21-0-0-24)
- Reverse Osmosis

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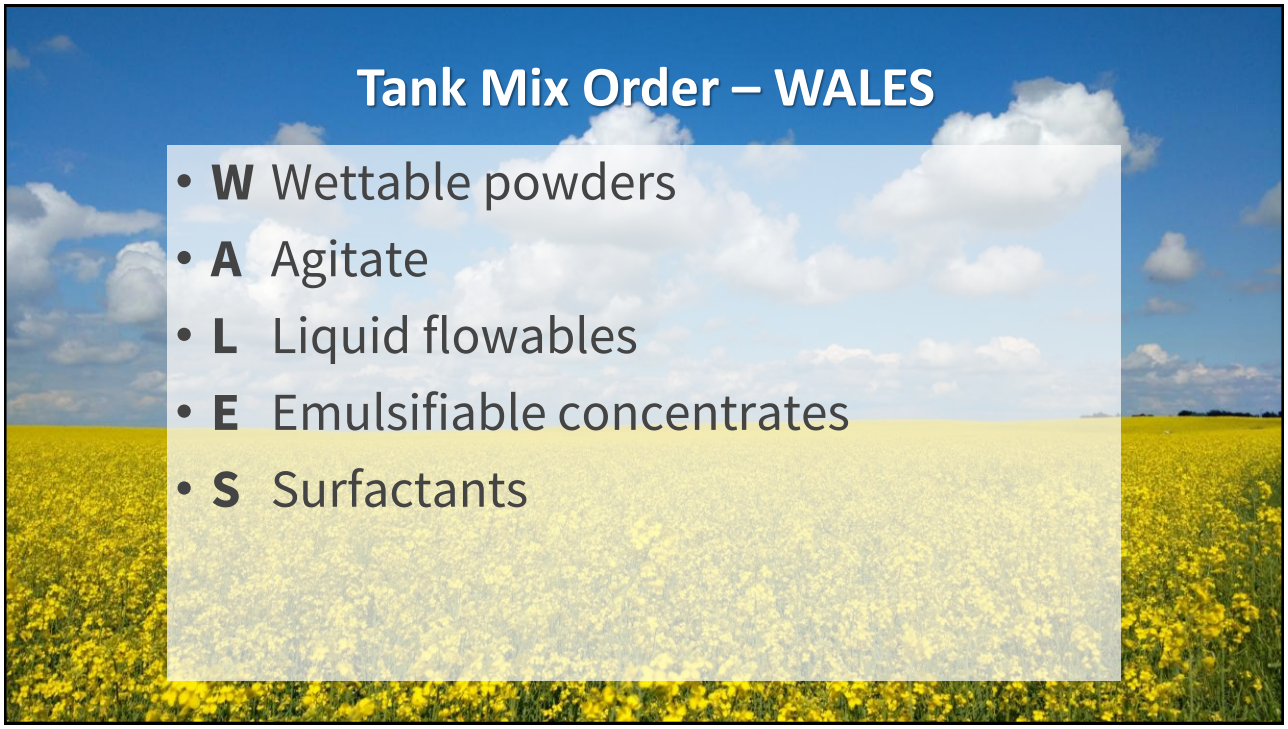
Tank Mix Order – WALES
• W Wettable powders
• A Agitate
• L Liquid flowables
• E Emulsifiable concentrates
• S Surfactants

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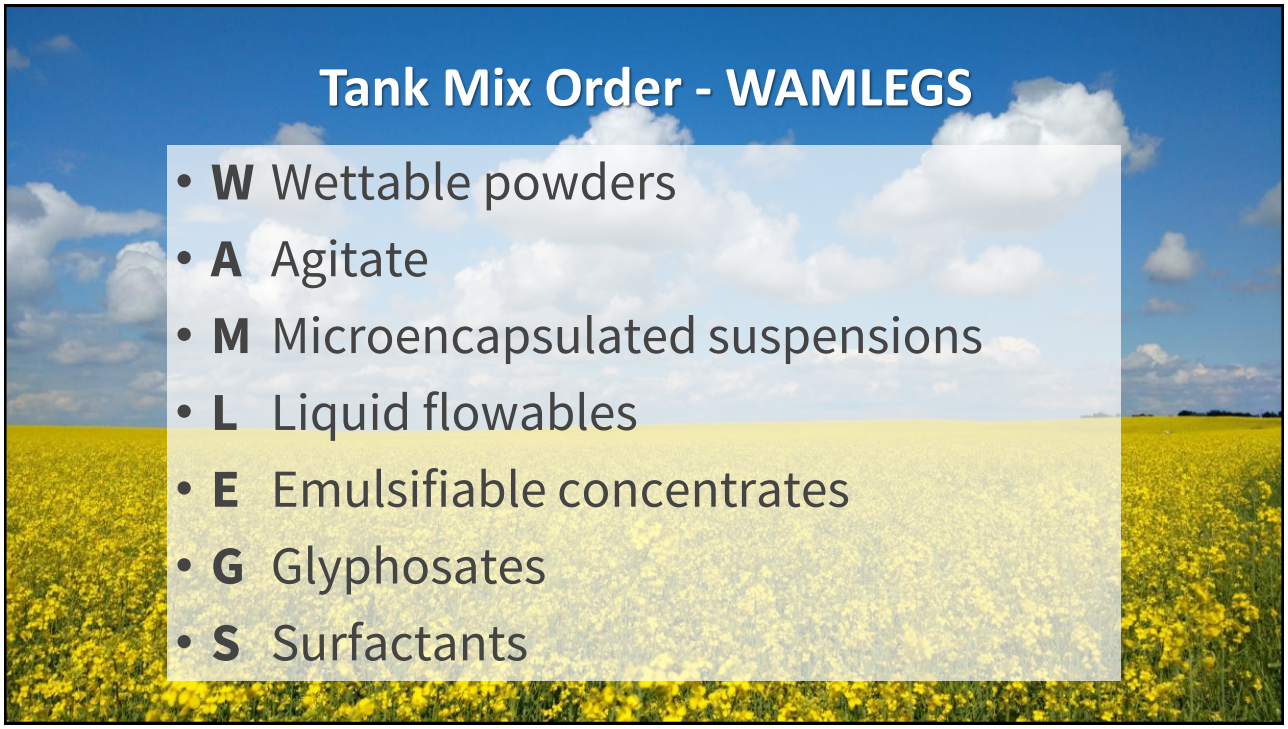
Tank Mix Order - WAMLEGS
• W Wettable powders
• A Agitate
• M Microencapsulated suspensions
• L Liquid flowables
• E Emulsifiable concentrates
• G Glyphosates
• S Surfactants

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Tank Mix Order - APPLES

- **A** Agitate
- **P** Powders soluble
- **P** Powders dry
- **L** Liquid flowables and suspensions
- **E** Emulsifiable concentrates
- **S** Solutions

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Summary

- Get water tested every few years;
- AMS is simple and effective water conditioner for hardness & bicarbonates;
- Avoid pH adjustment unless required by label;
- Follow label for mixing order.

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Adjuvant Definition

"Any substance added to the spray tank to modify biological activity or application characteristics"

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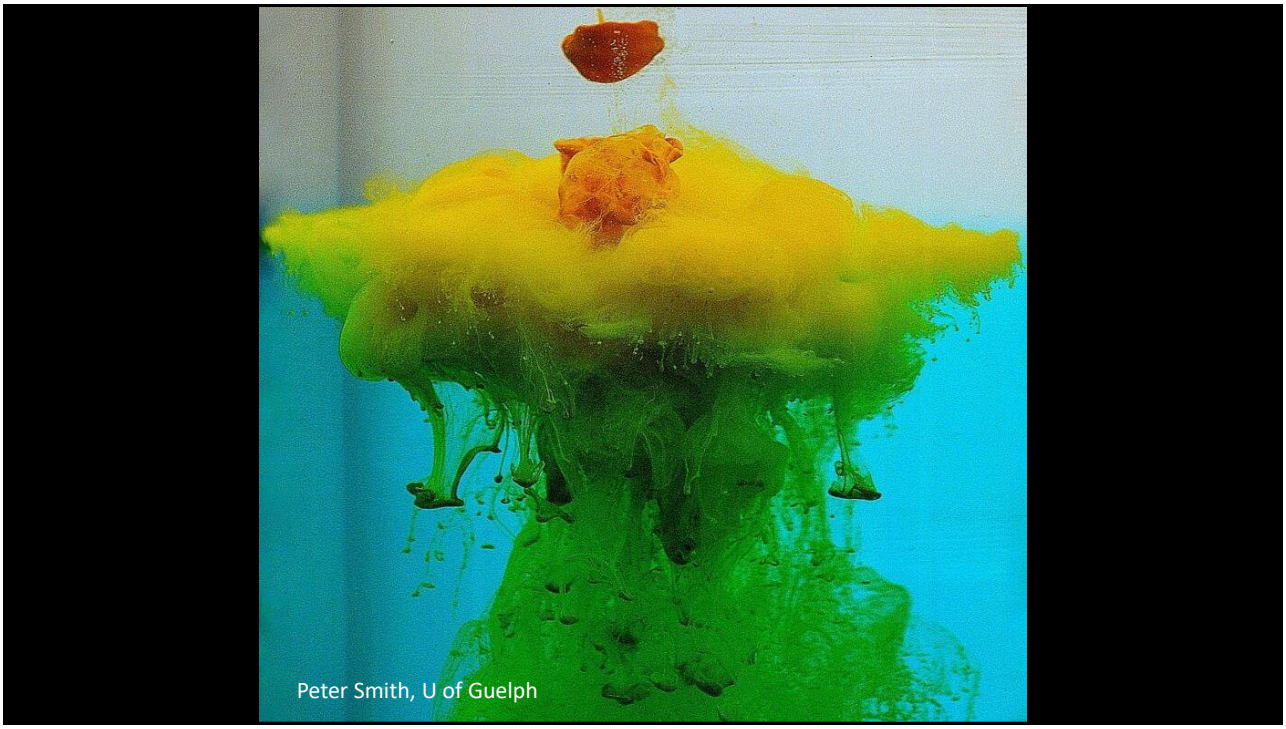

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Low Drift Adjuvants

VALID® LECI-TECH

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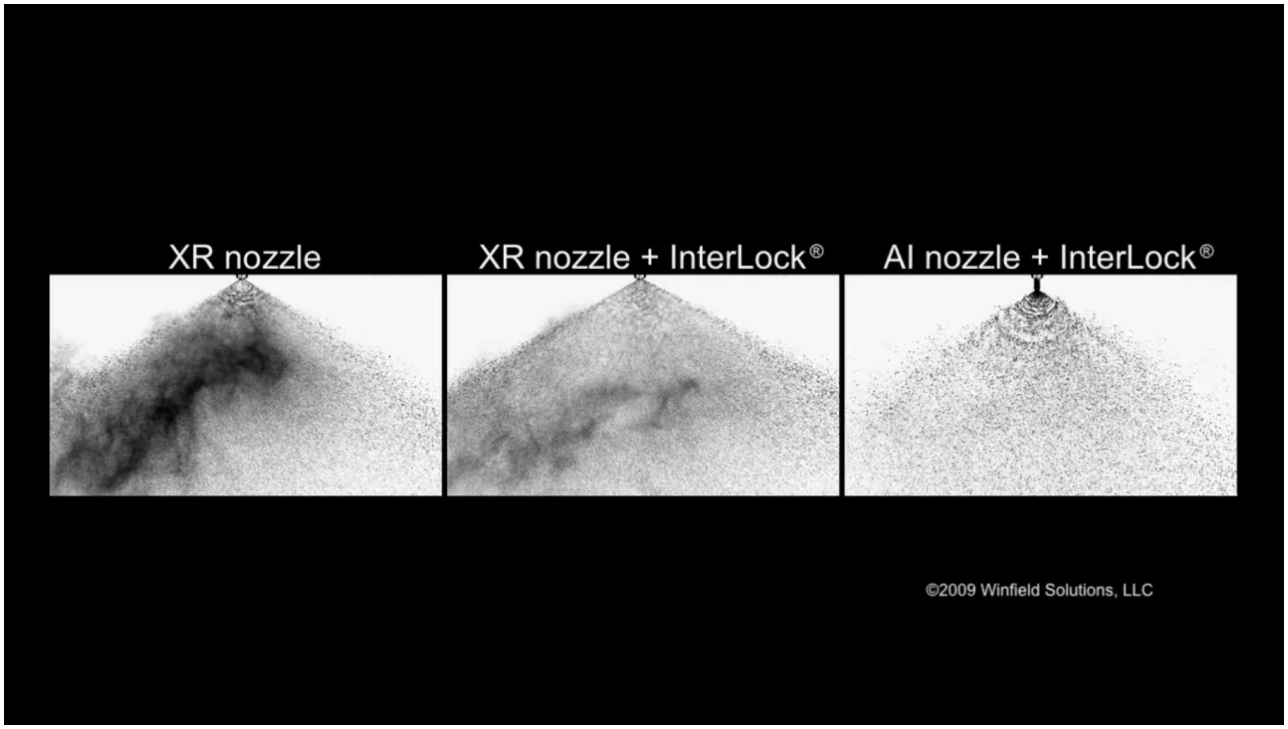

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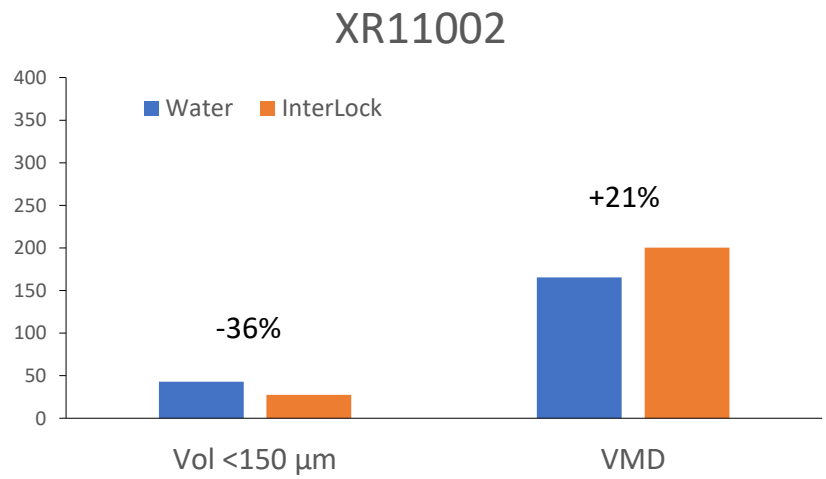
InterLock (Winfield United)



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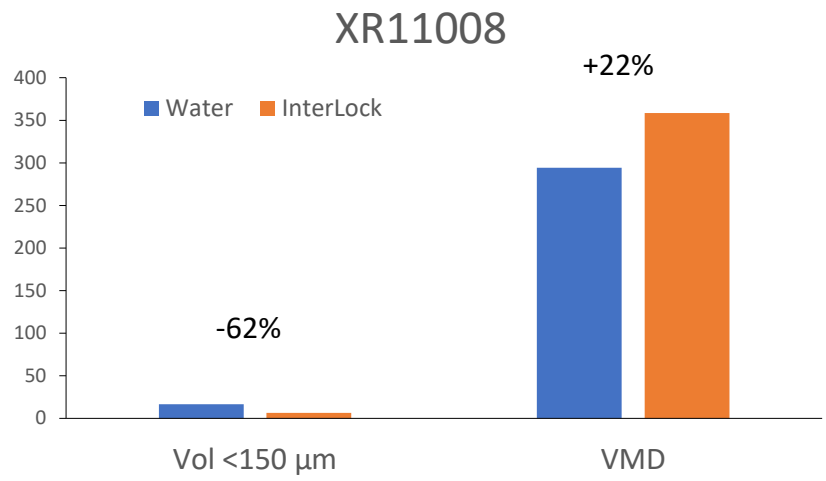

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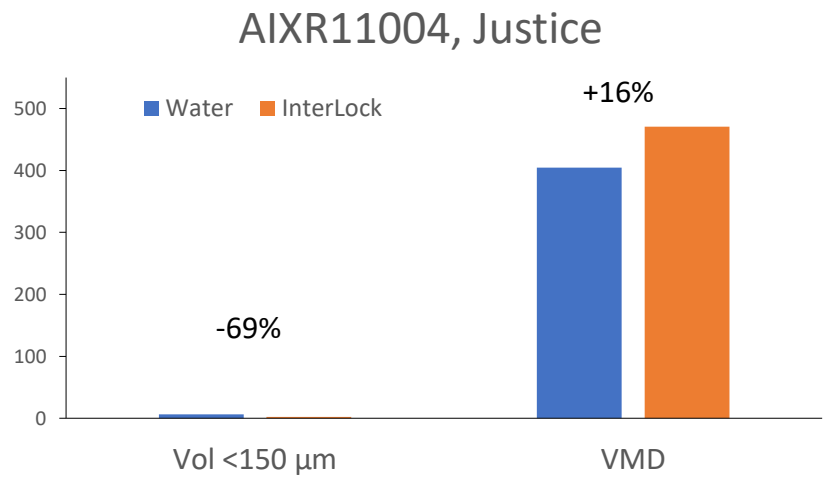

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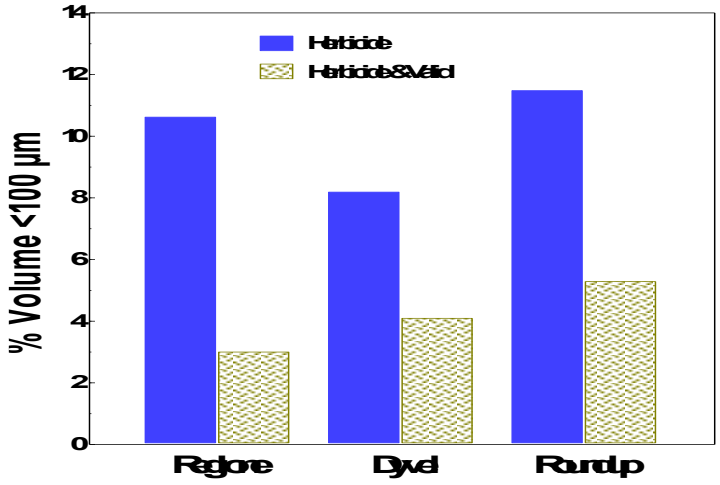
Reduction in Drift Potential



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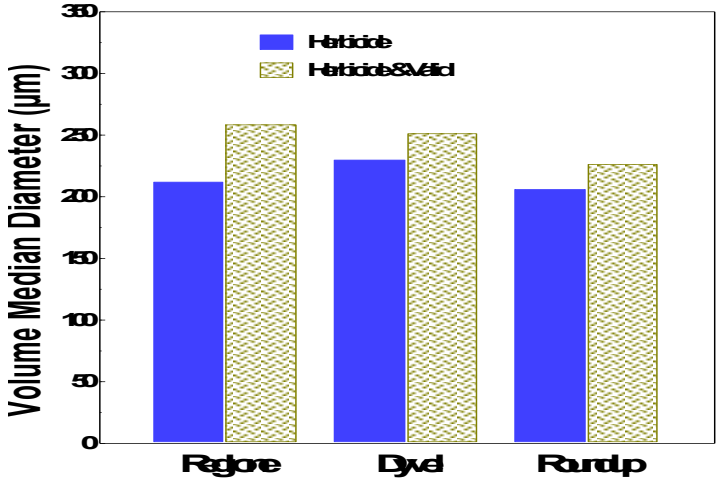
Droplet Size Effects



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Summary

- Low-Drift adjuvants can reduce driftable fines without increasing larger droplets;
- Some low-drift adjuvants also change pH – choose carefully;
- Selecting a good low-drift nozzle will have more effect than adding a low-drift adjuvant.

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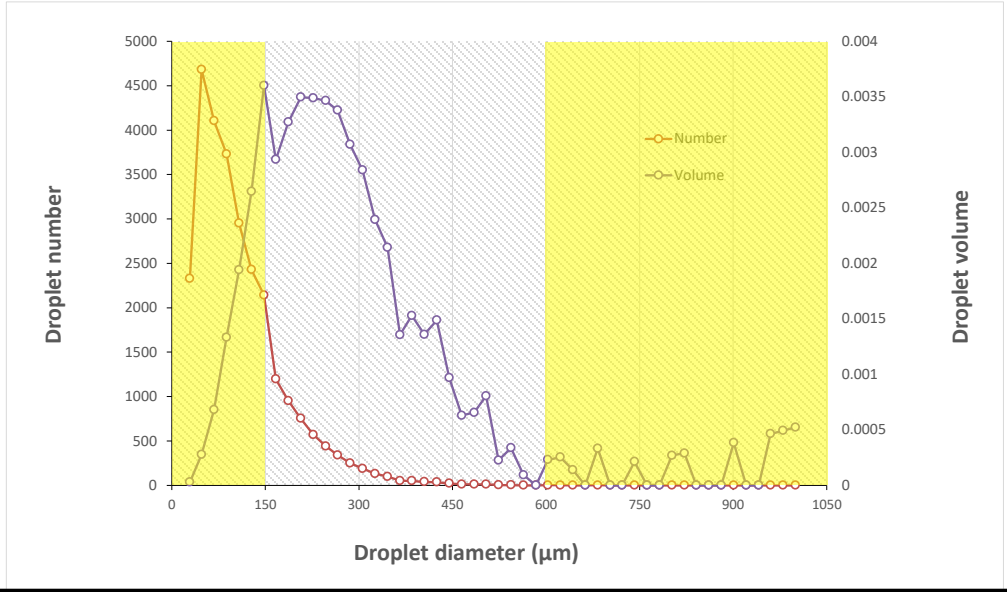
Medium Spray Quality



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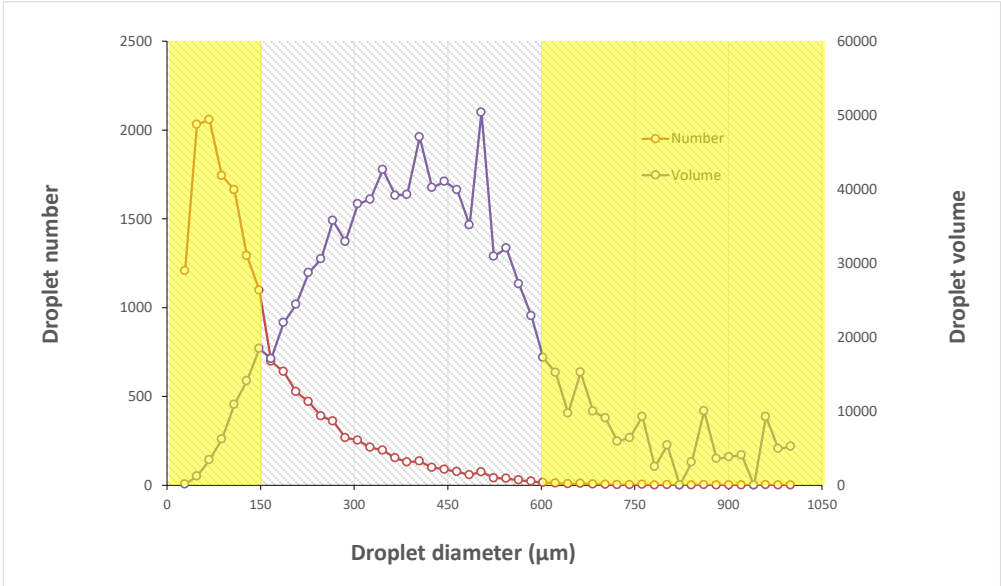
Coarse Spray Quality



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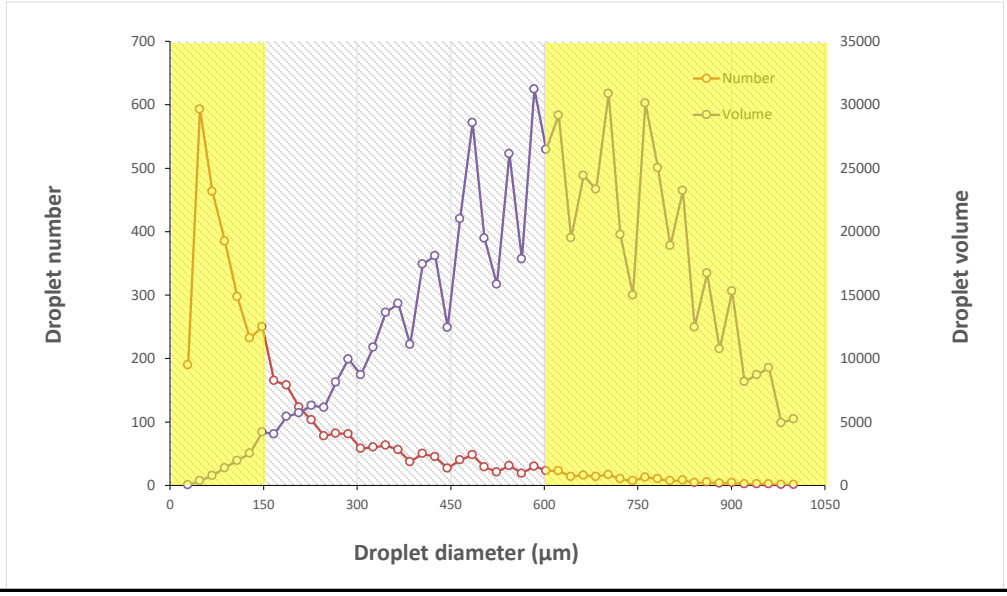
Extremely Coarse Spray Quality



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Choose Coarse or Very Coarse

Spray Quality	<200 µm	>600 µm	200 - 600 µm
Medium	50	3	47
Coarse	17	16	67
Very Coarse	11	25	64
Extremely Coarse	5	39	56

Drift, Evaporation

Rebound

Most likely to Target

70

Spray Quality Categories

Category	Symbol	Color Code	Approximate Dv0.5 (VMD) (microns)
Extremely Fine	XF	Purple	≈50
Very Fine	VF	Red	<136
Fine	F	Orange	136–177
Medium	M	Yellow	177–218
Coarse	C	Blue	218–349
Very Coarse	VC	Green	349–428
Extremely Coarse	XC	White	428–622
Ultra Coarse	UC	Black	>622

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Turbo TeeJet® (TT)

	PSI										
	15	20	25	30	35	40	50	60	70	80	90
TT11001	C	C	M	M	M	M	M	F	F	F	F
TT110015	VC	C	C	M	M	M	M	F	F	F	F
TT11002	VC	VC	C	C	M	M	M	M	M	F	F
TT110025	VC	VC	C	C	M	M	M	M	F	F	F
TT11003	VC	VC	C	C	C	C	C	M	M	M	F
TT11004	XC	VC	VC	C	C	C	M	M	M	M	M
TT11005	XC	VC	VC	VC	C	C	C	M	M	M	M
TT11006	XC	VC	VC	VC	VC	VC	C	C	C	M	M
TT11008	XC	VC	VC	VC	VC	C	C	C	C	M	M

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Nozzle Selection

73

Air Bubble Jet (ABJ)

- **Sizes**
  01 to 06
- **Pressure**
  30 – 70 psi
- **Spray Quality**
  Medium to Coarse

74

Greenleaf AirMix

- **Sizes**
  01 to 06
- **Pressure**
  30 – 90 psi
- **Spray Quality**
  Medium to V. Coarse

75

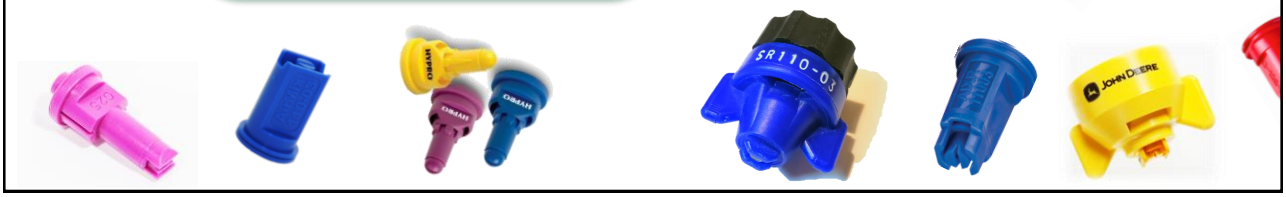
Hypro GuardianAIR (John Deere LDA)

- **Sizes**
  015 to 05 (035)
- **Pressure**
  30 – 90 psi
- **Spray Quality**
  Medium to V. Coarse

76

Lechler IDK

- **Sizes**
  01 to 06
- **Pressure**
  30 – 70 psi
- **Spray Quality**
  Medium to X. Coarse



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TeeJet AIXR

- **Sizes**
  015 to 10
- **Pressure**
  30 – 90 psi
- **Spray Quality**
  Coarse to X. Coarse

78

Wilger ComboJet

- **Sizes**
  01 to 15
- **Pressure**
  30 – 60 psi
- **Spray Quality**
  Fine to U. Coarse

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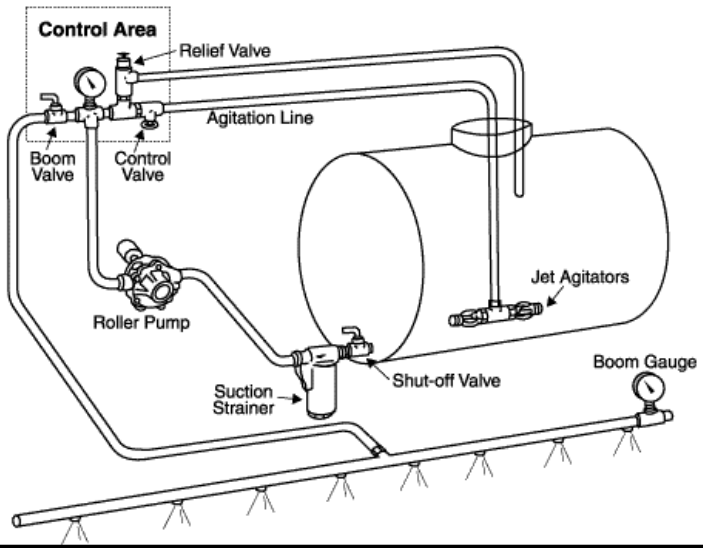
Sprayer Plumbing



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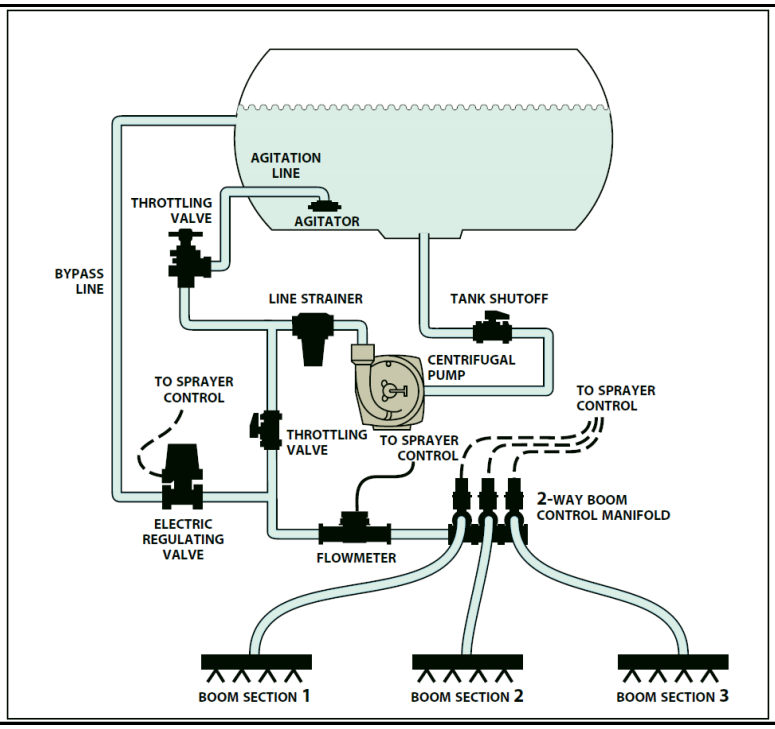

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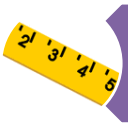
Information Needed for Nozzle Selection



Spacing

Volume

Speed

82

Assume you want to travel 14 mph to apply 10 gpa

What nozzle size should be used?

Sprayers101

83

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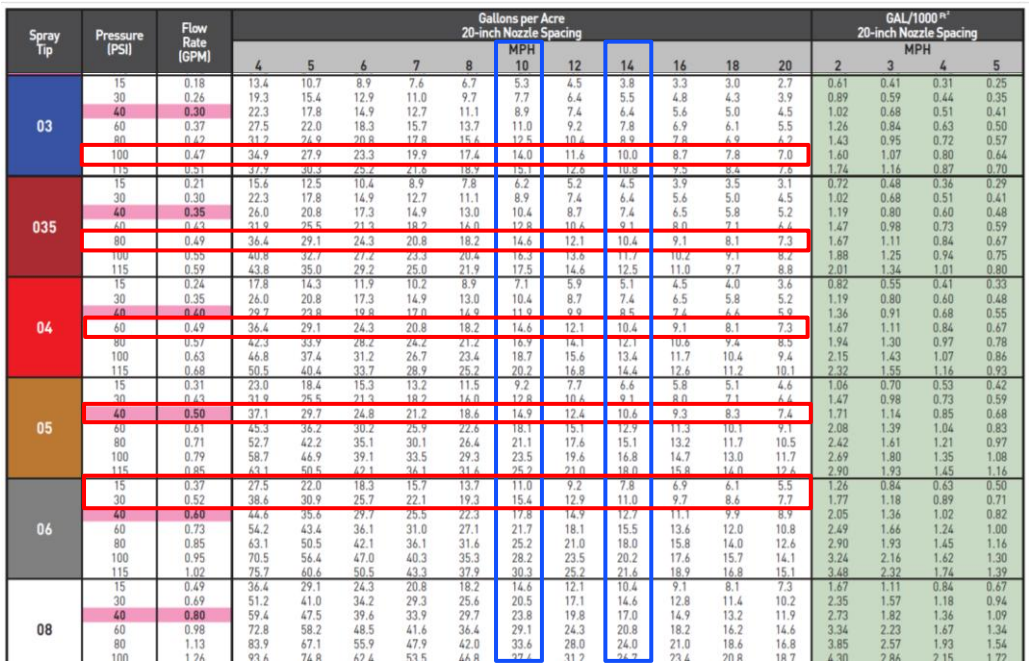

Spray Tip	Pressure (PSI)	Flow Rate (GPM)	Gallons per Acre 20-inch Nozzle Spacing MPH 4	5	6	7	8	10	12	14	16	18	20	GAL/1000 ft² 20-inch Nozzle Spacing MPH 2	3	4	5
03	15	0.18	13.4	10.7	8.9	7.6	6.7	5.3	4.5	3.8	3.3	3.0	2.7	0.61	0.41	0.31	0.25
	30	0.26	19.3	15.4	12.9	11.0	9.7	7.7	6.4	5.5	4.8	4.3	3.9	0.89	0.59	0.44	0.35
	40	0.30	22.3	17.8	14.9	12.7	11.1	8.9	7.4	6.4	5.6	5.0	4.5	1.02	0.68	0.51	0.41
	60	0.37	27.5	22.0	18.3	15.7	13.7	11.0	9.2	7.8	6.9	6.1	5.5	1.26	0.84	0.63	0.50
	80	0.42	31.2	24.9	20.8	17.8	15.6	12.5	10.4	8.9	7.8	6.9	6.2	1.43	0.95	0.72	0.57
	100	0.47	34.9	27.9	23.3	19.9	17.4	14.0	11.6	10.0	8.7	7.8	7.0	1.60	1.07	0.80	0.64
	115	0.51	37.9	30.3	25.2	21.6	18.9	15.1	12.6	10.8	9.5	8.4	7.6	1.74	1.16	0.87	0.70
035	15	0.21	15.6	12.5	10.4	8.9	7.8	6.2	5.2	4.5	3.9	3.5	3.1	0.72	0.48	0.36	0.29
	30	0.30	22.3	17.8	14.9	12.7	11.1	8.9	7.4	6.4	5.6	5.0	4.5	1.02	0.68	0.51	0.41
	40	0.35	26.0	20.8	17.3	14.9	13.0	10.4	8.7	7.4	6.5	5.8	5.2	1.19	0.80	0.60	0.48
	60	0.43	31.9	25.5	21.3	18.2	16.0	12.8	10.6	9.1	8.0	7.1	6.4	1.47	0.98	0.73	0.59
	80	0.49	36.4	29.1	24.3	20.8	18.2	14.6	12.1	10.4	9.1	8.1	7.3	1.67	1.11	0.84	0.67
	100	0.55	40.8	32.7	27.2	23.3	20.4	16.3	13.6	11.7	10.2	9.1	8.2	1.88	1.25	0.94	0.75
	115	0.59	43.8	35.0	29.2	25.0	21.9	17.5	14.6	12.5	11.0	9.7	8.8	2.01	1.34	1.01	0.80
04	15	0.24	17.8	14.3	11.9	10.2	8.9	7.1	5.9	5.1	4.5	4.0	3.6	0.82	0.55	0.41	0.33
	30	0.35	26.0	20.8	17.3	14.9	13.0	10.4	8.7	7.4	6.5	5.8	5.2	1.19	0.80	0.60	0.48
	40	0.40	29.7	23.8	19.8	17.0	14.9	11.9	9.9	8.5	7.4	6.6	5.9	1.36	0.91	0.68	0.55
	60	0.49	36.4	29.1	24.3	20.8	18.2	14.6	12.1	10.4	9.1	8.1	7.3	1.67	1.11	0.84	0.67
	80	0.57	42.3	33.9	28.2	24.2	21.2	16.9	14.1	12.1	10.6	9.4	8.5	1.94	1.30	0.97	0.78
	100	0.63	46.8	37.4	31.2	26.7	23.4	18.7	15.6	13.4	11.7	10.4	9.4	2.15	1.43	1.07	0.86
	115	0.68	50.5	40.4	33.7	28.9	25.2	20.2	16.8	14.4	12.6	11.2	10.1	2.32	1.55	1.16	0.93
05	15	0.31	23.0	18.4	15.3	13.2	11.5	9.2	7.7	6.6	5.8	5.1	4.6	1.06	0.70	0.53	0.42
	30	0.43	31.9	25.5	21.3	18.2	16.0	12.8	10.6	9.1	8.0	7.1	6.4	1.47	0.98	0.73	0.59
	40	0.50	37.1	29.7	24.8	21.2	18.6	14.9	12.4	10.6	9.3	8.3	7.4	1.71	1.14	0.85	0.68
	60	0.61	45.3	36.2	30.2	25.9	22.6	18.1	15.1	12.9	11.3	10.1	9.1	2.08	1.39	1.04	0.83
	80	0.71	52.7	42.2	35.1	30.1	26.4	21.1	17.6	15.1	13.2	11.7	10.5	2.42	1.61	1.21	0.97
	100	0.79	58.7	46.9	39.1	33.5	29.3	23.5	19.6	16.8	14.7	13.0	11.7	2.69	1.80	1.35	1.08
	115	0.85	63.1	50.5	42.1	36.1	31.6	25.2	21.0	18.0	15.8	14.0	12.6	2.90	1.93	1.45	1.16
06	15	0.37	27.5	22.0	18.3	15.7	13.7	11.0	9.2	7.8	6.9	6.1	5.5	1.26	0.84	0.63	0.50
	30	0.52	38.6	30.9	25.7	22.1	19.3	15.4	12.9	11.0	9.7	8.6	7.7	1.77	1.18	0.89	0.71
	40	0.60	44.6	35.6	29.7	25.5	22.3	17.8	14.9	12.7	11.1	9.9	8.9	2.05	1.36	1.02	0.82
	60	0.73	54.2	43.4	36.1	31.0	27.1	21.7	18.1	15.5	13.6	12.0	10.8	2.49	1.66	1.24	1.00
	80	0.85	63.1	50.5	42.1	36.1	31.6	25.2	21.0	18.0	15.8	14.0	12.6	2.90	1.93	1.45	1.16
	100	0.95	70.5	56.4	47.0	40.3	35.3	28.2	23.5	20.2	17.6	15.7	14.1	3.24	2.16	1.62	1.30
	115	1.02	75.7	60.6	50.5	43.3	37.9	30.3	25.2	21.6	18.9	16.8	15.1	3.48	2.32	1.74	1.39
08	15	0.49	36.4	29.1	24.3	20.8	18.2	14.6	12.1	10.4	9.1	8.1	7.3	1.67	1.11	0.84	0.67
	30	0.69	51.2	41.0	34.2	29.3	25.6	20.5	17.1	14.6	12.8	11.4	10.2	2.35	1.57	1.18	0.94
	40	0.80	59.4	47.5	39.6	33.9	29.7	23.8	19.8	17.0	14.9	13.2	11.9	2.73	1.82	1.36	1.09
	60	0.98	72.8	58.2	48.5	41.6	36.4	29.1	24.3	20.8	18.2	16.2	14.6	3.34	2.23	1.67	1.34
	80	1.13	83.9	67.1	55.9	47.9	42.0	33.6	28.0	24.0	21.0	18.6	16.8	3.85	2.57	1.93	1.54
	100	1.26	93.6	74.8	62.4	53.5	44.8	37.4	31.2	26.7	23.4	20.8	18.7	4.30	2.86	2.15	1.72

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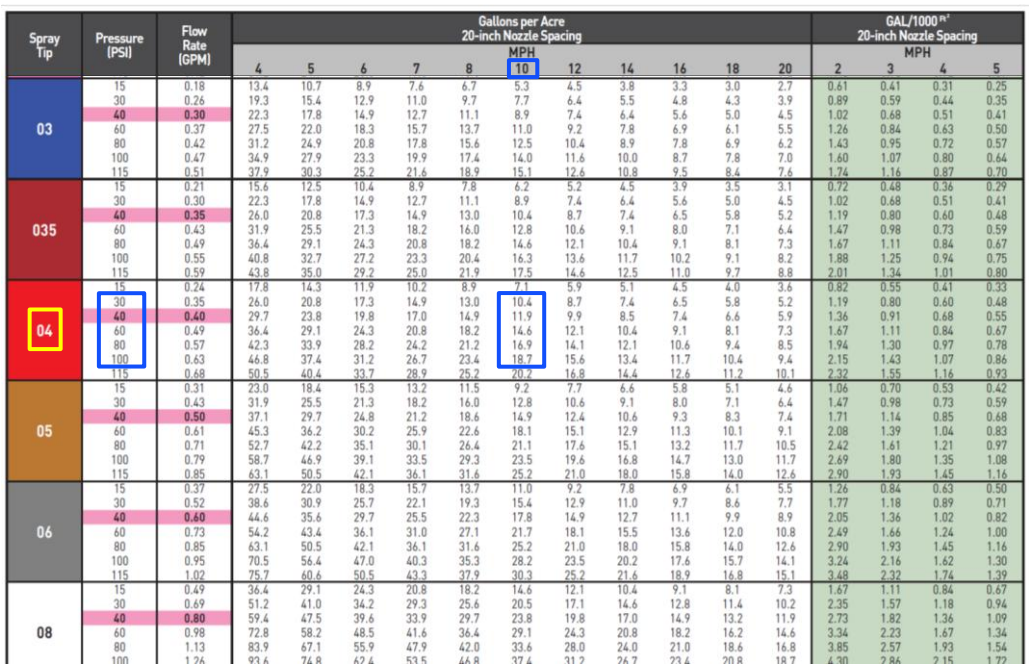

Spray Tip	Pressure (PSI)	Flow Rate (GPM)	Gallons per Acre 20-inch Nozzle Spacing MPH 4	5	6	7	8	10	12	14	16	18	20	GAL/1000 ft² 20-inch Nozzle Spacing MPH 2	3	4	5
03	15	0.18	13.4	10.7	8.9	7.6	6.7	5.3	4.5	3.8	3.3	3.0	2.7	0.61	0.41	0.31	0.25
	30	0.26	19.3	15.4	12.9	11.0	9.7	7.7	6.4	5.5	4.8	4.3	3.9	0.89	0.59	0.44	0.35
	40	0.30	22.3	17.8	14.9	12.7	11.1	8.9	7.4	6.4	5.6	5.0	4.5	1.02	0.68	0.51	0.41
	60	0.37	27.5	22.0	18.3	15.7	13.7	11.0	9.2	7.8	6.9	6.1	5.5	1.26	0.84	0.63	0.50
	80	0.42	31.2	24.9	20.8	17.8	15.6	12.5	10.4	8.9	7.8	6.9	6.2	1.43	0.95	0.72	0.57
	100	0.47	34.9	27.9	23.3	19.9	17.4	14.0	11.6	10.0	8.7	7.8	7.0	1.60	1.07	0.80	0.64
	115	0.51	37.9	30.3	25.2	21.6	18.9	15.1	12.6	10.8	9.5	8.4	7.6	1.74	1.16	0.87	0.70
035	15	0.21	15.6	12.5	10.4	8.9	7.8	6.2	5.2	4.5	3.9	3.5	3.1	0.72	0.48	0.36	0.29
	30	0.30	22.3	17.8	14.9	12.7	11.1	8.9	7.4	6.4	5.6	5.0	4.5	1.02	0.68	0.51	0.41
	40	0.35	26.0	20.8	17.3	14.9	13.0	10.4	8.7	7.4	6.5	5.8	5.2	1.19	0.80	0.60	0.48
	60	0.43	31.9	25.5	21.3	18.2	16.0	12.8	10.6	9.1	8.0	7.1	6.4	1.47	0.98	0.73	0.59
	80	0.49	36.4	29.1	24.3	20.8	18.2	14.6	12.1	10.4	9.1	8.1	7.3	1.67	1.11	0.84	0.67
	100	0.55	40.8	32.7	27.2	23.3	20.4	16.3	13.6	11.7	10.2	9.1	8.2	1.88	1.25	0.94	0.75
	115	0.59	43.8	35.0	29.2	25.0	21.9	17.5	14.6	12.5	11.0	9.7	8.8	2.01	1.34	1.01	0.80
04	15	0.24	17.8	14.3	11.9	10.2	8.9	7.1	5.9	5.1	4.5	4.0	3.6	0.82	0.55	0.41	0.33
	30	0.35	26.0	20.8	17.3	14.9	13.0	10.4	8.7	7.4	6.5	5.8	5.2	1.19	0.80	0.60	0.48
	40	0.40	29.7	23.8	19.8	17.0	14.9	11.9	9.9	8.5	7.4	6.6	5.9	1.36	0.91	0.68	0.55
	60	0.49	36.4	29.1	24.3	20.8	18.2	14.6	12.1	10.4	9.1	8.1	7.3	1.67	1.11	0.84	0.67
	80	0.57	42.3	33.9	28.2	24.2	21.2	16.9	14.1	12.1	10.6	9.4	8.5	1.94	1.30	0.97	0.78
	100	0.63	46.8	37.4	31.2	26.7	23.4	18.7	15.6	13.4	11.7	10.4	9.4	2.15	1.43	1.07	0.86
	115	0.68	50.5	40.4	33.7	28.9	25.2	20.2	16.8	14.4	12.6	11.2	10.1	2.32	1.55	1.16	0.93
05	15	0.31	23.0	18.4	15.3	13.2	11.5	9.2	7.7	6.6	5.8	5.1	4.6	1.06	0.70	0.53	0.42
	30	0.43	31.9	25.5	21.3	18.2	16.0	12.8	10.6	9.1	8.0	7.1	6.4	1.47	0.98	0.73	0.59
	40	0.50	37.1	29.7	24.8	21.2	18.6	14.9	12.4	10.6	9.3	8.3	7.4	1.71	1.14	0.85	0.68
	60	0.61	45.3	36.2	30.2	25.9	22.6	18.1	15.1	12.9	11.3	10.1	9.1	2.08	1.39	1.04	0.83
	80	0.71	52.7	42.2	35.1	30.1	26.4	21.1	17.6	15.1	13.2	11.7	10.5	2.42	1.61	1.21	0.97
	100	0.79	58.7	46.9	39.1	33.5	29.3	23.5	19.6	16.8	14.7	13.0	11.7	2.69	1.80	1.35	1.08
	115	0.85	63.1	50.5	42.1	36.1	31.6	25.2	21.0	18.0	15.8	14.0	12.6	2.90	1.93	1.45	1.16
06	15	0.37	27.5	22.0	18.3	15.7	13.7	11.0	9.2	7.8	6.9	6.1	5.5	1.26	0.84	0.63	0.50
	30	0.52	38.6	30.9	25.7	22.1	19.3	15.4	12.9	11.0	9.7	8.6	7.7	1.77	1.18	0.89	0.71
	40	0.60	44.6	35.6	29.7	25.5	22.3	17.8	14.9	12.7	11.1	9.9	8.9	2.05	1.36	1.02	0.82
	60	0.73	54.2	43.4	36.1	31.0	27.1	21.7	18.1	15.5	13.6	12.0	10.8	2.49	1.66	1.24	1.00
	80	0.85	63.1	50.5	42.1	36.1	31.6	25.2	21.0	18.0	15.8	14.0	12.6	2.90	1.93	1.45	1.16
	100	0.95	70.5	56.4	47.0	40.3	35.3	28.2	23.5	20.2	17.6	15.7	14.1	3.24	2.16	1.62	1.30
	115	1.02	75.7	60.6	50.5	43.3	37.9	30.3	25.2	21.6	18.9	16.8	15.1	3.48	2.32	1.74	1.39
08	15	0.49	36.4	29.1	24.3	20.8	18.2	14.6	12.1	10.4	9.1	8.1	7.3	1.67	1.11	0.84	0.67
	30	0.69	51.2	41.0	34.2	29.3	25.6	20.5	17.1	14.6	12.8	11.4	10.2	2.35	1.57	1.18	0.94
	40	0.80	59.4	47.5	39.6	33.9	29.7	23.8	19.8	17.0	14.9	13.2	11.9	2.73	1.82	1.36	1.09
	60	0.98	72.8	58.2	48.5	41.6	36.4	29.1	24.3	20.8	18.2	16.2	14.6	3.34	2.23	1.67	1.34
	80	1.13	83.9	67.1	55.9	47.9	42.0	33.6	28.0	24.0	21.0	18.6	16.8	3.85	2.57	1.93	1.54
	100	1.26	93.6	74.8	62.4	53.5	44.8	37.4	31.2	26.7	23.4	20.8	18.7	4.30	2.86	2.15	1.72

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Nozzle size	Pressure psi	Flow rate US gal/min	Numbers in Table Body are mph (20" nozzle spacing)											
			3 gpa	4 gpa	5 gpa	6 gpa	7 gpa	8 gpa	9 gpa	10 gpa	12 gpa	14 gpa	16 gpa	18 gpa	20 gpa
03 Blue	30	0.26	25.7	19.3	15.4	12.9	11.0	9.6	8.6	7.7	6.4	5.5	4.8	4.3	3.9
	40	0.30	29.7	22.3	17.8	14.9	12.7	11.1	9.9	8.9	7.4	6.4	5.6	5.0	4.5
	50	0.34	33.2	24.9	19.9	16.6	14.2	12.5	11.1	10.0	8.3	7.1	6.2	5.5	5.0
	60	0.37	36.4	27.3	21.8	18.2	15.6	13.6	12.1	10.9	9.1	7.8	6.8	6.1	5.5
	70	0.40	39.3	29.5	23.6	19.6	16.8	14.7	13.1	11.8	9.8	8.4	7.4	6.5	5.9
	80	0.42	42.0	31.5	25.2	21.0	18.0	15.8	14.0	12.6	10.5	9.0	7.9	7.0	6.3
	90	0.45	44.6	33.4	26.7	22.3	19.1	16.7	14.9	13.4	11.1	9.5	8.4	7.4	6.7
	100	0.47	47.0	35.2	28.2	23.5	20.1	17.6	15.7	14.1	11.7	10.1	8.8	7.8	7.0
035 Brown Red Hypro GA, GAT Only	30	0.30	30.0	22.5	18.0	15.0	12.9	11.3	10.0	9.0	7.5	6.4	5.6	5.0	4.5
	40	0.35	34.7	26.0	20.8	17.3	14.9	13.0	11.6	10.4	8.7	7.4	6.5	5.8	5.2
	50	0.39	38.7	29.1	23.2	19.4	16.6	14.5	12.9	11.6	9.7	8.3	7.3	6.5	5.8
	60	0.43	42.4	31.8	25.5	21.2	18.2	15.9	14.1	12.7	10.6	9.1	8.0	7.1	6.4
	70	0.46	45.8	34.4	27.5	22.9	19.6	17.2	15.3	13.8	11.5	9.8	8.6	7.6	6.9
	80	0.49	49.0	36.8	29.4	24.5	21.0	18.4	16.3	14.7	12.3	10.5	9.2	8.2	7.4
	90	0.53	52.0	39.0	31.2	26.0	22.3	19.5	17.3	15.6	13.0	11.1	9.7	8.7	7.8
	100	0.55	54.8	41.1	32.9	27.4	23.5	20.5	18.3	16.4	13.7	11.7	10.3	9.1	8.2
04 Red	30	0.35	34.3	25.7	20.6	17.1	14.7	12.9	11.4	10.3	8.6	7.3	6.4	5.7	5.1
	40	0.40	39.6	29.7	23.8	19.8	17.0	14.9	13.2	11.9	9.9	8.5	7.4	6.6	5.9
	50	0.45	44.3	33.2	26.6	22.1	19.0	16.6	14.8	13.3	11.1	9.5	8.3	7.4	6.6
	60	0.49	48.5	36.4	29.1	24.2	20.8	18.2	16.2	14.5	12.1	10.4	9.1	8.1	7.3
	70	0.53	52.4	39.3	31.4	26.2	22.5	19.6	17.5	15.7	13.1	11.2	9.8	8.7	7.9
	80	0.57	56.0	42.0	33.6	28.0	24.0	21.0	18.7	16.8	14.0	12.0	10.5	9.3	8.4
	90	0.60	59.4	44.6	35.6	29.7	25.5	22.3	19.8	17.8	14.9	12.7	11.1	9.9	8.9
	100	0.63	62.6	47.0	37.6	31.3	26.8	23.5	20.9	18.8	15.7	13.4	11.7	10.4	9.4
05 Brown	30	0.43	42.9	32.2	25.7	21.4	18.4	16.1	14.3	12.9	10.7	9.2	8.0	7.1	6.4
	40	0.50	49.5	37.1	29.7	24.8	21.2	18.6	16.5	14.9	12.4	10.6	9.3	8.3	7.4
	50	0.56	55.3	41.5	33.2	27.7	23.7	20.8	18.4	16.6	13.8	11.9	10.4	9.2	8.3
	60	0.61	60.6	45.5	36.4	30.3	26.0	22.7	20.2	18.2	15.2	13.0	11.4	10.1	9.1
	70	0.66	65.5	49.1	39.3	32.7	28.1	24.6	21.8	19.6	16.4	14.0	12.3	10.9	9.8
	80	0.71	70.0	52.5	42.0	35.0	30.0	26.3	23.3	21.0	17.5	15.0	13.1	11.7	10.5
	90	0.75	74.3	55.7	44.6	37.1	31.8	27.8	24.8	22.3	18.6	15.9	13.9	12.4	11.1
	100	0.79	78.3	58.7	47.0	39.1	33.5	29.3	26.1	23.5	19.6	16.8	14.7	13.0	11.7
06	30	0.52	51.4	38.6	30.9	25.7	22.0	19.3	17.1	15.4	12.9	11.0	9.6	8.6	7.7
	40	0.60	59.4	44.6	35.6	29.7	25.5	22.3	19.8	17.8	14.9	12.7	11.1	9.9	8.9

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Assume 11005 nozzle applied 10 gpa at 13 mph

What pressure was used?

Sprayers101

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Nozzle size	Pressure psi	Flow rate US gal/min	Numbers in Table Body are mph (20" nozzle spacing)												
			3 gpa	4 gpa	5 gpa	6 gpa	7 gpa	8 gpa	9 gpa	10 gpa	12 gpa	14 gpa	16 gpa	18 gpa	20 gpa
03 Blue	30	0.26	25.7	19.3	15.4	12.9	11.0	9.6	8.6	7.7	6.4	5.5	4.8	4.3	3.9
	40	0.30	29.7	22.3	17.8	14.9	12.7	11.1	9.9	8.9	7.4	6.4	5.6	5.0	4.5
	50	0.34	33.2	24.9	19.9	16.6	14.2	12.5	11.1	10.0	8.3	7.1	6.2	5.5	5.0
	60	0.37	36.4	27.3	21.8	18.2	15.6	13.6	12.1	10.9	9.1	7.8	6.8	6.1	5.5
	70	0.40	39.3	29.5	23.6	19.6	16.8	14.7	13.1	11.8	9.8	8.4	7.4	6.5	5.9
	80	0.42	42.0	31.5	25.2	21.0	18.0	15.8	14.0	12.6	10.5	9.0	7.9	7.0	6.3
	90	0.45	44.6	33.4	26.7	22.3	19.1	16.7	14.9	13.4	11.1	9.5	8.4	7.4	6.7
	100	0.47	47.0	35.2	28.2	23.5	20.1	17.6	15.7	14.1	11.7	10.1	8.8	7.8	7.0
035 Brown Red Hypro GA, GAT Only	30	0.30	30.0	22.5	18.0	15.0	12.9	11.3	10.0	9.0	7.5	6.4	5.6	5.0	4.5
	40	0.35	34.7	26.0	20.8	17.3	14.9	13.0	11.6	10.4	8.7	7.4	6.5	5.8	5.2
	50	0.39	38.7	29.1	23.2	19.4	16.6	14.5	12.9	11.6	9.7	8.3	7.3	6.5	5.8
	60	0.43	42.4	31.8	25.5	21.2	18.2	15.9	14.1	12.7	10.6	9.1	8.0	7.1	6.4
	70	0.46	45.8	34.4	27.5	22.9	19.6	17.2	15.3	13.8	11.5	9.8	8.6	7.6	6.9
	80	0.49	49.0	36.8	29.4	24.5	21.0	18.4	16.3	14.7	12.3	10.5	9.2	8.2	7.4
	90	0.53	52.0	39.0	31.2	26.0	22.3	19.5	17.3	15.6	13.0	11.1	9.7	8.7	7.8
	100	0.55	54.8	41.1	32.9	27.4	23.5	20.5	18.3	16.4	13.7	11.7	10.3	9.1	8.2
04 Red	30	0.35	34.3	25.7	20.6	17.1	14.7	12.9	11.4	10.3	8.6	7.3	6.4	5.7	5.1
	40	0.40	39.6	29.7	23.8	19.8	17.0	14.9	13.2	11.9	9.9	8.5	7.4	6.6	5.9
	50	0.45	44.3	33.2	26.6	22.1	19.0	16.6	14.8	13.3	11.1	9.5	8.3	7.4	6.6
	60	0.49	48.5	36.4	29.1	24.2	20.8	18.2	16.2	14.5	12.1	10.4	9.1	8.1	7.3
	70	0.53	52.4	39.3	31.4	26.2	22.5	19.6	17.5	15.7	13.1	11.2	9.8	8.7	7.9
	80	0.57	56.0	42.0	33.6	28.0	24.0	21.0	18.7	16.8	14.0	12.0	10.5	9.3	8.4
	90	0.60	59.4	44.6	35.6	29.7	25.5	22.3	19.8	17.8	14.9	12.7	11.1	9.9	8.9
	100	0.63	62.6	47.0	37.6	31.3	26.8	23.5	20.9	18.8	15.7	13.4	11.7	10.4	9.4
05 Brown	30	0.43	42.9	32.2	25.7	21.4	18.4	16.1	14.3	12.9	10.7	9.2	8.0	7.1	6.4
	40	0.50	49.5	37.1	29.7	24.8	21.2	18.6	16.5	14.9	12.4	10.6	9.3	8.3	7.4
	50	0.56	55.3	41.5	33.2	27.7	23.7	20.8	18.4	16.6	13.8	11.9	10.4	9.2	8.3
	60	0.61	60.6	45.5	36.4	30.3	26.0	22.7	20.2	18.2	15.2	13.0	11.4	10.1	9.1
	70	0.66	65.5	49.1	39.3	32.7	28.1	24.6	21.8	19.6	16.4	14.0	12.3	10.9	9.8
	80	0.71	70.0	52.5	42.0	35.0	30.0	26.3	23.3	21.0	17.5	15.0	13.1	11.7	10.5
	90	0.75	74.3	55.7	44.6	37.1	31.8	27.8	24.8	22.3	18.6	15.9	13.9	12.4	11.1
	100	0.79	78.3	58.7	47.0	39.1	33.5	29.3	26.1	23.5	19.6	16.8	14.7	13.0	11.7
06	30	0.52	51.4	38.6	30.9	25.7	22.0	19.3	17.1	15.4	12.9	11.0	9.6	8.6	7.7
	40	0.60	59.4	44.6	35.6	29.7	25.5	22.3	19.8	17.8	14.9	12.7	11.1	9.9	8.9
	50	0.67	66.4	49.8	39.8	33.2	28.5	24.9	22.1	19.9	16.6	14.2	12.5	11.1	10.0

89

Pressure Gauge is Speedometer

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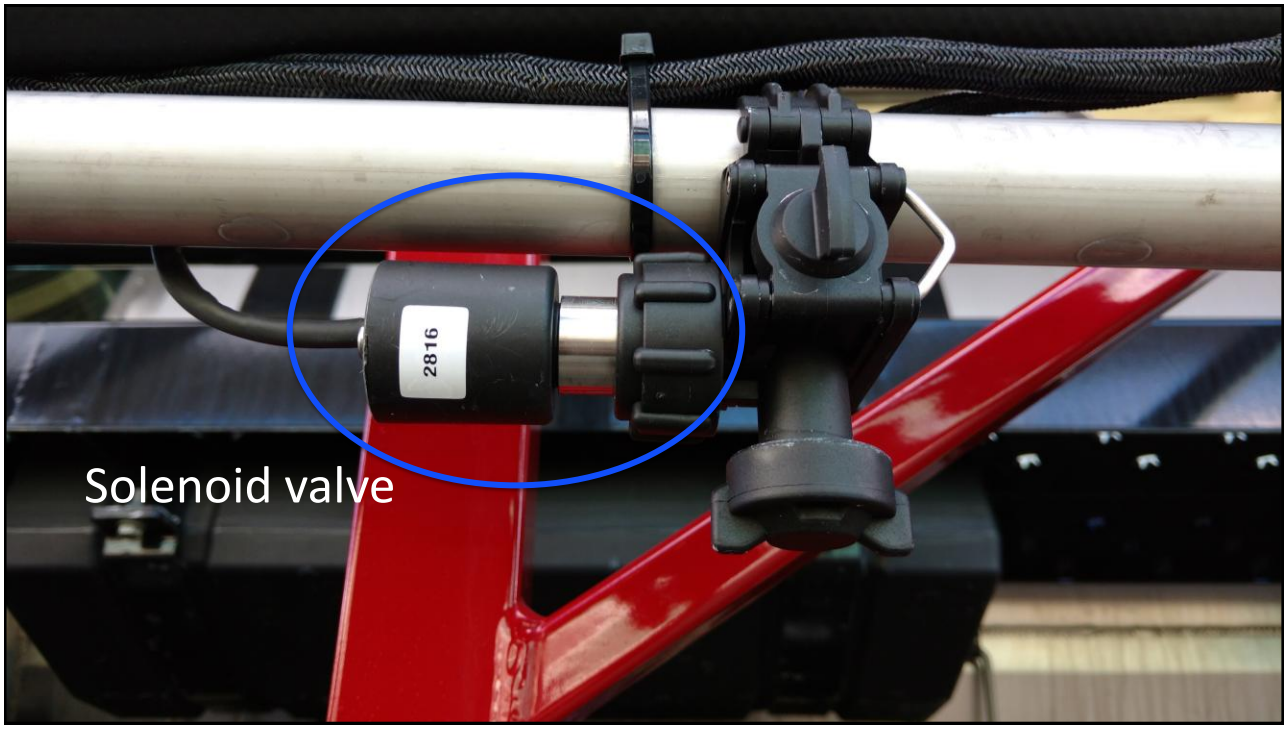
91

92



93

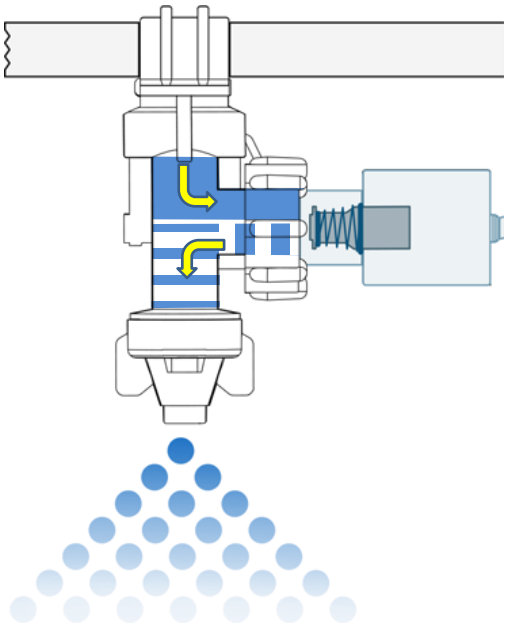
94

PWM Terms

Frequency:
- The number of open/close cycles per second
- Most systems run at 15 Hz
- Some can vary the frequency with travel speed (PWFM)

Duty Cycle:
- The proportion of time that the valve is open
- 100% is wide open
- Lowest is between 10 and 20%

Pressure Drop:
- PWM valves have flow restrictions
- Can drop nozzle pressures by up to 20 psi at high flow rates



Source: Capstanag.com

95

PWM Terms

Frequency:
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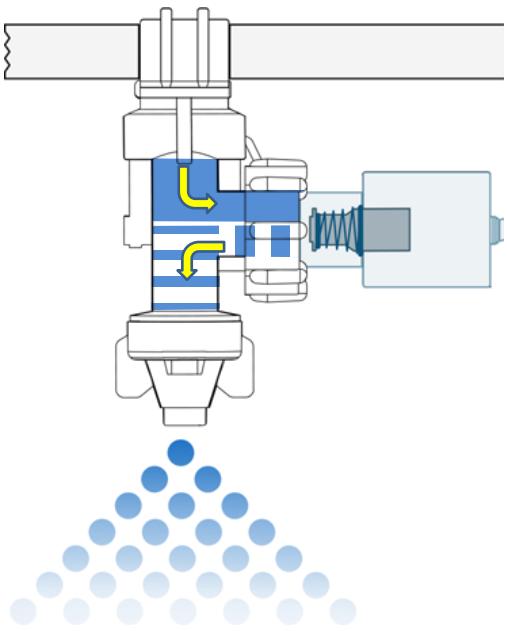

Source: Capstanag.com

96

PWM Terms

Frequency:

- The number of open/close cycles per second
- Most systems run at 15 Hz
- Some can vary the frequency with travel speed (PWFM)

Duty Cycle:

- The proportion of time that the valve is open
- 100% is wide open
- Lowest is between 10 and 20%

Pressure Drop:

- PWM valves have flow restrictions
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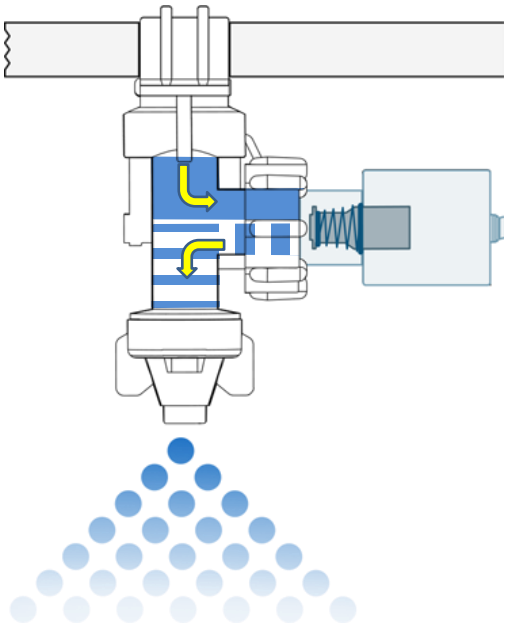

Source: Capstanag.com

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Flow rates - Dynamic Range

	Pressure System	Low Frequency PWM System
Pressure / Duty Cycle Ratio	30 – 90 psi	20 – 100%
Travel Speed Ratio	1.73	5
Example Speeds	10 – 17 mph	4 – 20 mph
Dosage Resolution	Entire boom	Individual nozzles

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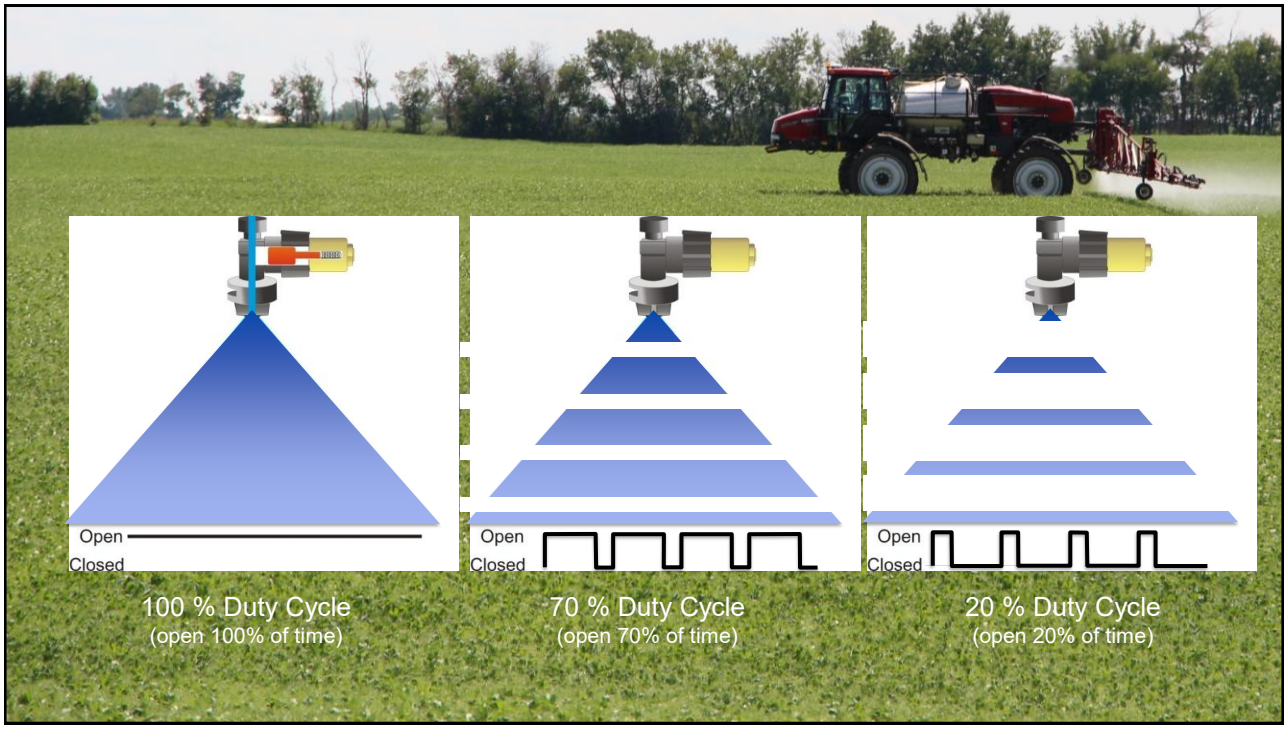

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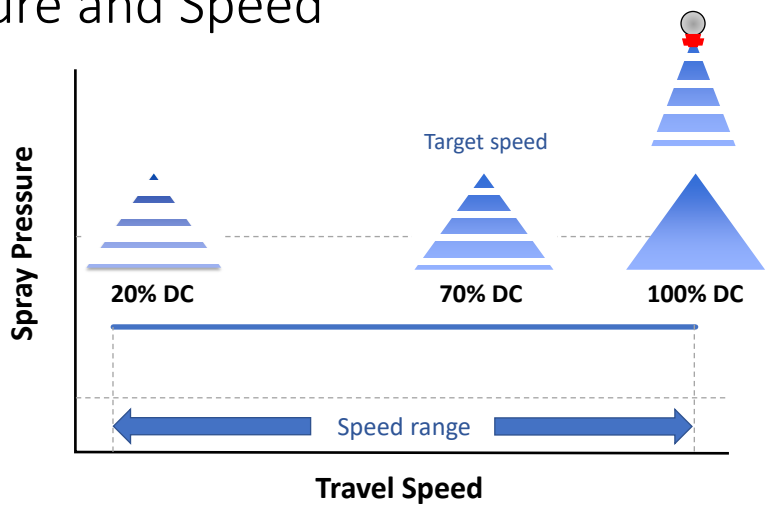
Pressure and Speed



100

Conventional Rate Control (10 gpa, 14 mph)

Nozzle Size	Pressure (psi)	Nozzle Flow (US gpm)	Travel Speed (columns, mph) at listed application volume (headings, US gal/acre)											
			3	4	5	6	7	8	9	10	12	14	16	18
			US gpa											
03 Blue	30	0.260	25.7	19.3	15.4	12.9	11.0	9.6	8.6	7.7	6.4	5.5	4.8	4.3
	40	0.300	29.7	22.3	17.8	14.9	12.7	11.1	9.9	8.9	7.4	6.4	5.6	5.0
	50	0.335	33.2	24.9	19.9	16.6	14.2	12.5	11.1	10.0	8.3	7.1	6.2	5.5
	60	0.367	36.4	27.3	21.8	18.2	15.6	13.6	12.1	10.9	9.1	7.8	6.8	6.1
	70	0.397	39.3	29.5	23.6	19.6	16.8	14.7	13.1	11.8	9.8	8.4	7.4	6.5
	80	0.424	42.0	31.5	25.2	21.0	18.0	15.8	14.0	12.6	10.5	9.0	7.9	7.0
	90	0.450	44.6	33.4	26.7	22.3	19.1	16.7	14.9	13.4	11.1	9.5	8.4	7.4
	100	0.474	47.0	35.2	28.2	23.5	20.1	17.6	15.7	14.1	11.7	10.1	8.8	7.8
04 Red	30	0.346	34.3	25.7	20.6	17.1	14.7	12.9	11.4	10.3	8.6	7.3	6.4	5.7
	40	0.400	39.6	29.7	23.8	19.8	17.0	14.9	13.2	11.9	9.9	8.5	7.4	6.6
	50	0.447	44.3	33.2	26.6	22.1	19.0	16.6	14.8	13.3	11.1	9.5	8.3	7.4
	60	0.490	48.5	36.4	29.1	24.2	20.8	18.2	16.2	14.5	12.1	10.4	9.1	8.1
	70	0.529	52.4	39.3	31.4	26.2	22.5	19.6	17.5	15.7	13.1	11.2	9.8	8.7
	80	0.566	56.0	42.0	33.6	28.0	24.0	21.0	18.7	16.8	14.0	12.0	10.5	9.3
	90	0.600	59.4	44.6	35.6	29.7	25.5	22.3	19.8	17.8	14.9	12.7	11.1	9.9
	100	0.632	62.6	47.0	37.6	31.3	26.8	23.5	20.9	18.8	15.7	13.4	11.7	10.4
05 Brown	30	0.433	42.9	32.2	25.7	21.4	18.4	16.1	14.3	12.9	10.7	9.2	8.0	7.1
	40	0.500	49.5	37.1	29.7	24.8	21.2	18.6	16.5	14.9	12.4	10.6	9.3	8.3
	50	0.559	55.3	41.5	33.2	27.7	23.7	20.8	18.4	16.6	13.8	11.9	10.4	9.2
	60	0.612	60.6	45.5	36.4	30.3	26.0	22.7	20.2	18.2	15.2	13.0	11.4	10.1
	70	0.661	65.5	49.1	39.3	32.7	28.1	24.6	21.8	19.6	16.4	14.0	12.3	10.9
	80	0.707	70.0	52.5	42.0	35.0	30.0	26.3	23.3	21.0	17.5	15.0	13.1	11.7
	90	0.750	74.3	55.7	44.6	37.1	31.8	27.8	24.8	22.3	18.6	15.9	13.9	12.4
	100	0.791	78.3	58.7	47.0	39.1	33.5	29.3	26.1	23.5	19.6	16.8	14.7	13.0
06 Gray	30	0.520	51.4	38.6	30.9	25.7	22.0	19.3	17.1	15.4	12.9	11.0	9.6	8.6
	40	0.600	59.4	44.6	35.6	29.7	25.5	22.3	19.8	17.8	14.9	12.7	11.1	9.9
	50	0.671	66.4	49.8	39.8	33.2	28.5	24.9	22.1	19.9	16.6	14.2	12.5	11.1
	60	0.735	72.7	54.6	43.6	36.4	31.2	27.3	24.2	21.8	18.2	15.6	13.6	12.1
	70	0.794	78.6	58.9	47.1	39.3	33.7	29.5	26.2	23.6	19.6	16.8	14.7	13.1
	80	0.849	84.0	63.0	50.4	42.0	36.0	31.5	28.0	25.2	21.0	18.0	15.8	14.0
	90	0.900	89.1	66.8	53.5	44.6	38.2	33.4	29.7	26.7	22.3	19.1	16.7	14.9
	100	0.949	93.9	70.4	56.4	47.0	40.3	35.2	31.3	28.2	23.5	20.1	17.6	15.7
08 White	30	0.693	68.6	51.4	41.2	34.3	29.4	25.7	22.9	20.6	17.1	14.7	12.9	11.4
	40	0.800	79.2	59.4	47.5	39.6	33.9	29.7	26.4	23.8	19.8	17.0	14.9	13.2
	50	0.894	88.5	66.4	53.1	44.3	37.9	33.2	29.5	26.6	22.1	19.0	16.6	14.8
	60	0.980	97.0	72.7	58.2	48.5	41.6	36.4	32.3	29.1	24.2	20.8	18.2	16.2
	70	1.058	104.8	78.6	62.9	52.4	44.9	39.3	34.9	31.4	26.2	22.5	19.6	17.5
	80	1.131	112.0	84.0	67.2	56.0	48.0	42.0	37.3	33.6	28.0	24.0	21.0	18.7
	90	1.200	118.8	89.1	71.3	59.4	50.9	44.6	39.6	35.6	29.7	25.5	22.3	19.8
	100	1.265	125.2	93.9	75.1	62.6	53.7	47.0	41.7	37.6	31.3	26.8	23.5	20.9

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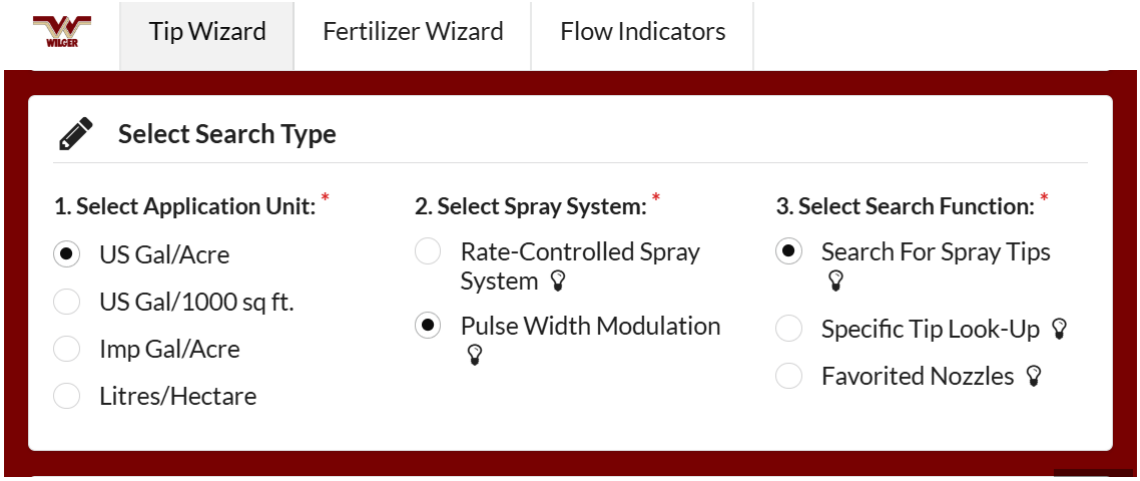
PWM Rate Control – oversize flows 30-40%

Nozzle Size	Pressure (psi)	Nozzle Flow (US gpm)	Travel Speed (columns, mph) at listed application volume (headings, US gal/acre)											
			3	4	5	6	7	8	9	10	12	14	16	18
			US gpa											
03 Blue	30	0.260	25.7	19.3	15.4	12.9	11.0	9.6	8.6	7.7	6.4	5.5	4.8	4.3
	40	0.300	29.7	22.3	17.8	14.9	12.7	11.1	9.9	8.9	7.4	6.4	5.6	5.0
	50	0.335	33.2	24.9	19.9	16.6	14.2	12.5	11.1	10.0	8.3	7.1	6.2	5.5
	60	0.367	36.4	27.3	21.8	18.2	15.6	13.6	12.1	10.9	9.1	7.8	6.8	6.1
	70	0.397	39.3	29.5	23.6	19.6	16.8	14.7	13.1	11.8	9.8	8.4	7.4	6.5
	80	0.424	42.0	31.5	25.2	21.0	18.0	15.8	14.0	12.6	10.5	9.0	7.9	7.0
	90	0.450	44.6	33.4	26.7	22.3	19.1	16.7	14.9	13.4	11.1	9.5	8.4	7.4
	100	0.474	47.0	35.2	28.2	23.5	20.1	17.6	15.7	14.1	11.7	10.1	8.8	7.8
04 Red	30	0.346	34.3	25.7	20.6	17.1	14.7	12.9	11.4	10.3	8.6	7.3	6.4	5.7
	40	0.400	39.6	29.7	23.8	19.8	17.0	14.9	13.2	11.9	9.9	8.5	7.4	6.6
	50	0.447	44.3	33.2	26.6	22.1	19.0	16.6	14.8	13.3	11.1	9.5	8.3	7.4
	60	0.490	48.5	36.4	29.1	24.2	20.8	18.2	16.2	14.5	12.1	10.4	9.1	8.1
	70	0.529	52.4	39.3	31.4	26.2	22.5	19.6	17.5	15.7	13.1	11.2	9.8	8.7
	80	0.566	56.0	42.0	33.6	28.0	24.0	21.0	18.7	16.8	14.0	12.0	10.5	9.3
	90	0.600	59.4	44.6	35.6	29.7	25.5	22.3	19.8	17.8	14.9	12.7	11.1	9.9
	100	0.632	62.6	47.0	37.6	31.3	26.8	23.5	20.9	18.8	15.7	13.4	11.7	10.4
05 Brown	30	0.433	42.9	32.2	25.7	21.4	18.4	16.1	14.3	12.9	10.7	9.2	8.0	7.1
	40	0.500	49.5	37.1	29.7	24.8	21.2	18.6	16.5	14.9	12.4	10.6	9.3	8.3
	50	0.559	55.3	41.5	33.2	27.7	23.7	20.8	18.4	16.6	13.8	11.9	10.4	9.2
	60	0.612	60.6	45.5	36.4	30.3	26.0	22.7	20.2	18.2	15.2	13.0	11.4	10.1
	70	0.661	65.5	49.1	39.3	32.7	28.1	24.6	21.8	19.6	16.4	14.0	12.3	10.9
	80	0.707	70.0	52.5	42.0	35.0	30.0	26.3	23.3	21.0	17.5	15.0	13.1	11.7
	90	0.750	74.3	55.7	44.6	37.1	31.8	27.8	24.8	22.3	18.6	15.9	13.9	12.4
	100	0.791	78.3	58.7	47.0	39.1	33.5	29.3	26.1	23.5	19.6	16.8	14.7	13.0
06 Gray	30	0.520	51.4	38.6	30.9	25.7	22.0	19.3	17.1	15.4	12.9	11.0	9.6	8.6
	40	0.600	59.4	44.6	35.6	29.7	25.5	22.3	19.8	17.8	14.9	12.7	11.1	9.9
	50	0.671	66.4	49.8	39.8	33.2	28.5	24.9	22.1	19.9	16.6	14.2	12.5	11.1
	60	0.735	72.7	54.6	43.6	36.4	31.2	27.3	24.2	21.8	18.2	15.6	13.6	12.1
	70	0.794	78.6	58.9	47.1	39.3	33.7	29.5	26.2	23.6	19.6	16.8	14.7	13.1
	80	0.849	84.0	63.0	50.4	42.0	36.0	31.5	28.0	25.2	21.0	18.0	15.8	14.0
	90	0.900	89.1	66.8	53.5	44.6	38.2	33.4	29.7	26.7	22.3	19.1	16.7	14.9
	100	0.949	93.9	70.4	56.4	47.0	40.3	35.2	31.3	28.2	23.5	20.1	17.6	15.7
08 White	30	0.693	68.6	51.4	41.2	34.3	29.4	25.7	22.9	20.6	17.1	14.7	12.9	11.4
	40	0.800	79.2	59.4	47.5	39.6	33.9	29.7	26.4	23.8	19.8	17.0	14.9	13.2
	50	0.894	88.5	66.4	53.1	44.3	37.9	33.2	29.5	26.6	22.1	19.0	16.6	14.8
	60	0.980	97.0	72.7	58.2	48.5	41.6	36.4	32.3	29.1	24.2	20.8	18.2	16.2
	70	1.058	104.8	78.6	62.9	52.4	44.9	39.3	34.9	31.4	26.2	22.5	19.6	17.5
	80	1.131	112.0	84.0	67.2	56.0	48.0	42.0	37.3	33.6	28.0	24.0	21.0	18.7
	90	1.200	118.8	89.1	71.3	59.4	50.9	44.6	39.6	35.6	29.7	25.5	22.3	19.8
	100	1.265	125.2	93.9	75.1	62.6	53.7	47.0	41.7	37.6	31.3	26.8	23.5	20.9

102

Wilger Tip Wizard



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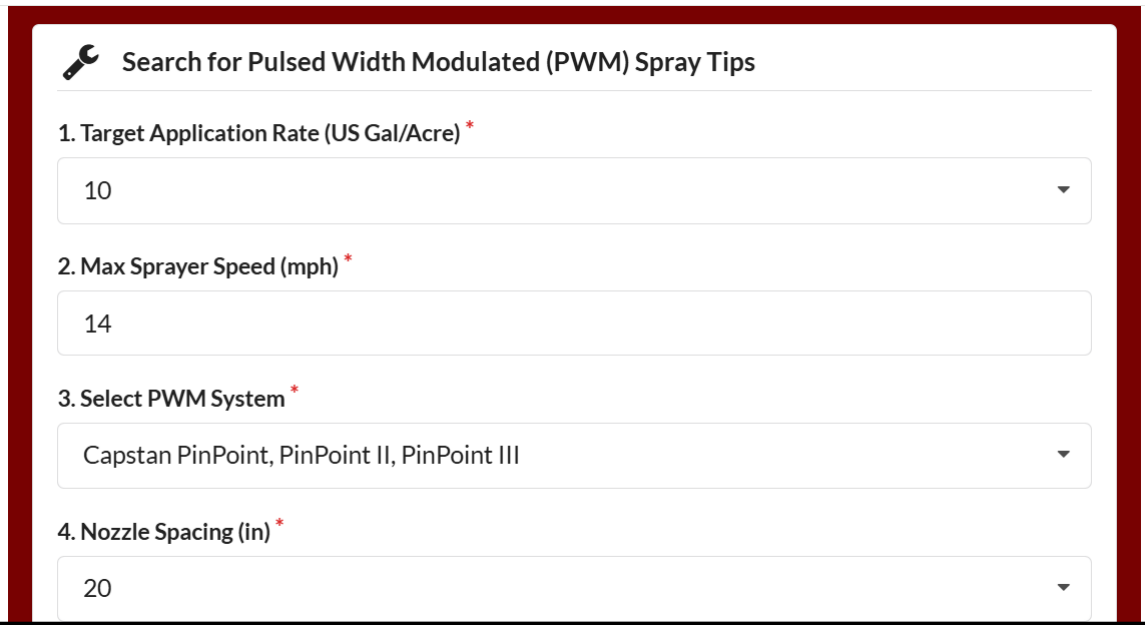
Wilger Tip Wizard



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Wilger Tip Wizard

3. Select PWM System *

Capstan PinPoint, PinPoint II, PinPoint III

4. Nozzle Spacing (in) *

20

5. Spray Tip Angle *

- 80°
- 110°

6. Target Spray Classification or Droplet Size (µ)

400

105

Combo-Jet® MR110-05
Part No: 40291-05 Color: Brown
Screen No: 50 Mesh (#40250-00)

Pressure (psi)	Speed Range (mph)	DC (%) @ 14 mph	Class	VMD (µ)	<141 (%)	<600 (%)
25	2.8-11.2	>100	XC	527µ	2	64
30	3.1-12.2	>100	XC	500µ	3	69
35	3.3-13.2	>100	XC	478µ	4	73
40	3.5-14.1	99	VC	459µ	4	76
45	3.7-15.0	93	VC	442µ	5	78
50	3.9-15.8	89	VC	427µ	5	80
55	4.1-16.6	84	VC	413µ	6	82
60	4.3-17.3	81	C	400µ	6	83
65	4.5-18.0	78	C	389µ	6	84

106

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

Pressure (psi)	Speed Range (mph)	DC (%) @ 14 mph	Class	VMD (µ)	<141 (%)	<600 (%)
25	3.3-13.2	>100	XC	466µ	3	76
30	3.6-14.4	97	VC	438µ	5	81
35	3.9-15.6	90	VC	414µ	6	84
40	4.2-16.6	84	C	393µ	7	87
45	4.4-17.6	80	C	375µ	8	88
50	4.7-18.6	75	C	358µ	9	90
55	4.9-19.5	72	C	344µ	10	91
60	5.1-20.4	69	C	330µ	11	92
65	5.3-21.2	66	C	318µ	11	93

107

Combo-Jet® SR110-08
Part No: 40287-08 Color: White
Screen No: Not Required

Pressure (psi)	Speed Range (mph)	DC (%) @ 14 mph	Class	VMD (µ)	<141 (%)	<600 (%)
25	4.2-16.6	84	UC	517µ	3	52
30	4.6-18.2	77	UC	489µ	4	59
35	4.9-19.7	71	XC	465µ	5	64
40	5.3-21.0	67	XC	445µ	6	68
45	5.6-22.3	63	XC	426µ	7	71
50	5.9-23.5	60	XC	410µ	7	74
55	6.2-24.7	57	XC	396µ	8	76
60	6.4-25.8	54	XC	382µ	8	78
65	6.7-26.8	52	VC	370µ	9	79

108

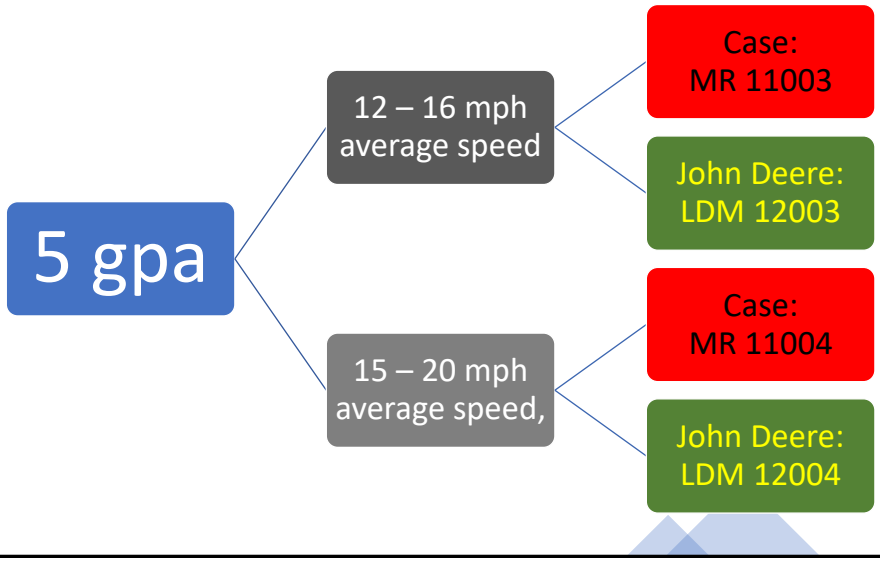
Why 70% Duty Cycle?

- Room to move, up and down
  - Speed up by 30%
  - Slow down by factor of 3
- Change pressure to control droplet size
  - Lower pressure
  - Less flow
  - Duty cycle increases
  - Speed stays same
- Turn compensation
  - Outside boom needs less extra flow than inside boom needs less flow.
  - e.g. TC won't work well at 100% DC or at 40% DC

Sprayers101

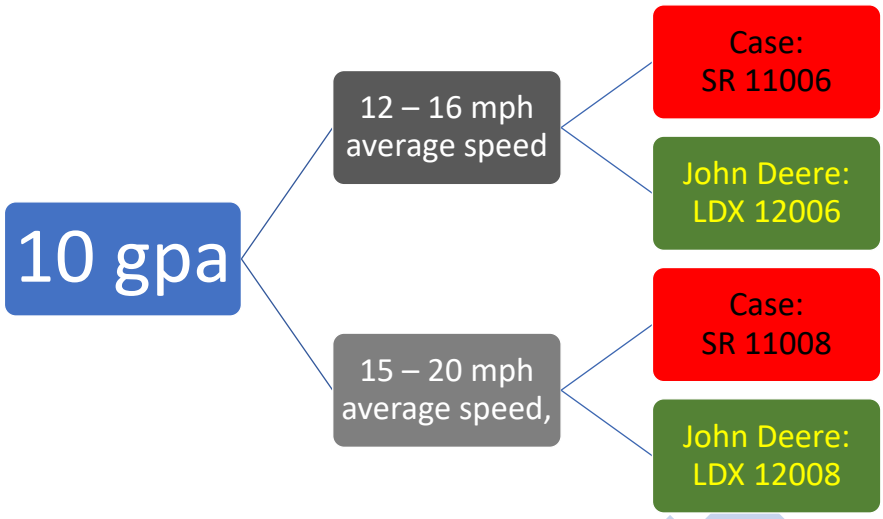
109

PWM Rules of Thumb



110

PWM Rules of Thumb



111

Wilger ComboJet ER, SR, MR, DR

- **Sizes**
  01 to 15
- **Pressure**
  30 – 60 psi
- **Spray Quality**
  Fine to U. Coarse

112

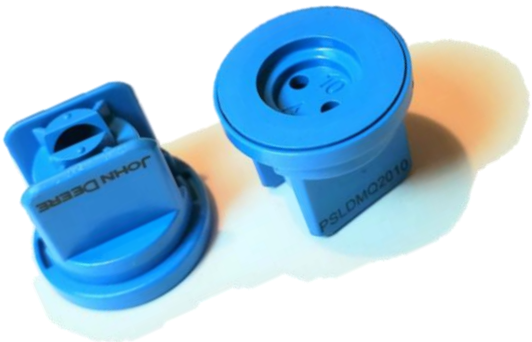
Hypro Guardian, John Deere LDX

- **Sizes**
  015 to 08
- **Pressure**
  20 – 100 psi
- **Spray Quality**
  Fine to V. Coarse

113

Hypro, John Deere LDM

- **Sizes**
  03 to 10
- **Pressure**
  30 – 80 psi
- **Spray Quality**
  Medium to X. Coarse



114

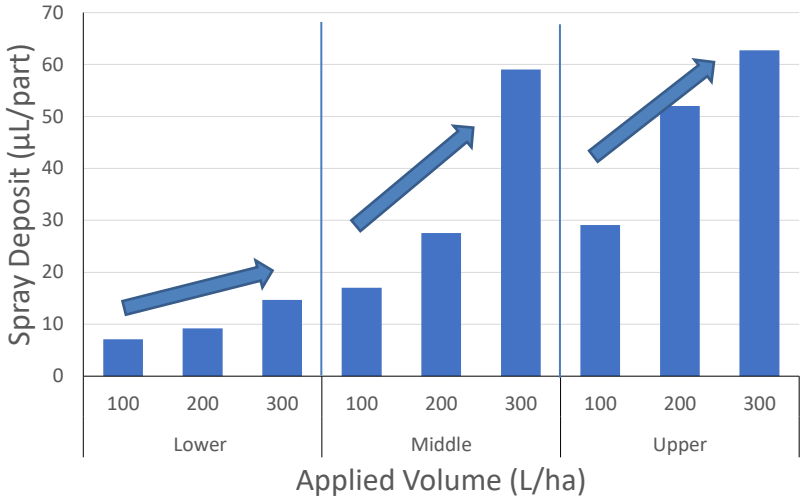
Arag CFLD

- **Sizes**
  02 to 06
- **Pressure**
  30 – 90 psi
- **Spray Quality**
  Coarse to X. Coarse

115

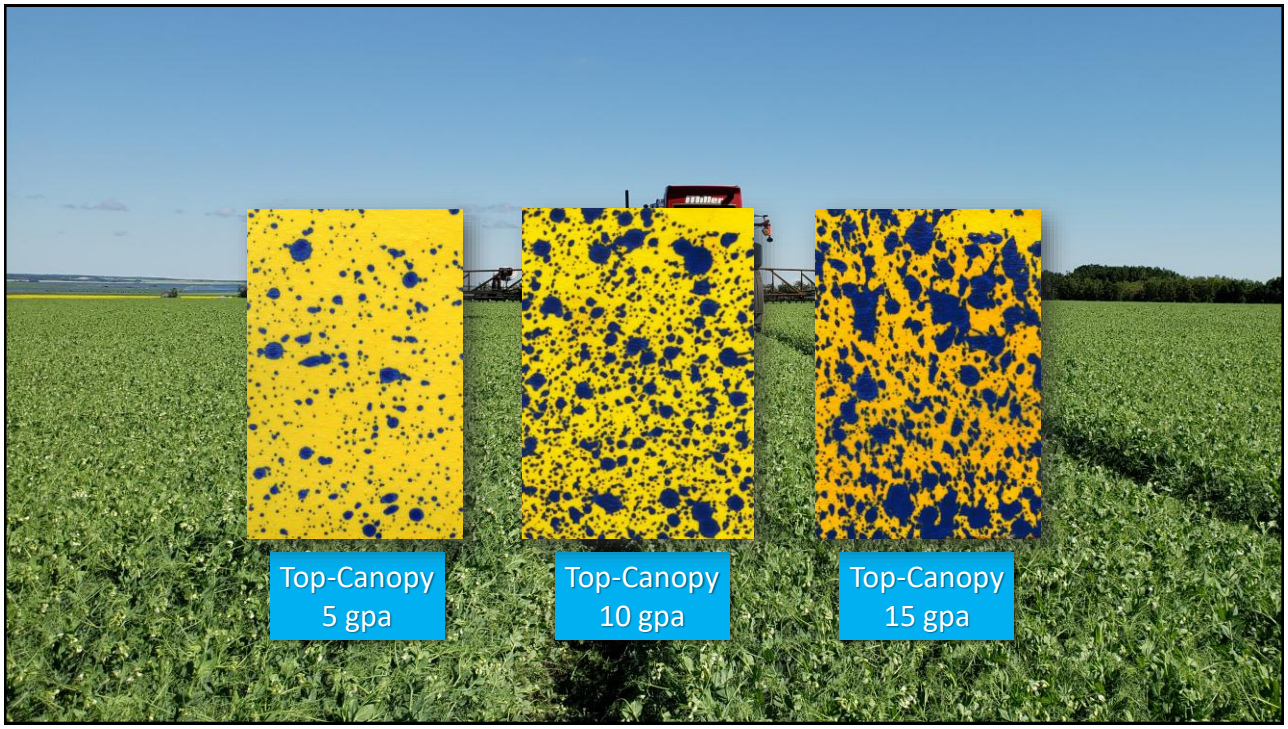
116

Volume - Desi (closed canopy)

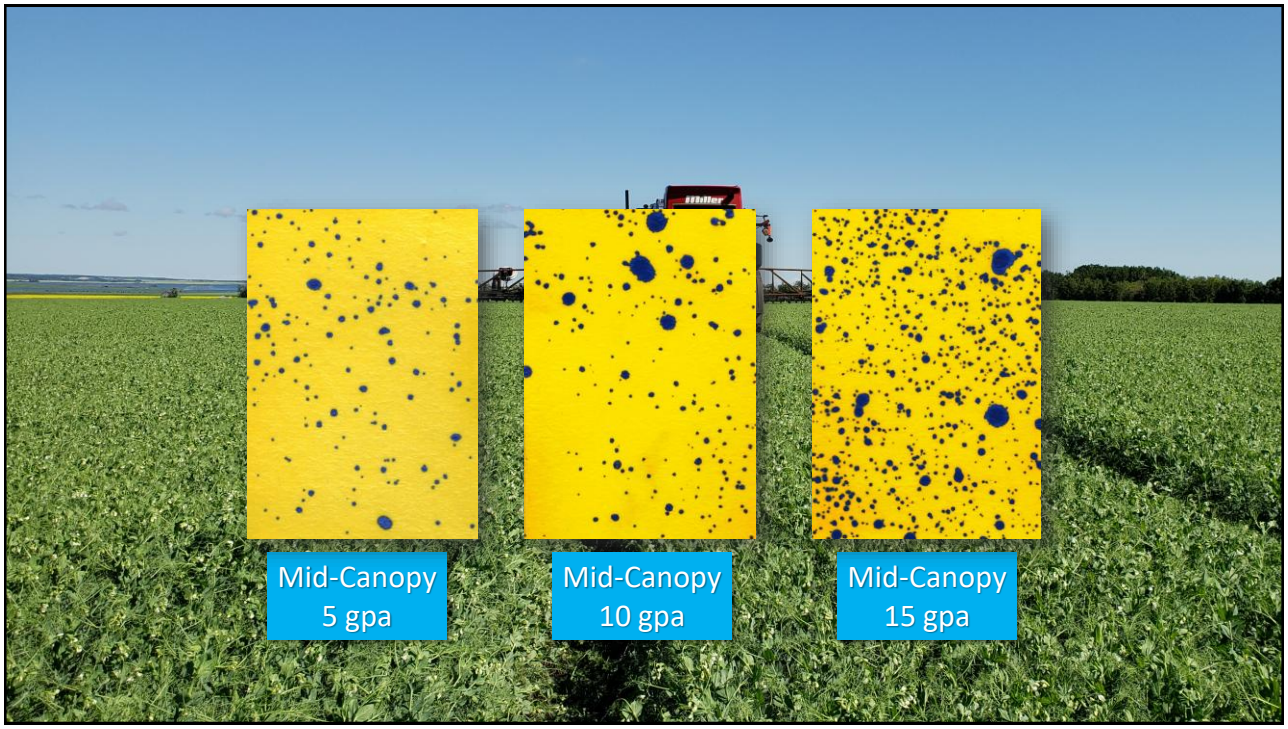


117

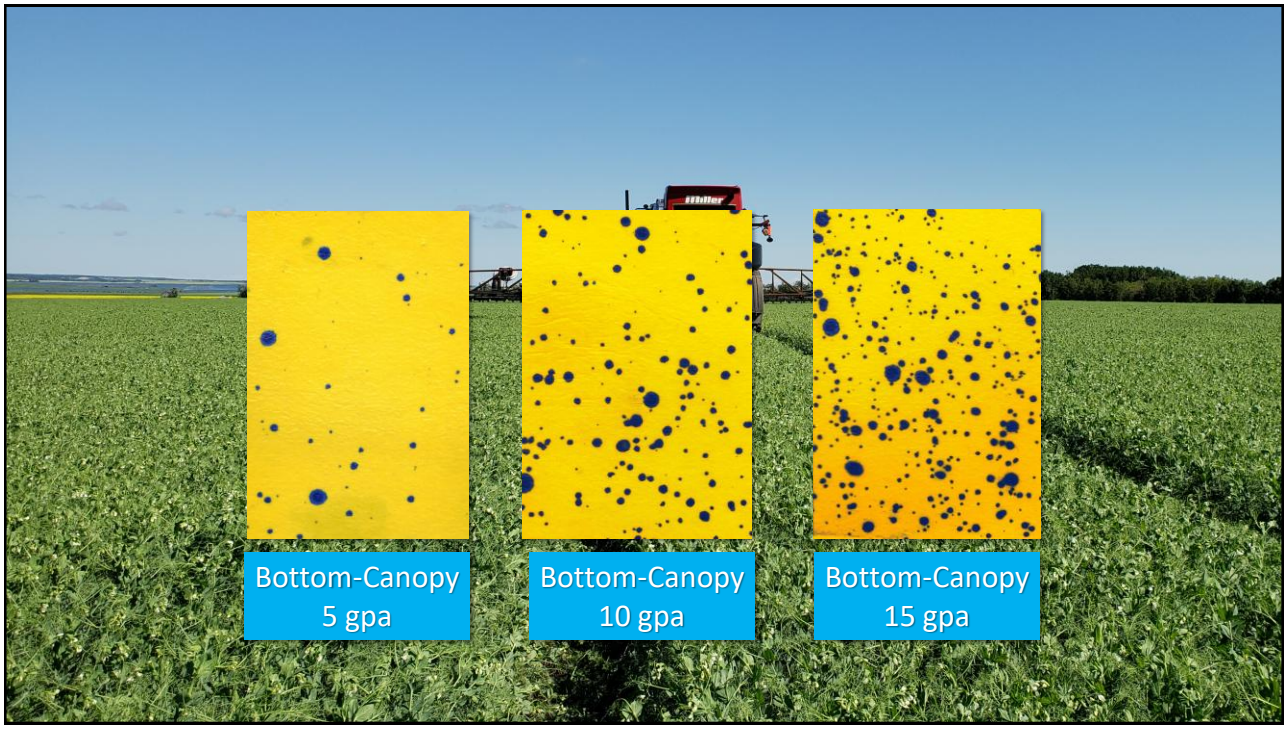
118


Top-Canopy
5 gpa
Top-Canopy
10 gpa
Top-Canopy
15 gpa

119


Mid-Canopy
5 gpa
Mid-Canopy
10 gpa
Mid-Canopy
15 gpa

120



121

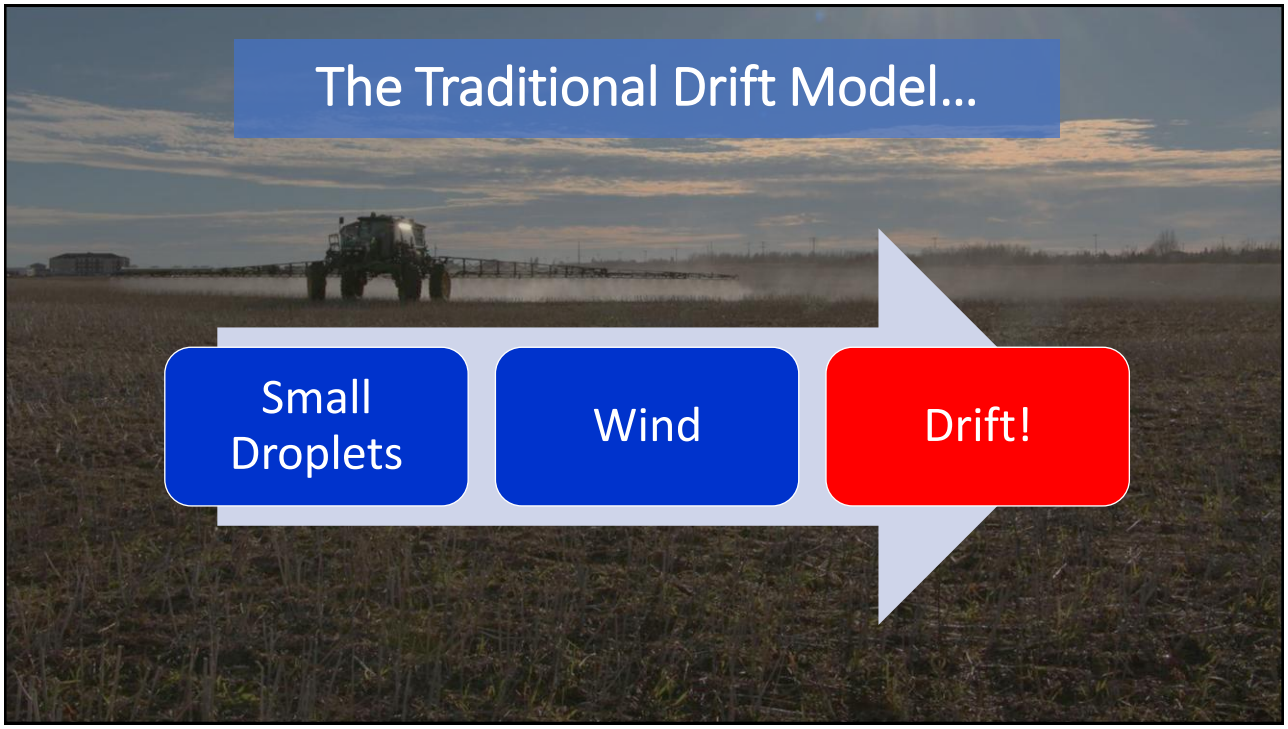
Summary

- Choose a nozzle size that can operate in the middle of its pressure range;
- With PWM, over-size the nozzle flow by 30 to 40% so to operate at 70% DC;
- Increasing water volume is the best way to improve coverage and canopy penetration.

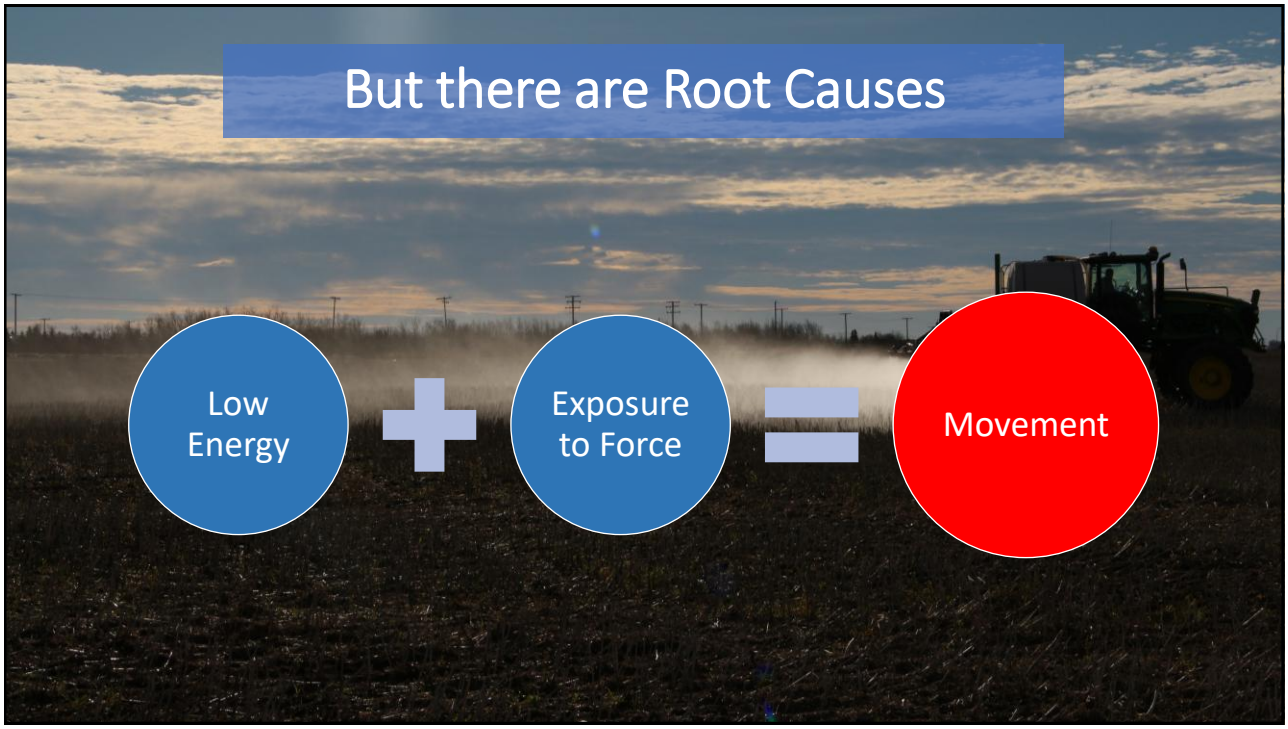
122

SPRAY DRIFT

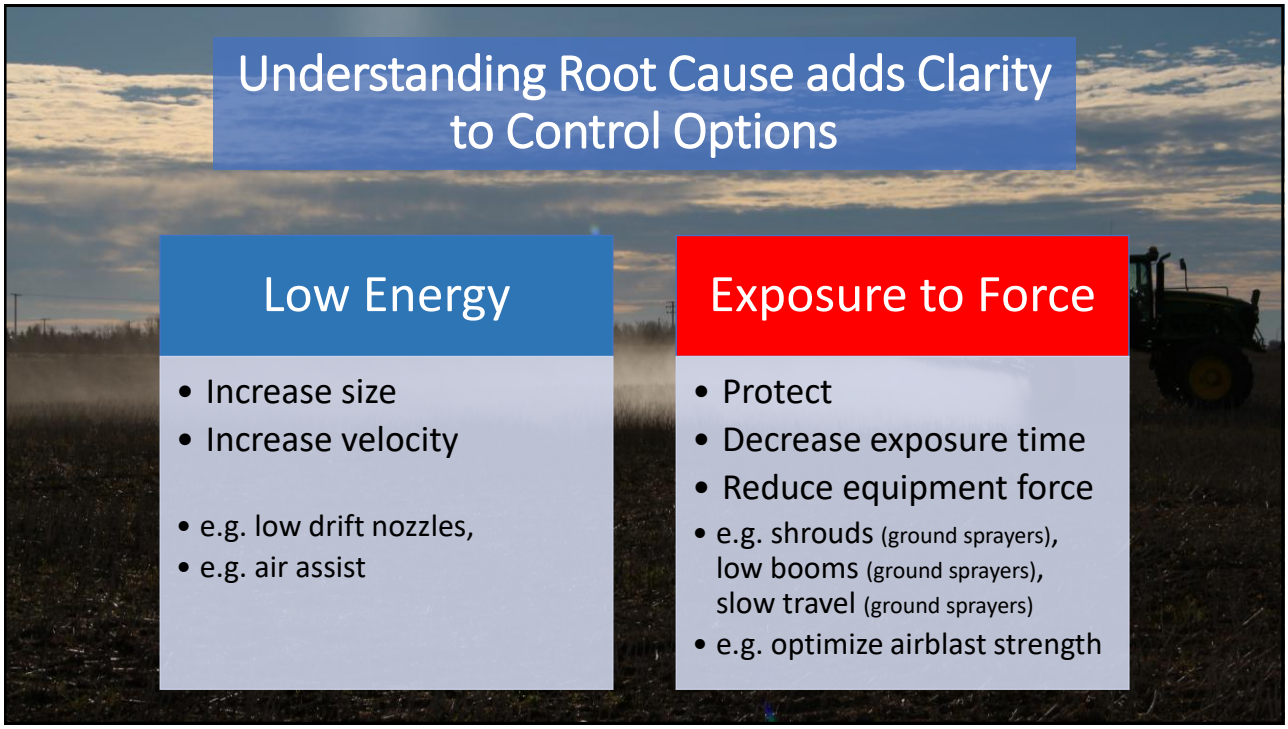
123



124

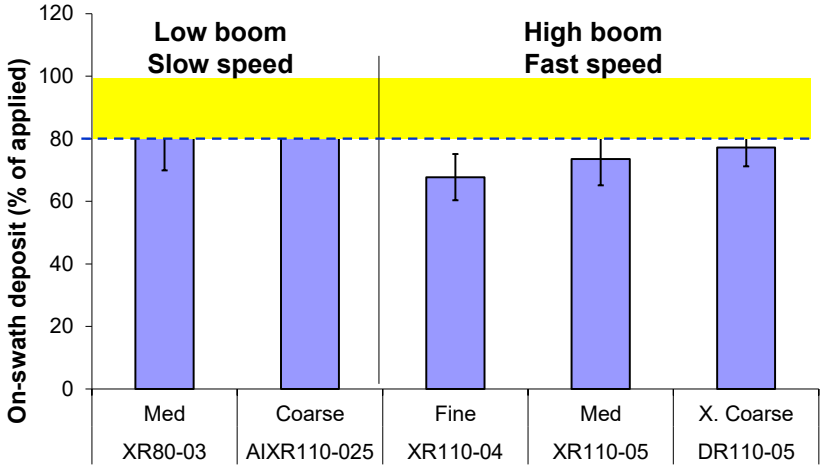

But there are Root Causes
Low Energy
Exposure to Force
Movement

125


Understanding Root Cause adds Clarity to Control Options
Low Energy
• Increase size
• Increase velocity
• e.g. low drift nozzles,
• e.g. air assist
Exposure to Force
• Protect
• Decrease exposure time
• Reduce equipment force
• e.g. shrouds (ground sprayers), low booms (ground sprayers), slow travel (ground sprayers)
• e.g. optimize airblast strength

126

For ground sprayers, about 20% of spray does not land on swath



Sprayers101

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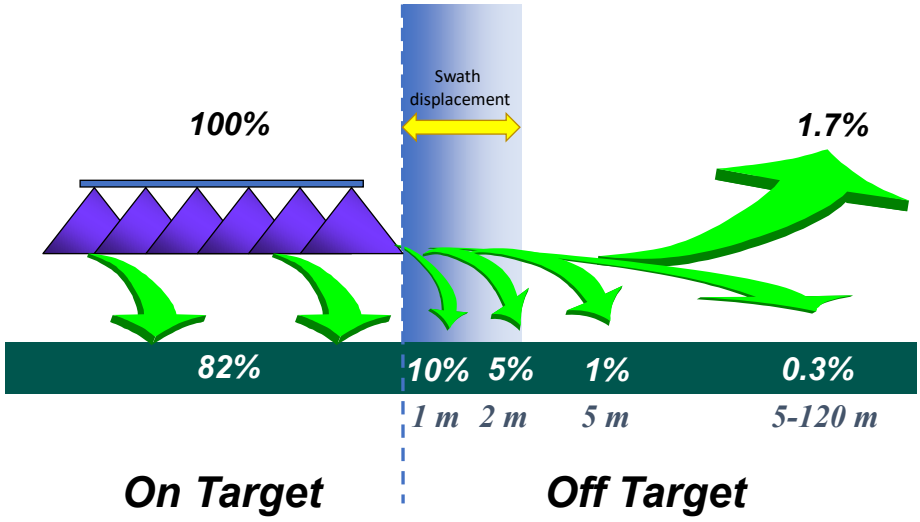
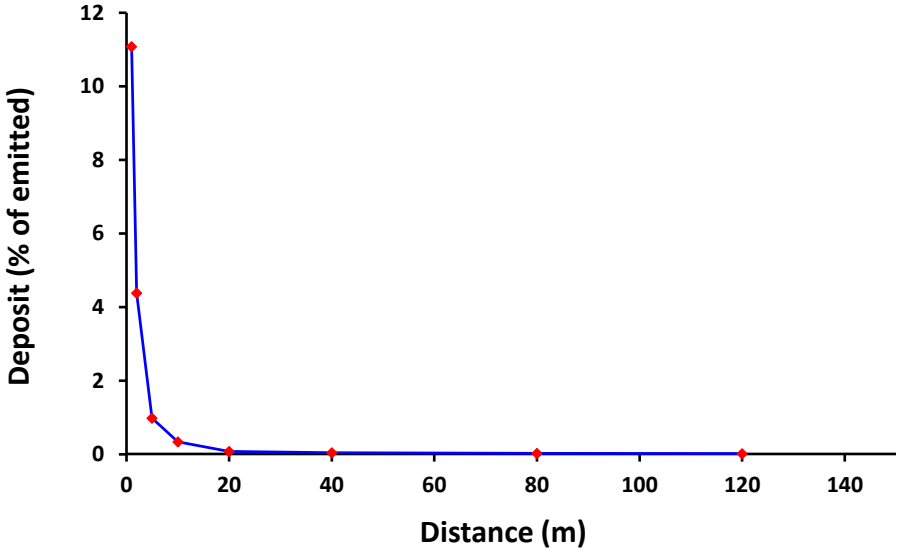


Sprayers101

128

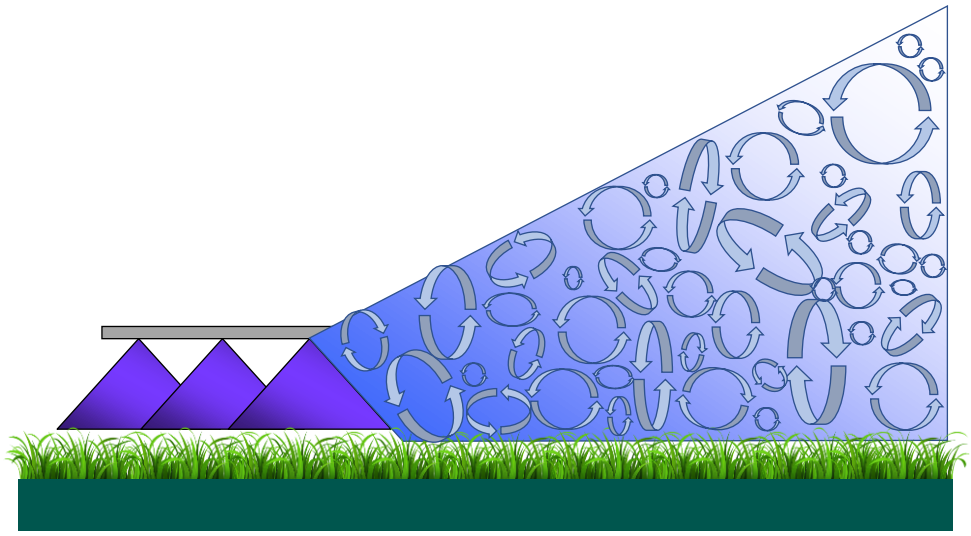
During windy conditions, deposited spray amount diminishes exponentially with distance



Sprayers101

129

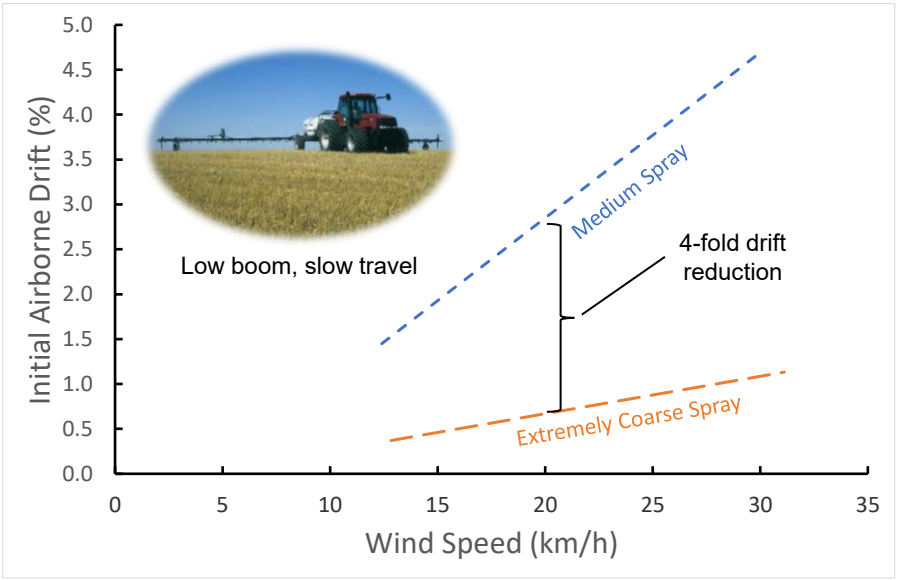
Turbulence increases losses but also dilutes pollutants and reduces downwind deposits



Sprayers101

130

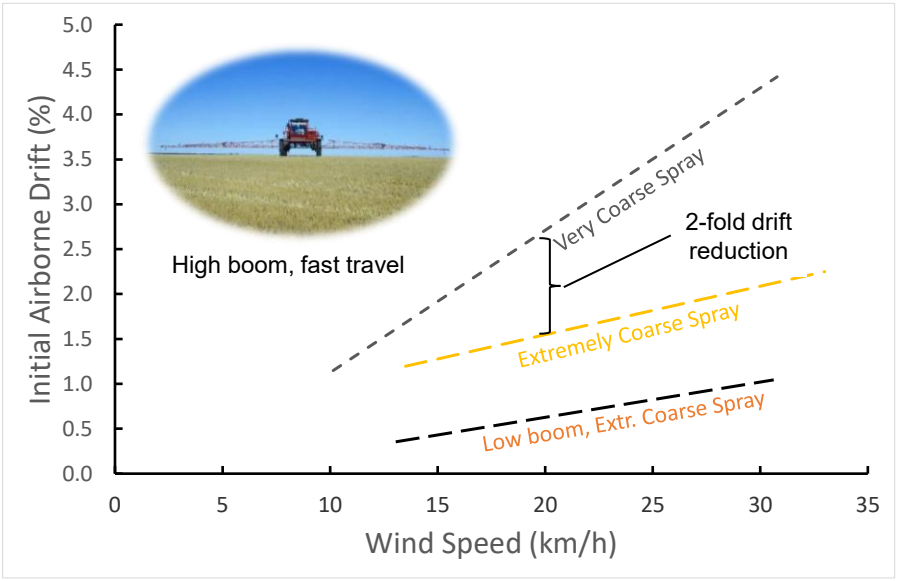
Coarse sprays reduce airborne drift…



Sprayers101

131

… but can only do so much



Sprayers101

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CORTEVA™ agriscience

Pixxaro™ A
Herbicide

with ARYLEX™ ACTIVE

GROUP	4	HERBICIDE

FOR SALE FOR USE IN THE PRAIRIE PROVINCES AND THE INTERIOR OF BRITISH COLUMBIA AND IN EASTERN CANADA

To Reduce Spray Drift:

1. Use nozzles delivering higher volumes and coarser droplets.
2. Use low pressures (200 to 275 kPa).
3. Use 100 L/ha of spray solution.
4. Spray when the wind velocity is 15 km/hr or less.
5. Spot treatments should only be applied with a calibrated boom to prevent over-application.

Field sprayer application

DO NOT apply when wind speed is less than 1 km/h. Avoid application of this product when winds are gusty. **DO NOT** apply with sprays finer than the American Society of Agricultural and Biological Engineers (ASABE) S572 (572.1 to 572.3) coarse classification. Boom height must be 60 cm or less above the crop or ground.

Sprayers101

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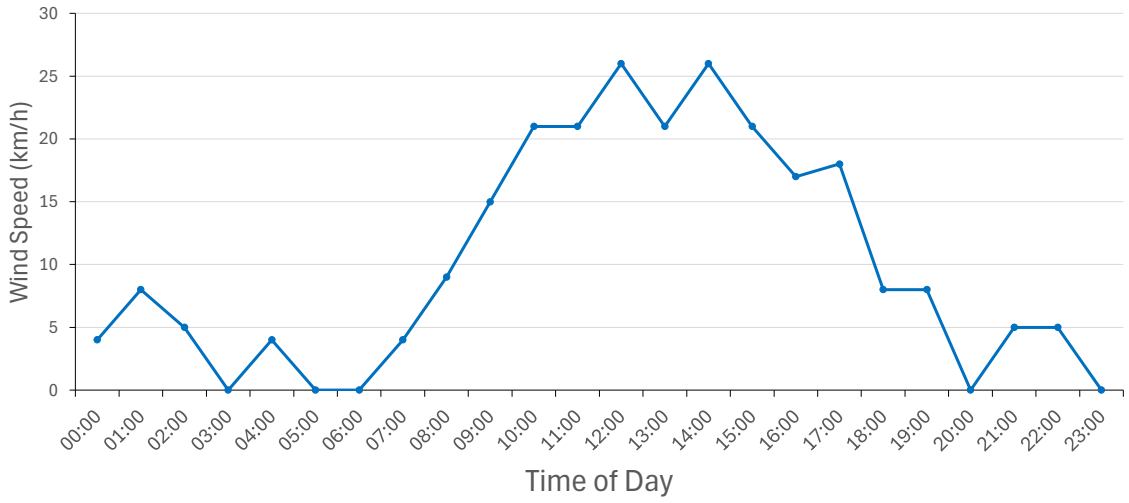
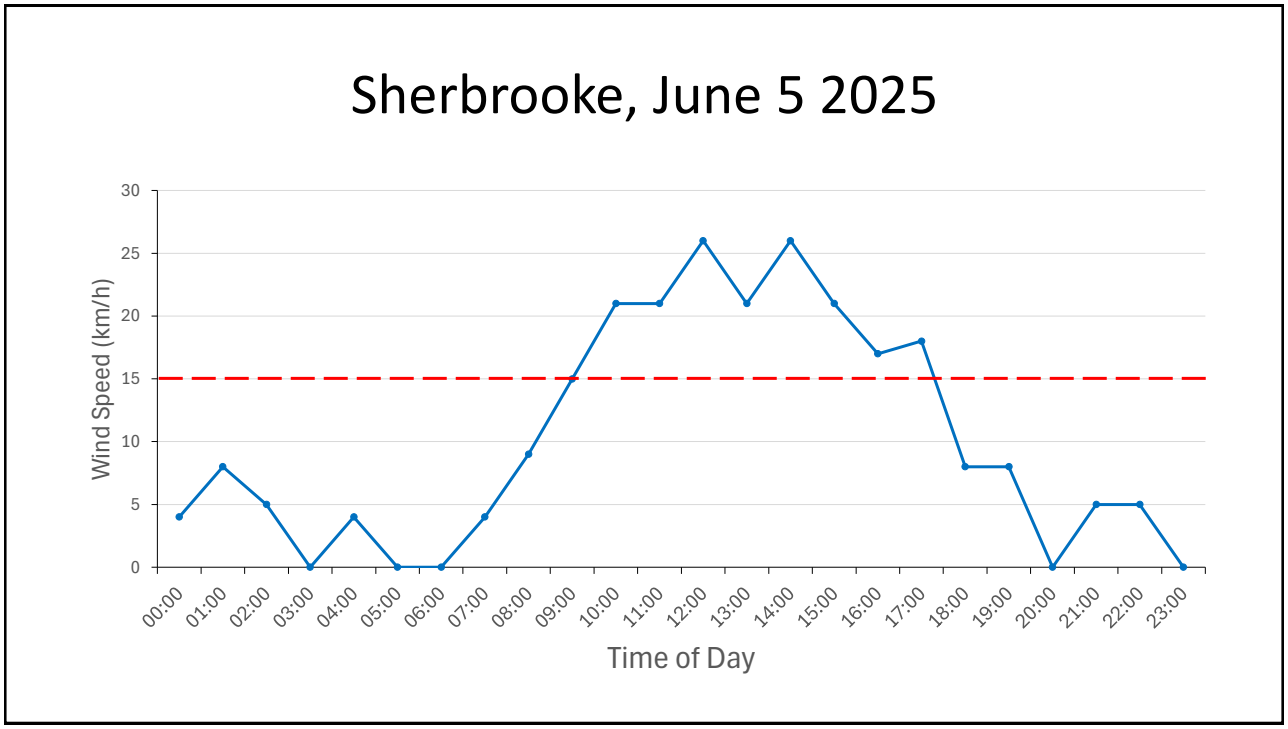
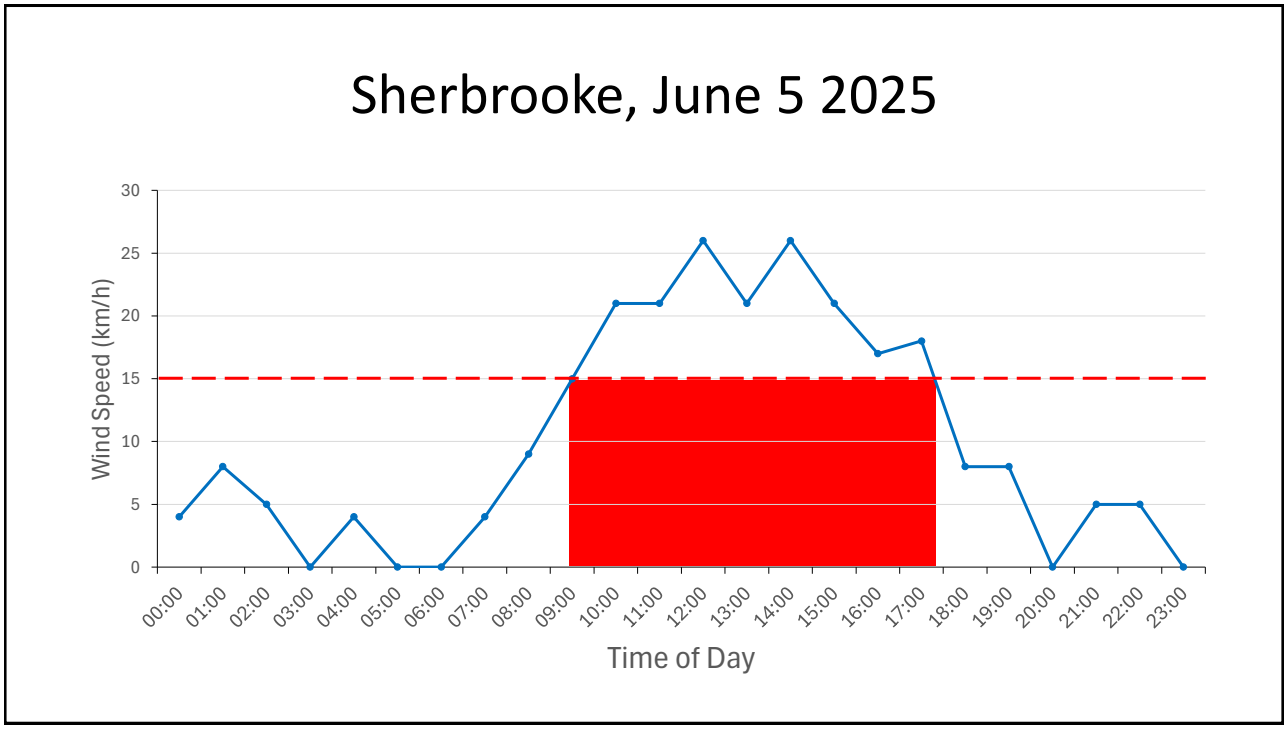
Sherbrooke, June 5 2025



134


Sherbrooke, June 5 2025
Wind Speed (km/h)
30
25
20
15
10
5
0
00:00
01:00
02:00
03:00
04:00
05:00
06:00
07:00
08:00
09:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time of Day

135


Sherbrooke, June 5 2025
Wind Speed (km/h)
30
25
20
15
10
5
0
00:00
01:00
02:00
03:00
04:00
05:00
06:00
07:00
08:00
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19:00
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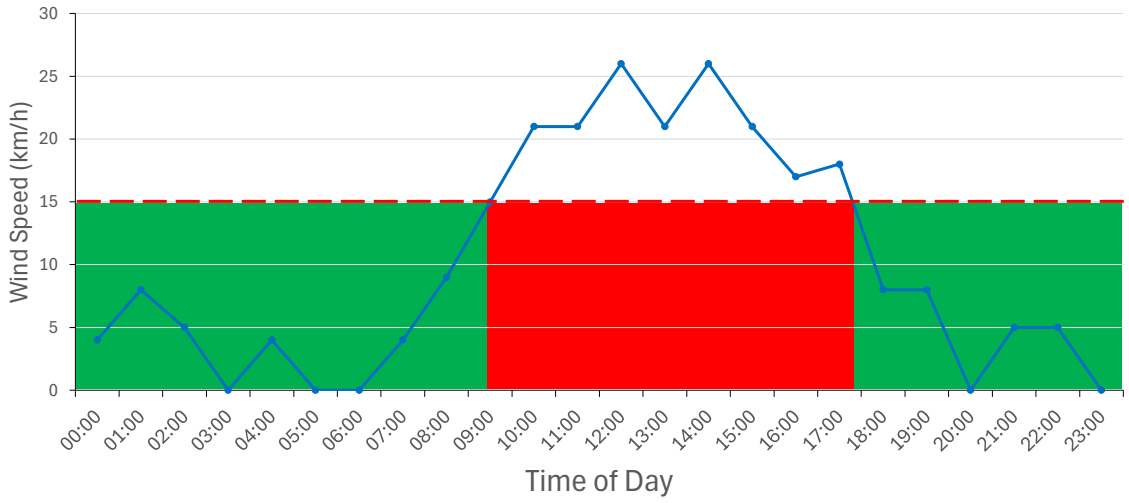
21:00
22:00
23:00
Time of Day

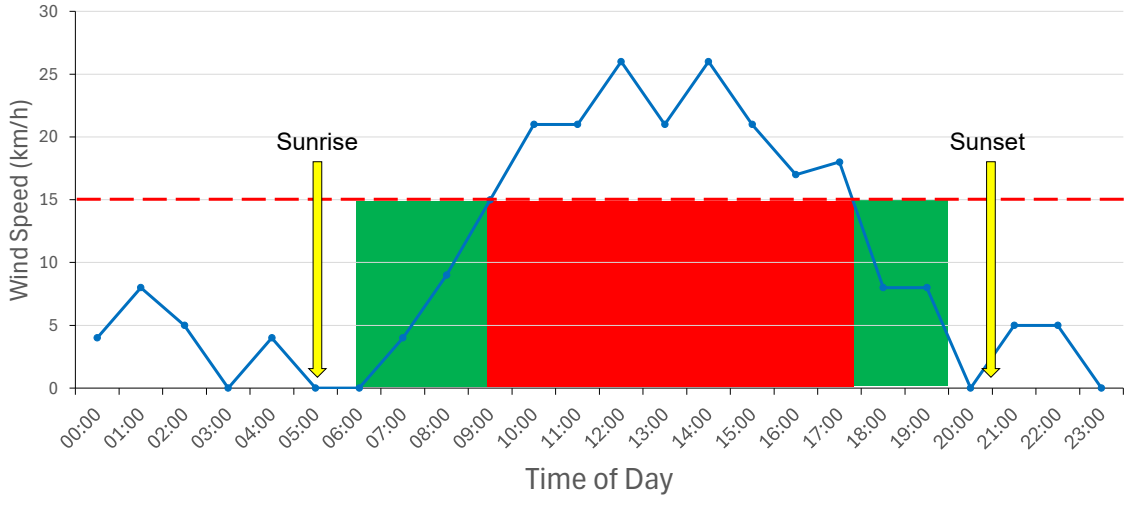
136

Sherbrooke, June 5 2025



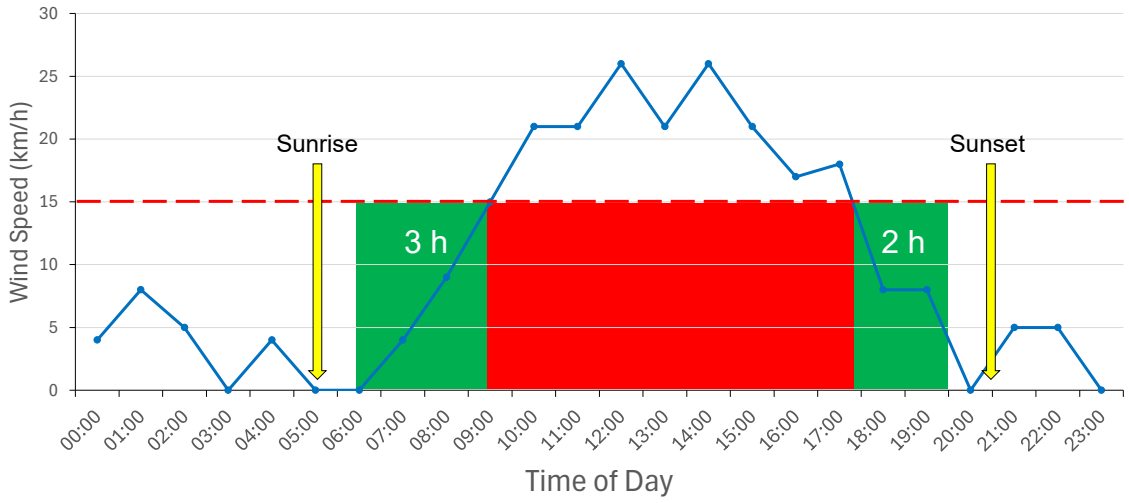
137

Sherbrooke, June 5 2025



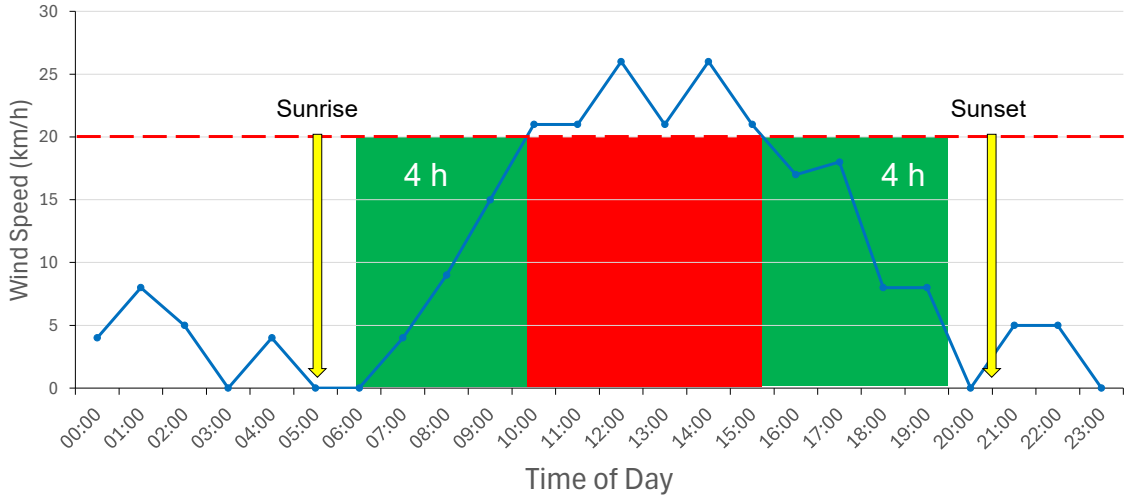
138

Sherbrooke, June 5 2025



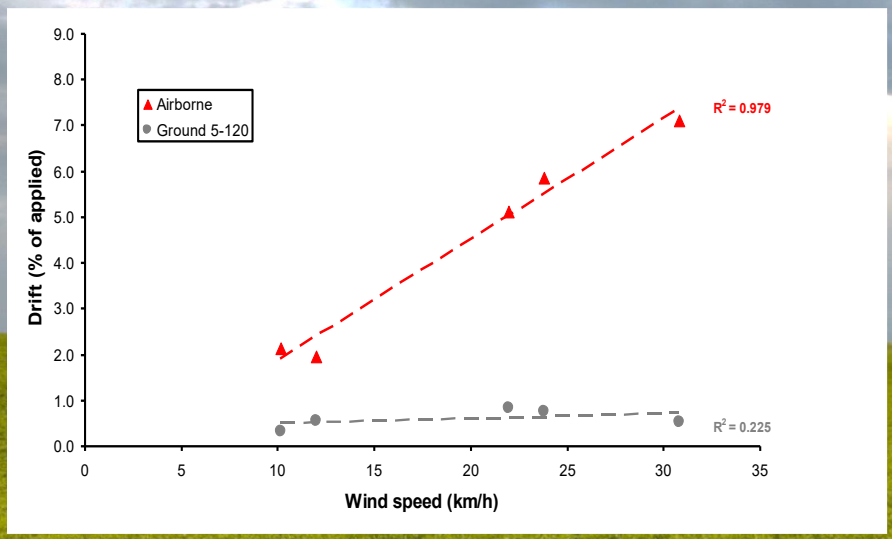
139

Sherbrooke, June 5 2025



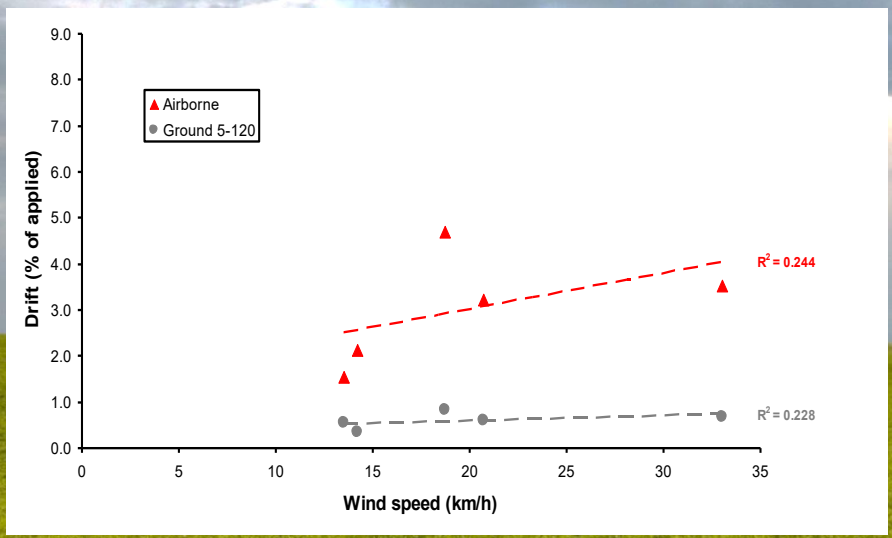
140

TT11005 (VC), 30” boom, 14 mph

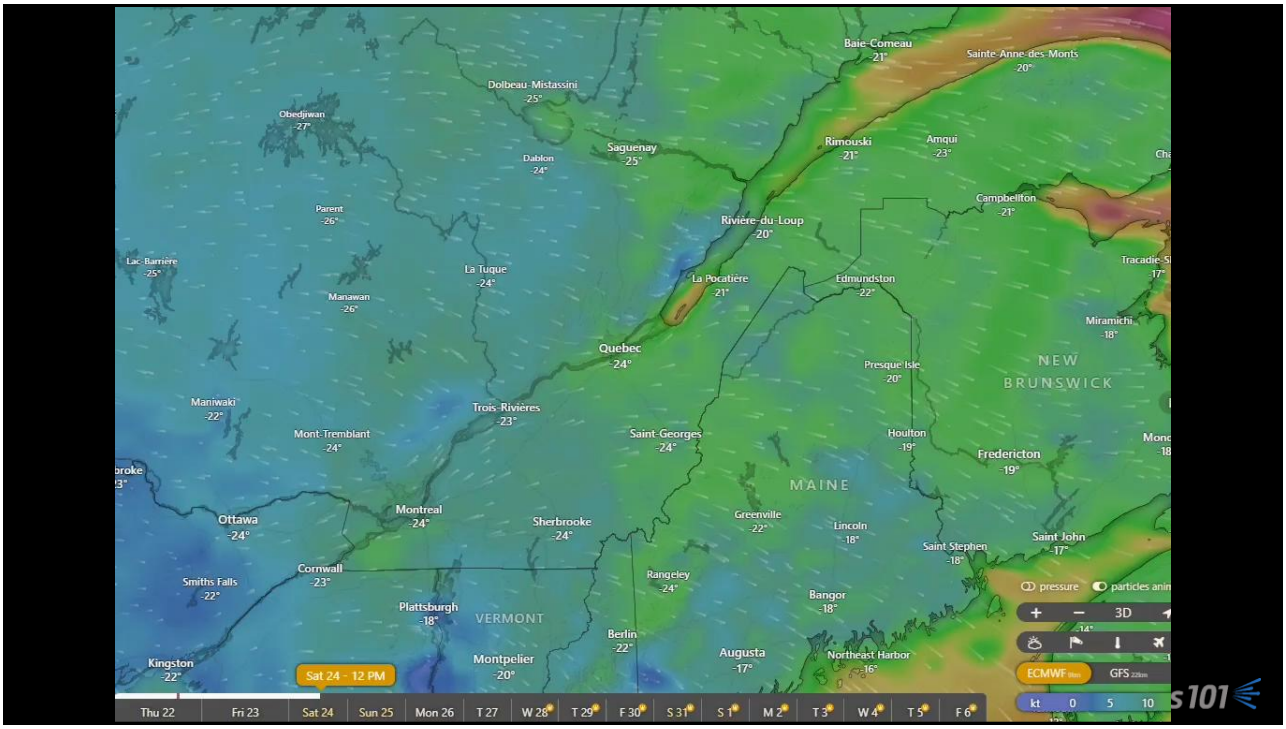


141

AI11004 (XC), 30” boom, 14 mph



142



143

INVERSIONS

144

It’s better to spray in wind than (inverted) calm

145

146

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148

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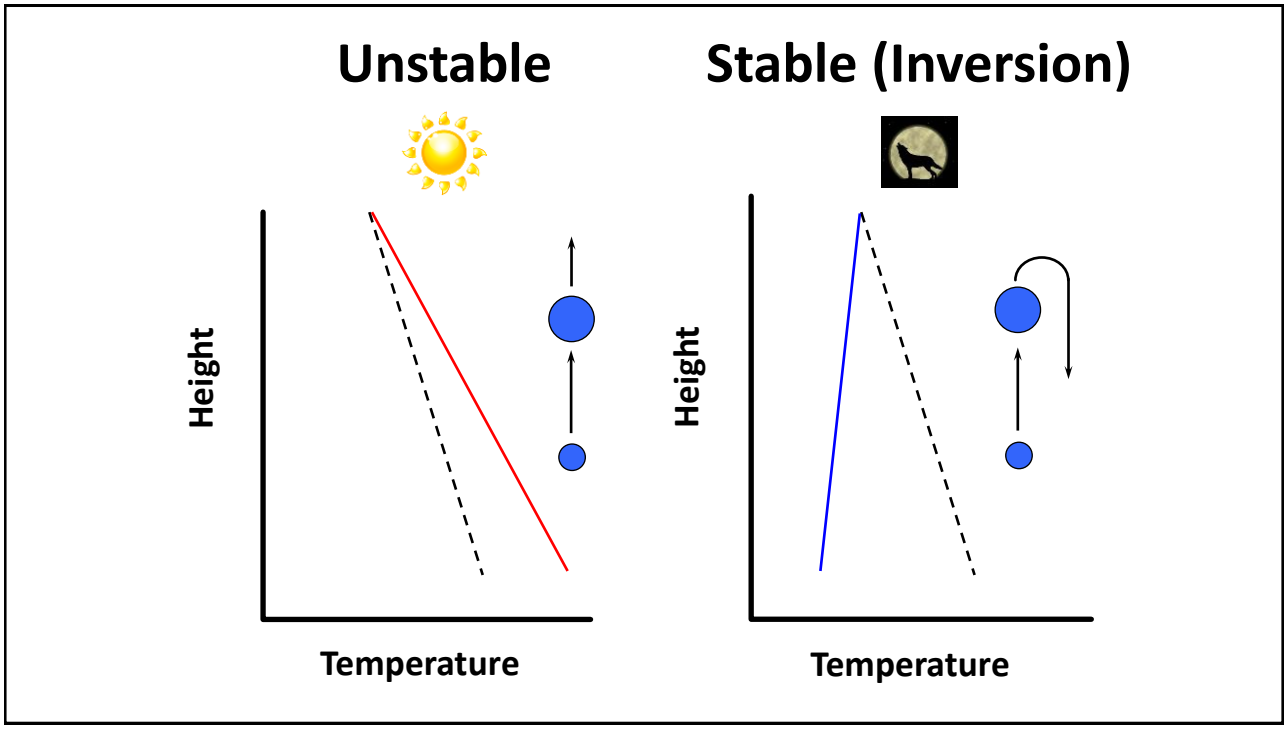
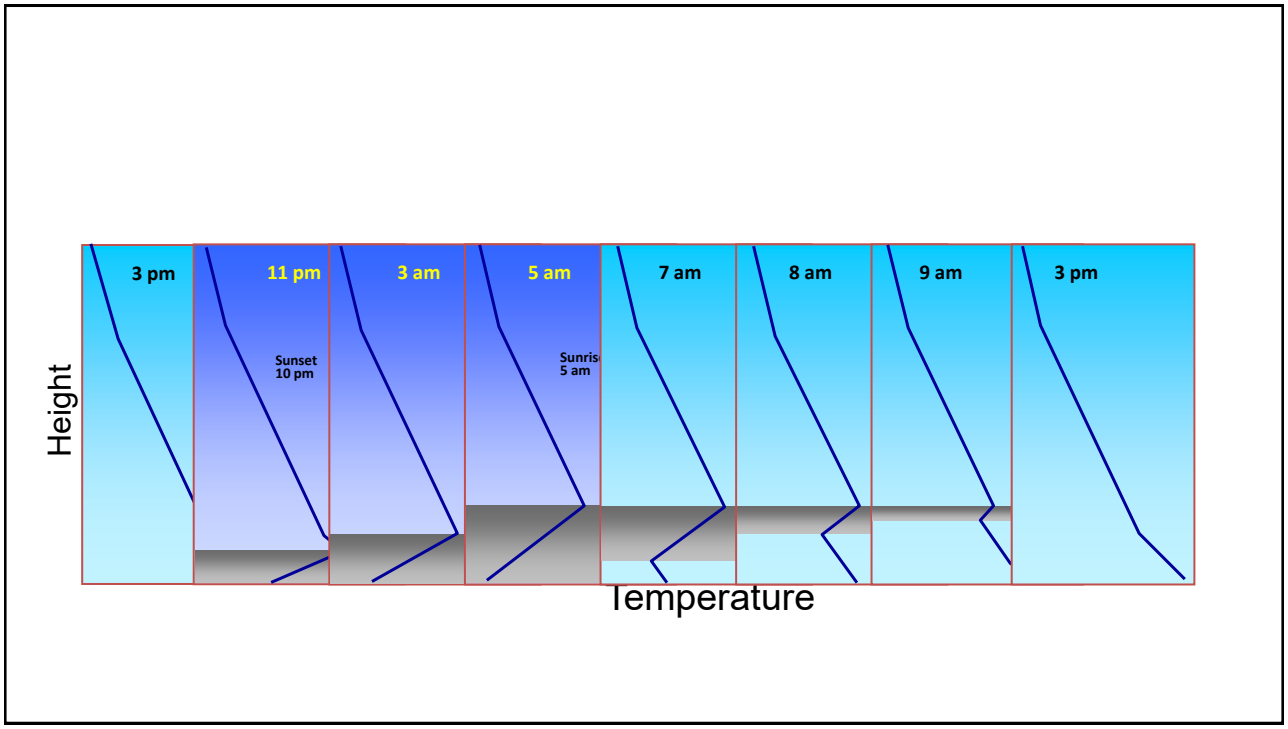
Inversion Definition

- An atmospheric condition in which air temperature increases with elevation
- Can be caused by
  - thermal cooling of the earth's surface (radiation inversion)
  - Sinking air (traps cold air)
  - Cold front (pushes warm air up)

150


Unstable
Stable (Inversion)
Height
Temperature
Height
Temperature

151

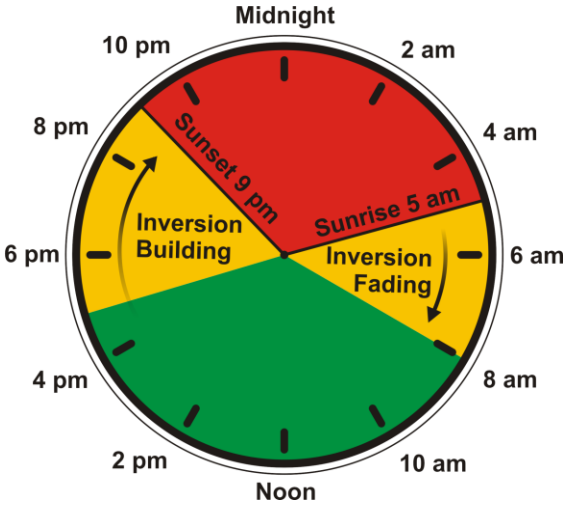

3 pm
11 pm
Sunset
10 pm
3 am
5 am
Sunris
5 am
7 am
8 am
9 am
3 pm
Height
Temperature

152

153

154

Inversions occur most nights on the prairies



155

156

157

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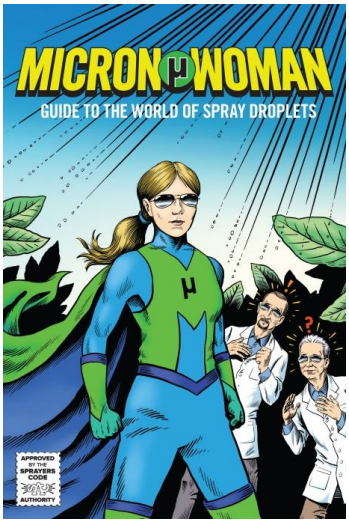
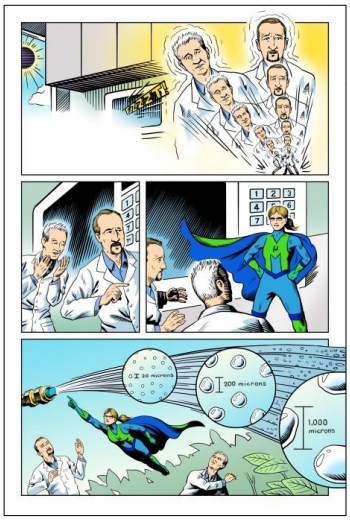
159

Summary

- A good low-drift nozzle is most powerful tool for reducing spray drift;
- Higher winds cause more drift loss, but not always more drift damage;
- Low winds during inversions can damage a large area.

160





Sprayers 101

Dr. Tom Wolf
@nozzle_guy

Dr. Jason Deveau
@spray_guy

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