Sprayer Calibration

Tom Getts UCCE Advisor

Some Slides Courtesy of: Lynn Wunderlich and Franz Niederholzer

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Calibration

- Uniform pesticide application
  - Approximately +- 5%

- Application rate
  - Quarts/acre
  - Pounds/acre

Calibration

- Example Milestone- 7 fl oz/acre
  - 7 oz = Little more than ½ a can of beer
  - 1acre=little less than football field (no endzones)
    - (43,560^2 vs 48,000ft^2)

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Calibration

- Example Milestone- 7 fl oz/acre
  - 7 oz = Little more than ½ a can of beer
  - 1acre=little less than football field (no endzones)
    - (43,560^2 vs 48,000ft^2)
- Need to spread thin
- Mix in water-(sometimes oil)

Why Calibrate?

- Efficacy of application
  - Poor weed control vs Crop damage
- Delay resistance
- Legal- following label rate
  - Protect environment
  - Protect you
  - Ensure success

Why Calibrate?

- Labor expensive!
- Pesticides EXPENSIVE!
  - 20 oz of Chlorsulfuron (Telar generic) $379
  - 2.5 gallons Habitat- $319
  - 2.5 gallons Milestone-$870 (45 acres $19/acre)

What do you need to Know?

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What do you need to Know?

- Volume/area=Application rate
  - Gallons/acre
  - Liters/hectacre

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What do you need to Know?

- Volume/area=Application rate
  - Gallons/acre
  - Liters/hectacre
- Gallons/acre=
  Flow rate(gal/time) / Land rate(acres/time)

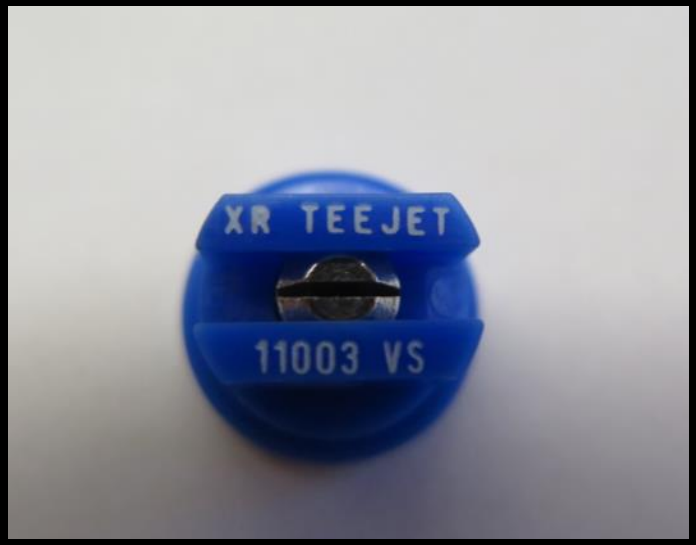
What do you need to Know?

- Volume/area=Application rate
  - Gallons/acre
  - Liters/hectacre
- Gallons/acre=
  Flow rate(gal/time) / Land rate(acres/time)
- Speed
- Pressure
- Orifice size

Step One

- Nozzle Selection
- What are you spraying?
  - Contact pesticide?
  - Systemic pesticide?
  - Target Gallons/acre?
  - Droplet Size?

Can you tell what flow rate this nozzle should deliver?



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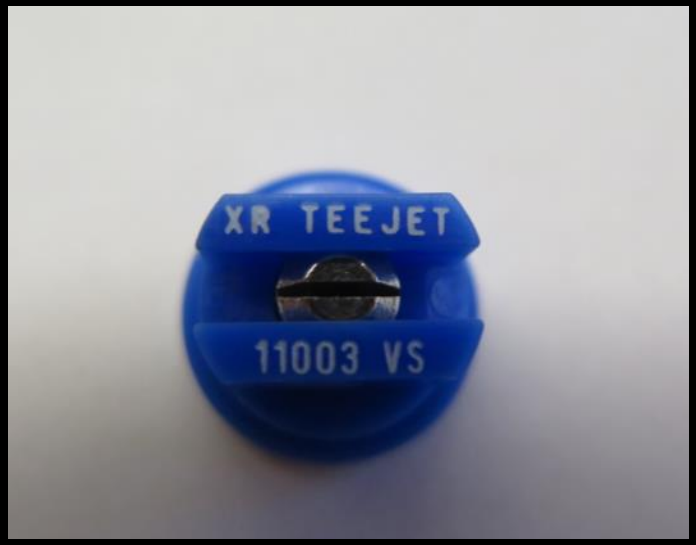
Can you tell what flow rate this nozzle should deliver?



This XR (extended range) flat fan nozzle is a 11003. It should deliver 0.3 gallons per minute at 40 psi with a spray angle of 110°. The VS stands for “visiflow”, the nozzle body material (visiflow plastic).

Flow Rate

- Volume of liquid / Time
  - Nozzle orifice size
  - Number of nozzles
  - Pressure
  - Viscosity (oil vs water)

XR TeeJet® Extended Range Flat Spray Tips

Typical Applications:

See selection guide on page 4 for recommended typical applications for XR TeeJet tips.

Features:

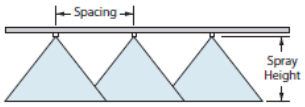
- Excellent spray distribution over a wide range of pressures—15–60 PSI (1–4 bar).
- Ideal for rigs equipped with sprayer controllers.
- Reduces drift at lower pressures, better coverage at higher pressures.
- Available in stainless steel, ceramic and polymer in 80° and 110° spray angles with VisiFlo® color-coding.
- Ceramic is available with corrosive-resistant polypropylene VisiFlo color-coded tip holder in 80° capacities 03–08 and 110° capacities 02–08.
- XR110025 only available in VK.
- XR80025 and XR80035 only available in VS.
- Brass available in 110° only.
- Automatic spray alignment with 25612-*-NYR Quick TeeJet® cap and gasket. Reference page 64 for more information.
- Automatic spray alignment for sizes 10 and 15 with 25610-*-NYR Quick TeeJet cap and gasket. Reference page 64 for more information.

At 15 PSI (1 bar) Pressure — At 60 PSI (4 bar) Pressure

	PSI	DROP SIZE 80°	DROP SIZE 110°	CAPACITY ONE NOZZLE IN GPM	CAPACITY ONE NOZZLE IN OZ./MIN.	20° GPA 4 MPH	GPA 5 MPH	GPA 6 MPH	GPA 8 MPH	GPA 10 MPH	GPA 12 MPH	GPA 15 MPH	GPA 20 MPH	GALLONS PER 1000 SQ. FT. 2 MPH	3 MPH	4 MPH	5 MPH
XR8001 XR11001 (100)	15	F	F	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	F	F	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	F	F	0.087	11	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	F	F	0.10	13	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	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	VF	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
XR80015 XR110015 (100)	15	M	F	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	F	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
	30	F	F	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	F	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
	50	F	F	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	F	F	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
XR8002 XR11002 (50)	15	M	M	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	M	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
	30	F	F	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	F	F	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	F	F	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	F	F	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
XR80025 XR110025 (50)	15	M	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
	20	M	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
	30	F	F	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	F	F	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	F	F	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	F	F	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
XR8003 XR11003 (50)	15	M	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
	20	M	M	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	F	F	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	F	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
	50	F	F	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	F	F	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
XR80035 (50)	15	M		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
	20	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
	30	M		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
	40	M		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
	50	F		0.39	50	29	23	19.3	14.5	11.6	9.7	7.7	5.8	1.3	0.88	0.66	0.53
	60	F		0.43	55	32	26	21	16.0	12.8	10.6	8.5	6.4	1.5	0.97	0.73	0.58
XR8004 XR11004 (50)	15	C	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
	20	M	M	0.28	36	21	16.6	13.9	10.4	8.3	6.9	5.5	4.2	1.0	0.63	0.48	0.38
	30	M	M	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	M	M	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	F	F	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	F	F	0.49	63	36	29	24	18.2	14.6	12.1	9.7	7.3	1.7	1.1	0.83	0.67
XR8005 XR11005 (50)	15	C	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
	20	C	M	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
	30	M	M	0.43	55	32	26	21	16.0	12.8	10.6	8.5	6.4	1.5	0.97	0.73	0.58
	40	M	M	0.50	64	37	30	25	18.6	14.9	12.4	9.9	7.4	1.7	1.1	0.85	0.68
	50	M	F	0.56	72	42	33	28	21	16.6	13.9	11.1	8.3	1.9	1.3	0.95	0.76
	60	F	F	0.61	78	45	36	30	23	18.1	15.1	12.1	9.1	2.1	1.4	1.0	0.83
XR8006 XR11006 (50)	15	C	C	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
	20	C	M	0.42	54	31	25	21	15.6	12.5	10.4	8.3	6.2	1.4	1.0	0.71	0.57
	30	M	M	0.52	67	39	31	26	19.3	15.4	12.9	10.3	7.7	1.8	1.2	0.88	0.71
	40	M	M	0.60	77	45	36	30	22	17.8	14.9	11.9	8.9	2.0	1.4	1.0	0.82
	50	M	M	0.67	86	50	40	33	25	19.9	16.6	13.3	9.9	2.3	1.5	1.1	0.91
	60	M	F	0.73	93	54	43	36	27	22	18.1	14.5	10.8	2.5	1.7	1.2	0.99
XR8008	15	VC	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
	20	VC	C	0.57	73	42	34	28	21	16.9	14.1	11.3	8.5	1.9	1.3	0.97	0.78
	30	C	C	0.69	88	51	41	34	26	20	17.1	13.7	10.2	2.3	1.6	1.2	0.94

CONTACT PRODUCT	SYSTEMIC PRODUCT	DRIFT MANAGEMENT
EXCELLENT	GOOD	GOOD
GOOD*	VERY GOOD*	VERY GOOD*

*At pressures below 30 PSI (2.0 bar)



Optimum Spray Height

	20°
80°	30"
110°	20"

How to order:

Specify tip number.

Examples:

XR8004VS – Stainless Steel with VisiFlo color-coding

The catalog has a lot of information on droplet size and gallons per acre -at a given pressure- at typical spacing and travel speeds.

Even if you have the manufacturer's listed rate from the catalog, it's still a good idea to measure the *actual* flow rate from the nozzle
(*why might these differ*?)

Always good to measure!

- Worn nozzles

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Always good to measure!

- Worn nozzles
  - 50 hours brass
  - 10-15% increase in flow rate
  - 50 hours steel
  - 2% increase flow rate

Always good to measure!

- Worn nozzles
  - 50 hours brass
  - 10-15% increase in flow rate
  - 50 hours steel
  - 2% increase flow rate
- Clogged nozzles
- Incorrect pressure
- Hose lengths

Tools you will need to measure flow rate.

Plus or minus 5%!

- Important to measure
- Average output of each nozzle
- Help detect worn/clogged nozzles

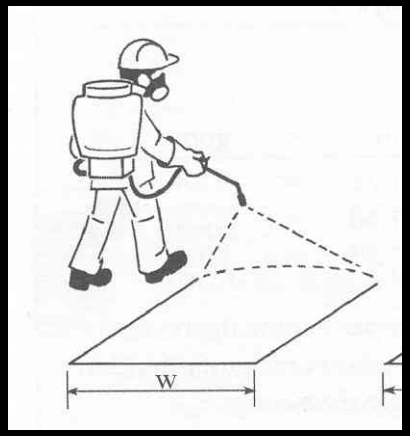
How to change flow rate?

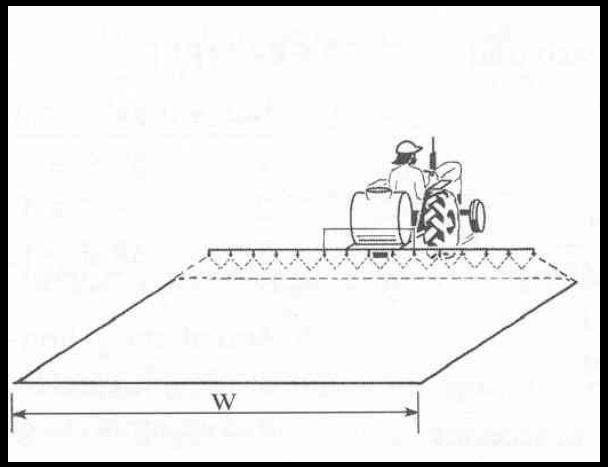
- Increase or decrease pressure
- Change nozzle orifice size

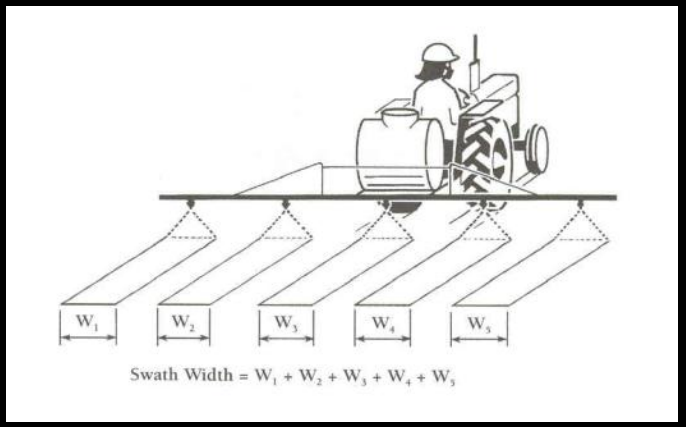
Land Rate

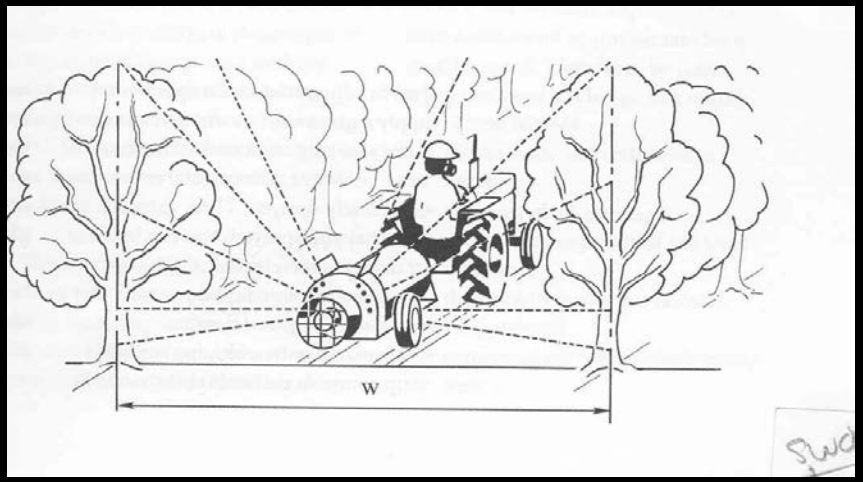
- Speed*Swath = land rate
- How fast you cover “land”

Swath measurements









Swath

- Effective boom width
  - Nozzle spacing
  - Number of nozzles

  - Example
  - 6 nozzle's*20 inch spacing=120inches=10 ft. boom width

Speed

- ATV/tractor-test speedometer
  - Drive over application area
  - Fill spray tank half full (exact volume known)
  - GPS
  - Stopwatch distance
  - Tractor Mark Gears/RPM

Speed

- ATV/tractor-test speedometer
  - Drive over application area
  - Fill spray tank half full (exact volume known)
  - GPS
  - Stopwatch distance
  - Tractor Mark Gears/RPM
- Walking consistent speed
  - Metronome

How to change land rate

- Alter speed

Application Rate

$$\frac{Gallons}{Acre} =$$

Application Rate

$$\frac{Gallons}{Acre} = \frac{Flow\ Rate}{Land\ Rate}$$

Application Rate

$$\frac{Gallons}{Acre} = \frac{Flow\ Rate}{Land\ Rate} = \frac{\frac{Gallons}{Time}}{\frac{Acres}{Time}}$$

Application Rate

$$\frac{Gallons}{Acre} = \frac{Flow\ Rate}{Land\ Rate} = \frac{\frac{Gallons}{Time}}{\frac{Acres}{Time}} = \frac{Gallons}{Time} * \frac{Time}{Acres}$$

Application Rate

$$\frac{Gallons}{Acre} = \frac{Flow\ Rate}{Land\ Rate} = \frac{\frac{Gallons}{Time}}{\frac{Acres}{Time}} = \frac{Gallons}{\cancel{Time}} * \frac{\cancel{Time}}{Acres}$$

Application Rate

$$\frac{Gallons}{Acre} = \frac{Flow\ Rate}{Land\ Rate} = \frac{\frac{Gallons}{Time}}{\frac{Acres}{Time}} = \frac{Gallons}{\cancel{Time}} * \frac{\cancel{Time}}{Acres}$$

Application Rate

- Gallons/acre
- Figure out how much pesticide to add to the tank!

How much pesticide goes in tank?

- 180 gallon/tank=Tank Size
- 15 gallons/acre= Application volume
- Desired application rate= 1.5oz Telar/acre

- How much Telar do you put in tank?

How much pesticide goes in tank?

$$\frac{1\ acre}{15\ gallons} * \frac{180\ gallons}{1\ tank} =$$

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How much pesticide goes in tank?

$$\frac{1\ acre}{15\ \cancel{gallons}} * \frac{180\ \cancel{gallons}}{1\ tank} = \frac{12\ acres}{1\ tank}$$

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How much pesticide goes in tank?

$$\frac{1\ acre}{15\ gallons} * \frac{180\ gallons}{1\ tank} = \frac{12\ acres}{1\ tank}$$

$$\frac{1.5\ oz\ Telar}{1 acre} * \frac{12\ acres}{1\ tank} =$$

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How much pesticide goes in tank?

$$\frac{1\ acre}{15\ gallons} * \frac{180\ gallons}{1\ tank} = \frac{12\ acres}{1\ tank}$$

$$\frac{1.5\ oz\ Telar}{1 acre} * \frac{12\ acres}{1\ tank} = \frac{18 oz\ Telar}{1\ tank}$$

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Outside

- Calibrate ATV and Backpack
  - Principles will work for all sprayers

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Data to collect ATV

- Land Rate
  - ATV Speed
  - ATV Swath width
- Flow Rate
  - Pressure
  - Nozzle size
  - Nozzle output per minute
    - Three nozzles- average output
    - +- 5%

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Data to collect for backpack

- Math less! kinda…
- 43,560ft^2 in acre
- 128 oz in gallon
- 43560/280=340ft.^2
- Time to spray 18.5*18.5 area (304 ft.^2)
- Volume sprayed over time

Outside!

Conversions you may find useful

- 1 mile=5280 ft.
- 1 acre=43560 ft^2
- 1 gallon=128 fl oz
- 1 oz=29.57 ml
- 1 hour= 3600 seconds

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ATV Sprayer

- Speed?
- 100 feet- how fast in seconds?

- We are interested in Area….

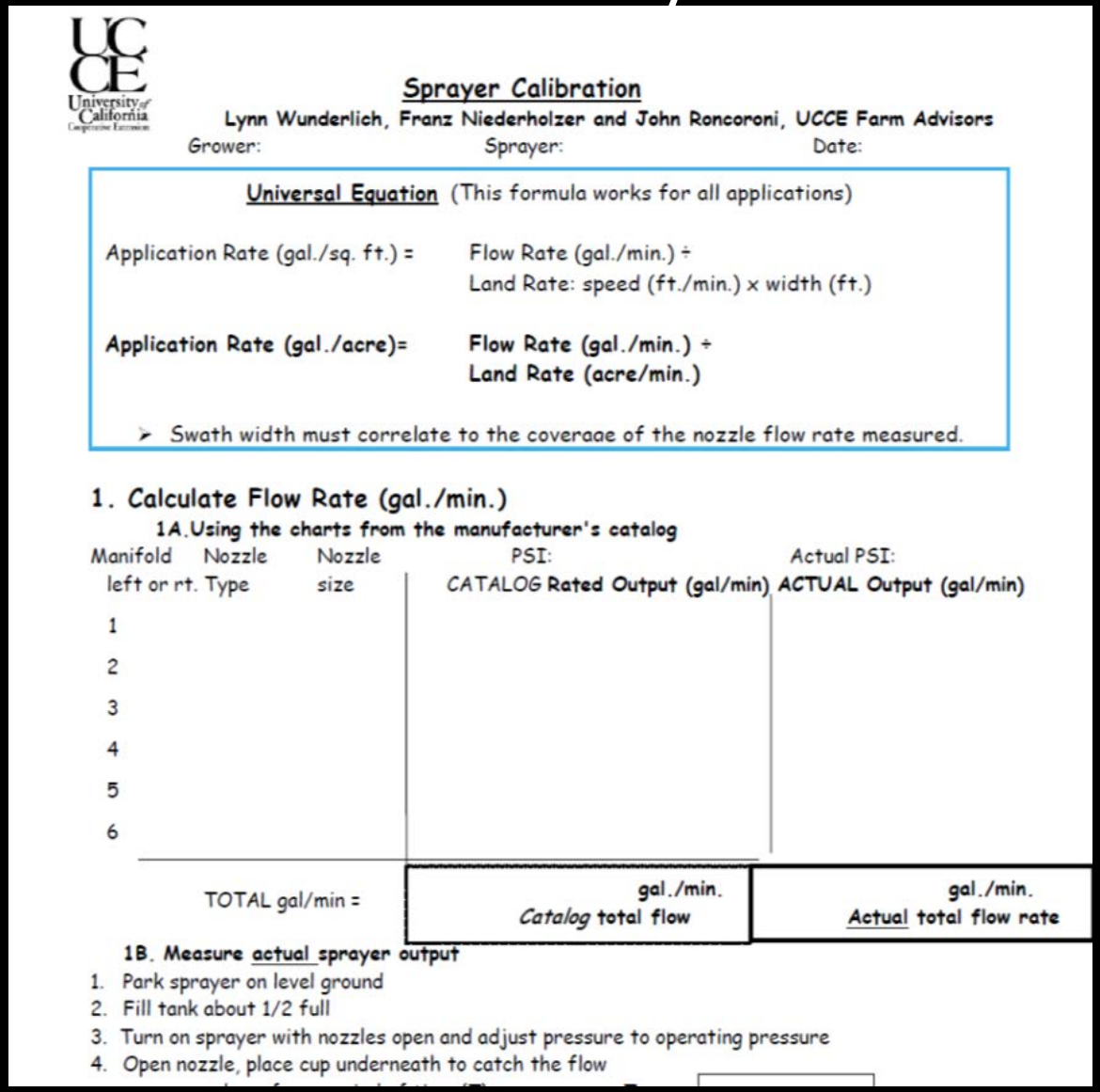
ATV Sprayer

- Boom Width
  - 3 nozzles
  - 20 inch Spacing
  - 3*20=60 inches
  - 60 inches=5 foot spray width
- Area Sprayed
  - 100 ft. long
  - 5 ft. wide
  - 500 Sq feet area sprayed in X seconds

Flow Rate

- 15 seconds collect nozzles
  - (go to excel sheet to do math)
  - Note pad

Lots of worksheets you can use



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Sprayer Calibration

Lynn Wunderlich, Franz Niederholzer and John Roncoroni, UCCE Farm Advisors

Grower: Sprayer: Date:

Universal Equation (This formula works for all applications)

Application Rate (gal./sq. ft.) = Flow Rate (gal./min.) ÷ Land Rate: speed (ft./min.) x width (ft.)

Application Rate (gal./acre)= Flow Rate (gal./min.) ÷ Land Rate (acre/min.)

- Swath width must correlate to the coverage of the nozzle flow rate measured.

1. Calculate Flow Rate (gal./min.)

1A. Using the charts from the manufacturer's catalog

Manifold left or rt.	Nozzle Type	Nozzle size	PSI: CATALOG Rated Output (gal/min)	Actual PSI: ACTUAL Output (gal/min)
1				
2				
3				
4				
5				
6				
TOTAL gal/min =			gal./min. *Catalog* total flow	gal./min. Actual total flow rate

1B. Measure actual sprayer output

1. Park sprayer on level ground
2. Fill tank about 1/2 full
3. Turn on sprayer with nozzles open and adjust pressure to operating pressure
4. Open nozzle, place cup underneath to catch the flow

Example area based method

- Fill sprayer half way
- Spray area
- Measure how much liquid was used!

Example area based method

- Tractor sprayer
  - 30 ft. boom
  - 20 inch spacing
  - 18 nozzles
  - 11004 flat fan
  - 250 gallon tank
- Want to spray 2 qt’s Roundup/acre over 160 acres

Example area based method

- Book says
  - 40 PSI
  - 11004 Nozzle will flow at .4 gallons per minute
  - 12.8oz -15 seconds
  - 24 gallons/acre at 5mph

Example area based method

- Fill tank half way up- spray for 300 feet
- Takes 42 seconds

Example area based method

- Fill tank half way up- spray for 300 feet
- Takes 42 seconds
- Land rate= 30 ft boom* 300 ft/ 42 seconds
- Land rate= 9000ft^2/42seconds

Example area based method

- Need flow rate
- Measure how much water was sprayed
- Fill tank back to halfway mark

Example area based method

- Need flow rate
- Measure how much water was sprayed
- Fill tank back to halfway mark
- 5.5 gallons sprayed
- So flow rate= 5.5 gallons/42 seconds

Example area based method

- So application rate?
- Land rate= 9000ft^2/42seconds
- So flow rate= 5.5 gallons/42 seconds
- 1 acre=42,560ft^2

Example area based method

$$\frac{5.5\ gallons}{42\ seconds} * \frac{42\ seconds}{9000ft\text{^}2} * \frac{43{,}560ft\text{^}2}{1acre} =$$

Example area based method

$$\frac{5.5\ gallons}{42\ seconds} * \frac{42\ seconds}{9000 ft\text{^}2} * \frac{43{,}560 ft\text{^}2}{1 acre} = \frac{26.62 gal}{acre}$$

Example area based method

- 2 qt’s per acre
- 250 gallon tank
- How much to put in?

Example area based method

- 2 qt's per acre
- 250 gallon tank
- How much to put in?
- $\frac{1\ acre}{26.2\ gal} * \frac{250\ gal}{1\ tank} = -$

Example area based method

- 2 qt's per acre
- 250 gallon tank
- How much to put in?

$$\frac{1\ acre}{26.2\ \cancel{gal}} * \frac{250\ \cancel{gal}}{1\ tank} = \frac{9.54\ acres}{1\ tank}$$

Example area based method

- 2 qt's per acre
- 250 gallon tank
- How much to put in?

$$\frac{1\ acre}{26.2\ gal} * \frac{250\ gal}{1\ tank} = \frac{9.54\ acres}{1\ tank} * \frac{2qt\ roundup}{1\ acre} = -$$

Example area based method

- 2 qt's per acre
- 250 gallon tank
- How much to put in?

$$\frac{1\ acre}{26.2\ gal} * \frac{250\ gal}{1\ tank} = \frac{9.54\ acres}{1\ tank} * \frac{2qt\ roundup}{1\ acre} = \frac{19.08\ qt\ r}{1\ tank}$$

No Math Method

- 1 Acre = 43560 ft^2
- 1 gallon = 128oz
- 43560/128 = 340 ft^2
- So number of oz used to cover 340 ft^2 = Gallons/acre!
- Time application, and collect liquid

No math

$$\frac{44oz}{340.31\ ft\text{^}2} * \frac{1gallon}{128oz} * \frac{42560ft\text{^}2}{1\ acre} =$$

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No math

$$\frac{44oz}{340.31\ ft\text{^}2} * \frac{1 gallon}{128oz} * \frac{42560 ft\text{^}2}{1\ acre} = \frac{42.99\ gal}{1\ acre}$$

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No Math Method

- How else can you get 340 ft^2?

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No Math Method

- 10 feet*34 feet =340

No Math Method

- 10 feet*34 feet =340
- What about bigger sprayers?
- 20 inch spacing
- 20/12=1.66666 feet
- 340/1.66666=204 feet

No Math Method

- 20 inch spacing
- Seconds to travel 204 feet
- Collect spray volume 1 nozzle
- Number oz=gallons per acre

Stationary Method

- Speed miles per hour to seconds to cover 204 feet
- $\frac{5\ miles}{1\ hour} * \frac{1\ hour}{60\ minute} * \frac{1\ minute}{60\ seconds} * \frac{5280\ ft}{1\ mile}$

Stationary Method

- Speed miles per hour to seconds to cover 204 feet
- $\frac{5\ miles}{1\ hour} * \frac{1\ hour}{60\ minute} * \frac{1\ minute}{60\ seconds} * \frac{5280\ ft}{1\ mile} = \frac{7.333\ feet}{1\ second}$
- $\frac{1\ second}{7.333\ feet}$*204 feet=

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Stationary Method

- Speed miles per hour to seconds to cover 204 feet
- $\frac{5\ miles}{1\ hour} * \frac{1\ hour}{60\ minute} * \frac{1\ minute}{60\ seconds} * \frac{5280\ ft}{1\ mile} = \frac{7.333\ feet}{1\ second}$
- $\frac{1\ second}{7.333\ feet}$*204 feet=27.8 seconds
- On 20 inch spacing, 5 miles per hour, need to collect liquid for 27.8 seconds to get sprayer output

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