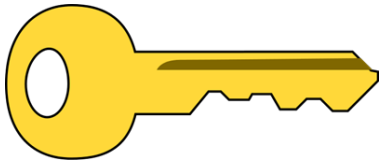
KEYS to CALIBRATION

Lynn R. Wunderlich, Farm Advisor
University of California Cooperative Extension-Central Sierra

Harvey Lyman 2017 Grape Grower Meeting-Lodi

November 30, 2017

What is calibration?



"the act of

selecting,

establishing,

maintaining, and

verifying

sprayer operation parameters which result in a

known,

desired and

uniform

application rate of spray material".

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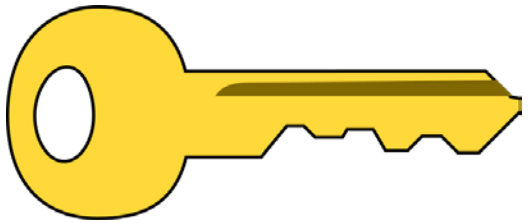

KNOW YOUR NOZZLES

SELECT, CHANGE and INSPECT THEM REGULARLY

What does the nozzle contribute to calibration?

1. FLOW RATE: Volume/Time (Gallons/Min)

Nozzle flow rate is directly proportional to application rate (Gallons/acre)

Want a larger application rate? Increase the flow rate by either:

Increase nozzle size (Larger droplets*)

Increase pressure (Smaller droplets)

2. DROPLET SIZE* (COVERAGE/DRIFT)

* Except for VENTURI sprayers, where droplets are always fine.

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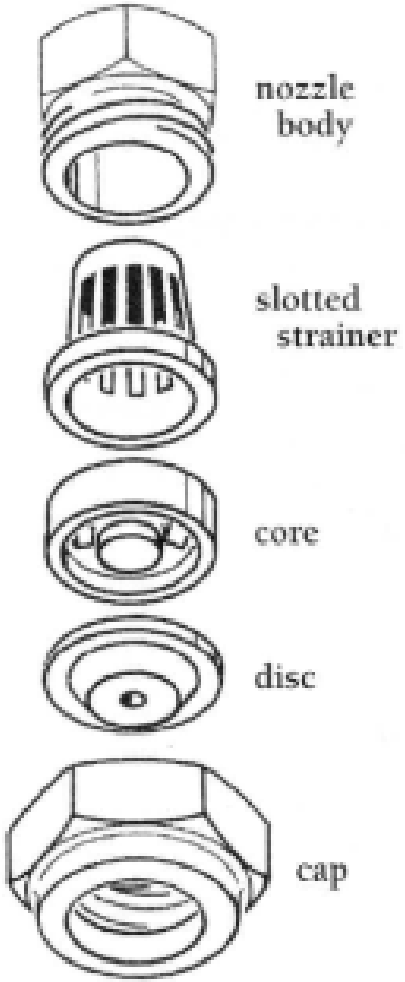
Disc-core nozzles are used in high volume applications



D-3 through D-16

Numbers indicate diameter in 1/64 inch:

D-4=4/64=0.06”

D-8 = 8/64 = 0.125”

D-16= 16/64 = 0.25”

Paired with various core or “spinner plate” nozzles (i.e. DC13 –DC 56).

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The stamp indicating the manufacturer's flow rate may be hard to see on disc and core nozzles.

This is a DC "35".

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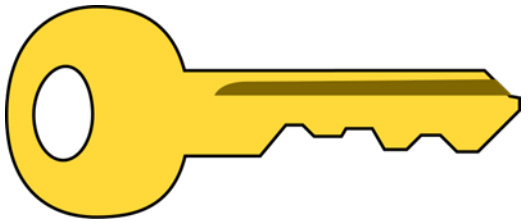

USE the manufacturer catalog (and in the appropriate language)

USE it to determine your nozzle

FLOW RATE

DROPLET SIZE RANGE

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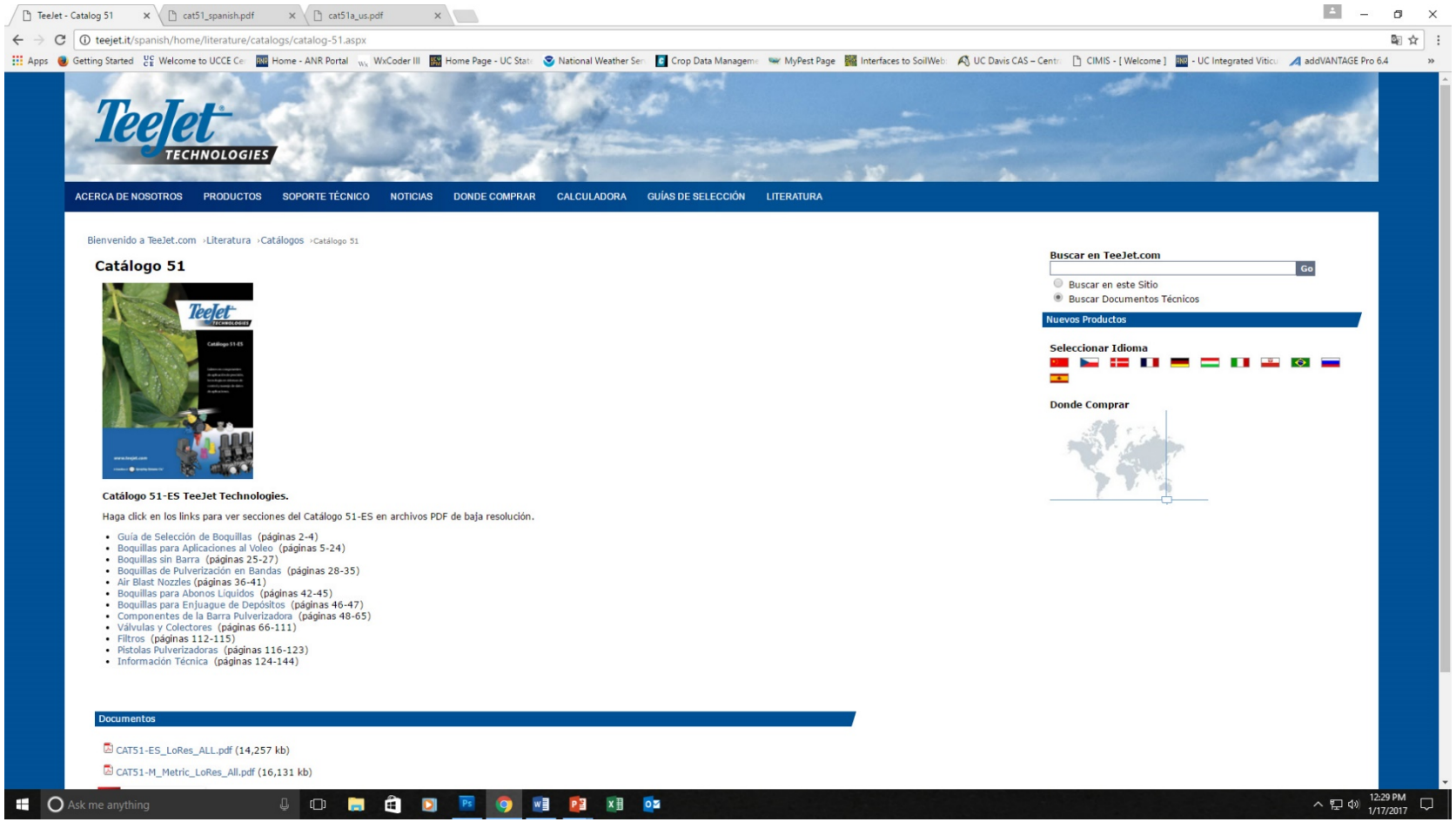
http://teejet.it/media/427750/cat51_spanish.pdf



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Check the manufacturer's catalog to determine the flow rate for a given nozzle(s) at a given pressure.

Hollow Cone Type Spray Tips

			GPM										20 PSI	40 PSI	80 PSI
			10 PSI	20 PSI	30 PSI	40 PSI	60 PSI	80 PSI	100 PSI	150 PSI	200 PSI	300 PSI			
D1	DC13	.031"	—	—	.059	.066	.078	.088	.097	.115	.128	.152	—	51°	62°
D1.5	DC13	.036"	—	.057	.067	.075	.088	.098	.110	.127	.142	.167	38°	55°	66°
D2	DC13	.041"	—	.064	.075	.08	.10	.11	.12	.14	.16	.18	49°	67°	72°
D3	DC13	.047"	—	.071	.08	.09	.11	.12	.13	.16	.18	.20	53°	70°	75°
D4	DC13	.063"	.070	.09	.11	.12	.14	.16	.17	.20	.23	.27	69°	79°	83°
D1	DC23	.031"	—	—	.064	.072	.080	.096	.107	.124	.139	.164	—	47°	58°
D1.5	DC23	.036"	—	.064	.076	.086	.103	.117	.130	.155	.175	.210	34°	51°	62°
D2	DC23	.041"	—	.078	.092	.10	.13	.14	.16	.19	.21	.25	51°	63°	70°
D3	DC23	.047"	.065	.087	.10	.12	.14	.16	.18	.21	.24	.28	58°	69°	75°
D4	DC23	.063"	.082	.113	.14	.15	.19	.21	.23	.28	.32	.38	68°	82°	87°
D5	DC23	.078"	.095	.13	.16	.18	.22	.25	.28	.34	.38	.46	79°	89°	94°
D6	DC23	.094"	.112	.15	.19	.21	.26	.29	.32	.39	.45	.54	84°	93°	98°
D1	DC25	.031"	—	—	.088	.101	.122	.138	.156	.185	.210	.255	—	27°	43°
D1.5	DC25	.036"	—	—	.118	.135	.162	.185	.205	.245	.280	.33	—	38°	49°
D2	DC25	.041"	—	.12	.14	.16	.19	.22	.25	.29	.34	.41	39°	51°	58°

The D4, DC23 nozzle should deliver 0.23 gallons per minute at an operating pressure of 100 p.s.i.

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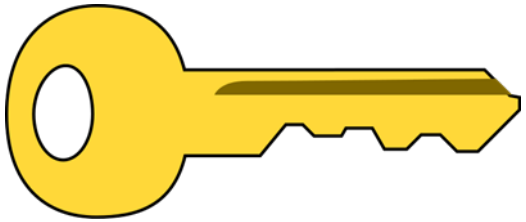

PRESSURE GAUGE: an essential component

Make sure the pressure gauge is operating properly and is maintained, is easy to read, and has a range that makes sense for the sprayer.

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Flow rate is pressure dependent

$$Q=K'\sqrt{\Delta P}$$

Where Q= flow rate

K= overall nozzle coefficient (nozzle shape and area)

$\sqrt{\Delta P}$= square root of change of pressure

So, if you want to double the flow rate, the pressure must increase by the square of two (2^2).

Likewise, if you wish to triple the flow rate, the pressure must increase by the square of three (3^2).

HOWEVER, adjusting pressure is one of the least desirable ways to change flow rate volume…(why?)


DANGER
ROTATING FAN HAZARD
KEEP AWAY
To prevent serious injury or death from rotating fan:
1. Keep guards in place over fan intake and outlet when operating.
2. Place all controls in neutral, stop tractor engine, set park brake, remove ignition key and wait for all moving parts to stop before servicing, adjusting, repairing or unplugging.
3. Keep hands, feet, hair and clothing away from rotating fan.
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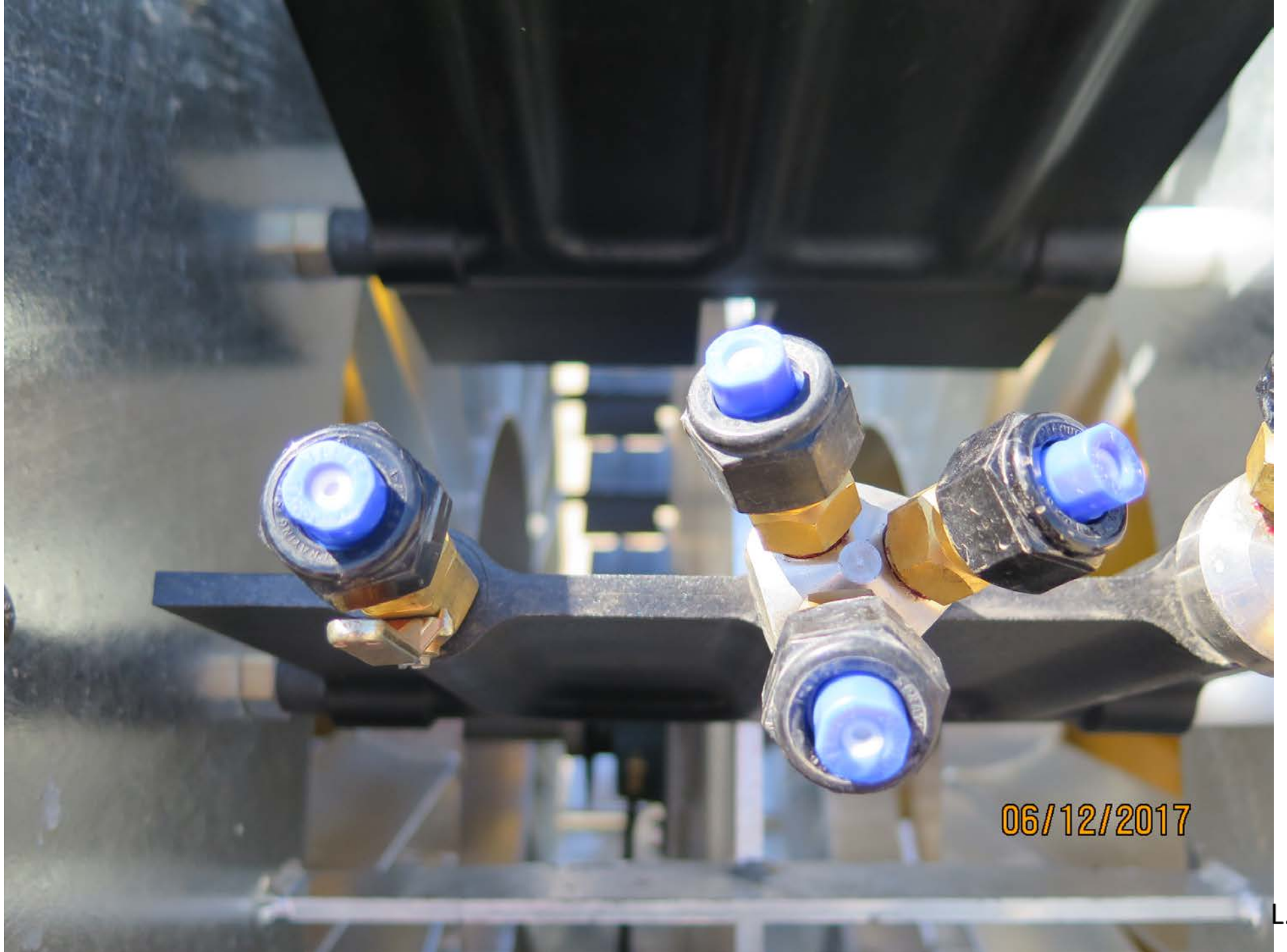

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TXR ConeJet® Hollow Cone Spray Tips

Typical Applications:

Use for directed applications in air blast spraying for orchards and vineyards and other specialty crops. Also well-suited for applications of insecticides, fungicides, defoliants and foliar fertilizers at pressures of 40 PSI (3 bar) and above.

Features:

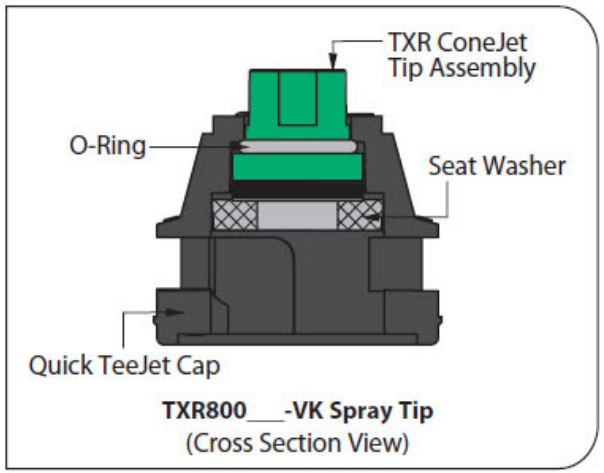
- Produces uniform, 80° hollow cone spray pattern ideal for airblast, directed and specialty applications.
- Flow rates are matched to serve as a direct replacement for commonly used non-TeeJet hollow cone spray tips.
- High-quality ceramic orifice provides superior wear life, including high-pressure operation.
- Low profile acetal tip body provides minimal impact with foliage and excellent chemical resistance.
- Color-coded holder based on tip flow rate allows for easy capacity identification.
- Snap-fit backup plate provides positive retention when handled in field, but allows for tool-free removal for easy cleaning.
- Best suited for use with TeeJet 98450 series brass rollover fittings.
- Compatible with TeeJet cap CP20230 for use on rollovers and threaded nozzle bodies, tighten to a maximum torque of: 100 in-lbs (11 N-m).
- Suggested spray pressure range of 30–360 PSI (2–25 bar).
- Uses 114396-1-NYR Quick TeeJet® cap, gasket and O-ring. Reference page 64 for more information.

How to order:

Specify tip number.
Examples:

TXR8003VK – Ceramic with color-coding

TXR8003VK-100X – Ceramic with color-coding, 100 Tip Pack



TXR800___-VK Spray Tip
(Cross Section View)

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		GPM																				
		30 PSI	40 PSI	50 PSI	60 PSI	70 PSI	80 PSI	90 PSI	100 PSI	120 PSI	140 PSI	160 PSI	180 PSI	200 PSI	220 PSI	240 PSI	260 PSI	280 PSI	300 PSI	320 PSI	340 PSI	360 PSI
TXR800053VK	100	0.046	0.053	0.059	0.064	0.069	0.073	0.077	0.081	0.089	0.095	0.101	0.107	0.113	0.118	0.123	0.127	0.132	0.136	0.140	0.144	0.148
		VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF
TXR800071VK	50	0.062	0.071	0.079	0.086	0.093	0.099	0.105	0.110	0.120	0.129	0.138	0.146	0.153	0.160	0.167	0.174	0.180	0.186	0.192	0.197	0.203
		F	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF
TXR8001VK	50	0.087	0.100	0.111	0.121	0.131	0.139	0.147	0.155	0.169	0.182	0.194	0.205	0.216	0.226	0.235	0.245	0.253	0.262	0.270	0.278	0.286
		F	F	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF
TXR80013VK	50	0.116	0.133	0.148	0.162	0.174	0.186	0.196	0.207	0.225	0.243	0.259	0.274	0.288	0.301	0.314	0.326	0.338	0.349	0.360	0.371	0.381
		F	F	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF
TXR80015VK	50	0.131	0.150	0.167	0.182	0.196	0.209	0.221	0.232	0.254	0.273	0.291	0.308	0.324	0.339	0.353	0.367	0.380	0.393	0.405	0.417	0.429
		F	F	F	F	F	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF
TXR80017VK	50	0.145	0.167	0.185	0.202	0.218	0.232	0.246	0.258	0.282	0.303	0.323	0.342	0.360	0.376	0.392	0.408	0.422	0.437	0.450	0.464	0.476
		F	F	F	F	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF
TXR8002VK	50	0.174	0.200	0.223	0.243	0.261	0.279	0.295	0.310	0.338	0.364	0.388	0.410	0.432	0.452	0.471	0.489	0.507	0.524	0.540	0.556	0.572
		F	F	F	F	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF
TXR80028VK	50	0.240	0.275	0.306	0.334	0.359	0.383	0.405	0.426	0.465	0.500	0.533	0.564	0.594	0.621	0.648	0.673	0.697	0.720	0.743	0.765	0.786
		F	F	F	F	F	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF
TXR8003VK	50	0.260	0.300	0.335	0.367	0.396	0.423	0.449	0.473	0.517	0.558	0.597	0.633	0.667	0.699	0.730	0.759	0.788	0.815	0.841	0.867	0.892
		F	F	F	F	F	F	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF
TXR80036VK	50	0.309	0.356	0.398	0.435	0.470	0.502	0.532	0.561	0.614	0.663	0.708	0.751	0.791	0.829	0.866	0.901	0.935	0.967	0.999	1.03	1.06
		F	F	F	F	F	F	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF
TXR8004VK	50	0.347	0.400	0.447	0.489	0.528	0.564	0.598	0.630	0.690	0.745	0.796	0.843	0.889	0.932	0.973	1.01	1.05	1.09	1.12	1.16	1.19
		F	F	F	F	F	F	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF
TXR80049VK	50	0.423	0.488	0.545	0.597	0.644	0.688	0.730	0.769	0.842	0.909	0.971	1.03	1.09	1.14	1.19	1.24	1.28	1.33	1.37	1.41	1.45
		F	F	F	F	F	F	F	F	F	F	F	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF

Note: Always double check your application rates. Tabulations are based on spraying water at 70°F (21°C).
See pages 136–157 for drop size classification, useful formulas and other information.

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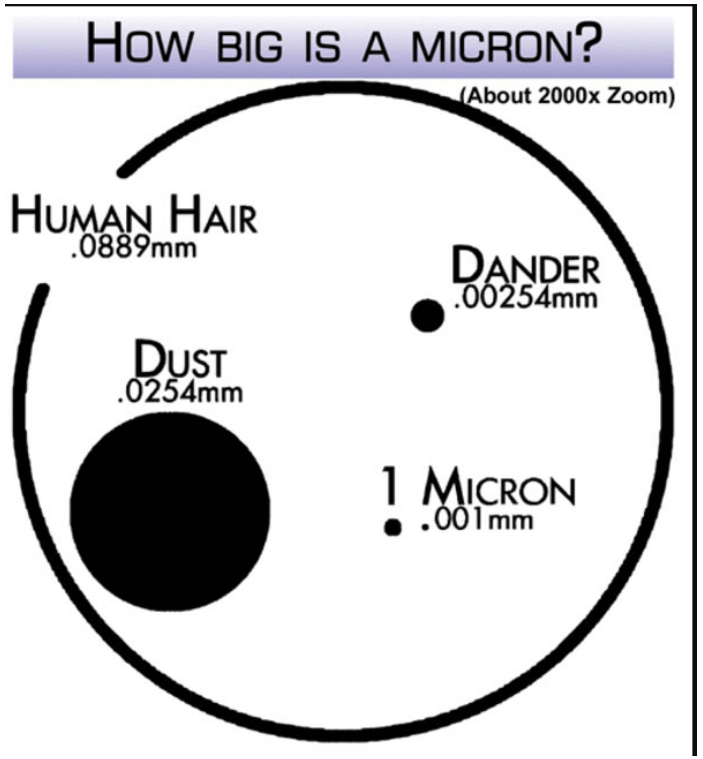
Table 2. Droplet classification system.

		VMD (0.5)
Very fine	VF	< 150
Fine	F	150 - 250
Medium	M	250 - 350
Coarse	C	350 - 450
Very coarse	VC	450 - 550
Extremely coarse	XC	> 550

Source: ASAE Standard S-572.

"VMD" is Volume Median Diameter.
Half of the droplets are larger,
half are smaller.
VMD is in MICRONS.



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CONSIDER DRIFT THE OPPOSITE OF COVERAGE: DROPLET SIZE MATTERS!

Table 1. Movement of spray particles.

Droplet diameter (microns)	Size classification (ASAE* equivalent)	Time required to fall 10 feet	Lateral movement in 3 mph wind
5	Fog	66 minutes	3 miles
20	Very fine	4.2 minutes	1,100 feet
100	Very fine	10 seconds	44 feet
240	Fine/medium	6 seconds	28 feet
400	Coarse	2 seconds	8.5 feet
1,000	Extremely coarse	1 second	4.7 feet

*American Society of Agricultural Engineers.
Source: Akesson and Yates, Annual Review of Entomology, 1964.

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This chart also tells you something about spray "Quality" (DROPLET SIZE) TeeJet Catalog

How to order:
Specify tip number.
Example:
AITXA8001VK – Ceramic with VisiFlo color-coding

		GPM													
		60 PSI	70 PSI	80 PSI	90 PSI	100 PSI	120 PSI	140 PSI	160 PSI	180 PSI	200 PSI	220 PSI	240 PSI	260 PSI	280 PSI	300 PSI
AITX†8001VK	50	0.121	0.130	0.138	0.146	0.154	0.168	0.181	0.192	0.203	0.214	0.224	0.233	0.242	0.251	0.260
		XC	XC	VC	VC	VC	C	C	C	C	C	C	C	M	M	M
AITX†80015VK	50	0.181	0.195	0.209	0.221	0.233	0.255	0.275	0.294	0.312	0.328	0.344	0.359	0.374	0.388	0.401
		XC	XC	XC	VC	VC	C	C	C	C	C	C	C	M	M	M
AITX†8002VK	50	0.247	0.195	0.286	0.303	0.320	0.351	0.379	0.405	0.430	0.453	0.476	0.497	0.517	0.537	0.556
		XC	XC	XC	XC	XC	VC	VC	VC	VC	C	C	C	C	C	C
AITX†80025VK	50	0.300	0.324	0.347	0.368	0.387	0.424	0.458	0.490	0.519	0.548	0.574	0.600	0.624	0.648	0.670
		UC	UC	XC	XC	XC	XC	XC	XC	VC	VC	VC	VC	VC	VC	C
AITX†8003VK	50	0.360	0.389	0.417	0.443	0.467	0.513	0.554	0.594	0.630	0.665	0.698	0.730	0.760	0.790	0.818
		UC	UC	XC	XC	XC	XC	XC	VC	VC	VC	VC	VC	C	C	C
AITX†8004VK	50	0.480	0.519	0.556	0.590	0.623	0.684	0.740	0.792	0.841	0.887	0.931	0.974	1.01	1.05	1.09
		UC	UC	UC	UC	XC	XC	XC	XC	XC	VC	VC	VC	VC	VC	VC

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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*?)

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Measuring actual flow rate for air-blast sprayers involves several steps

1. Park the sprayer on a level surface and fill up the tank with clean water to a line observed at the top of the tank.

2. Open up the nozzles and run the sprayer (or half of the sprayer bank of nozzles) for a set amount of time, from 15 seconds to 2 minutes. Be sure to record the pressure during this time.

3. Measure the amount of water it takes to fill the sprayer back up to the line observed in 1.

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What about Venturi sprayers?

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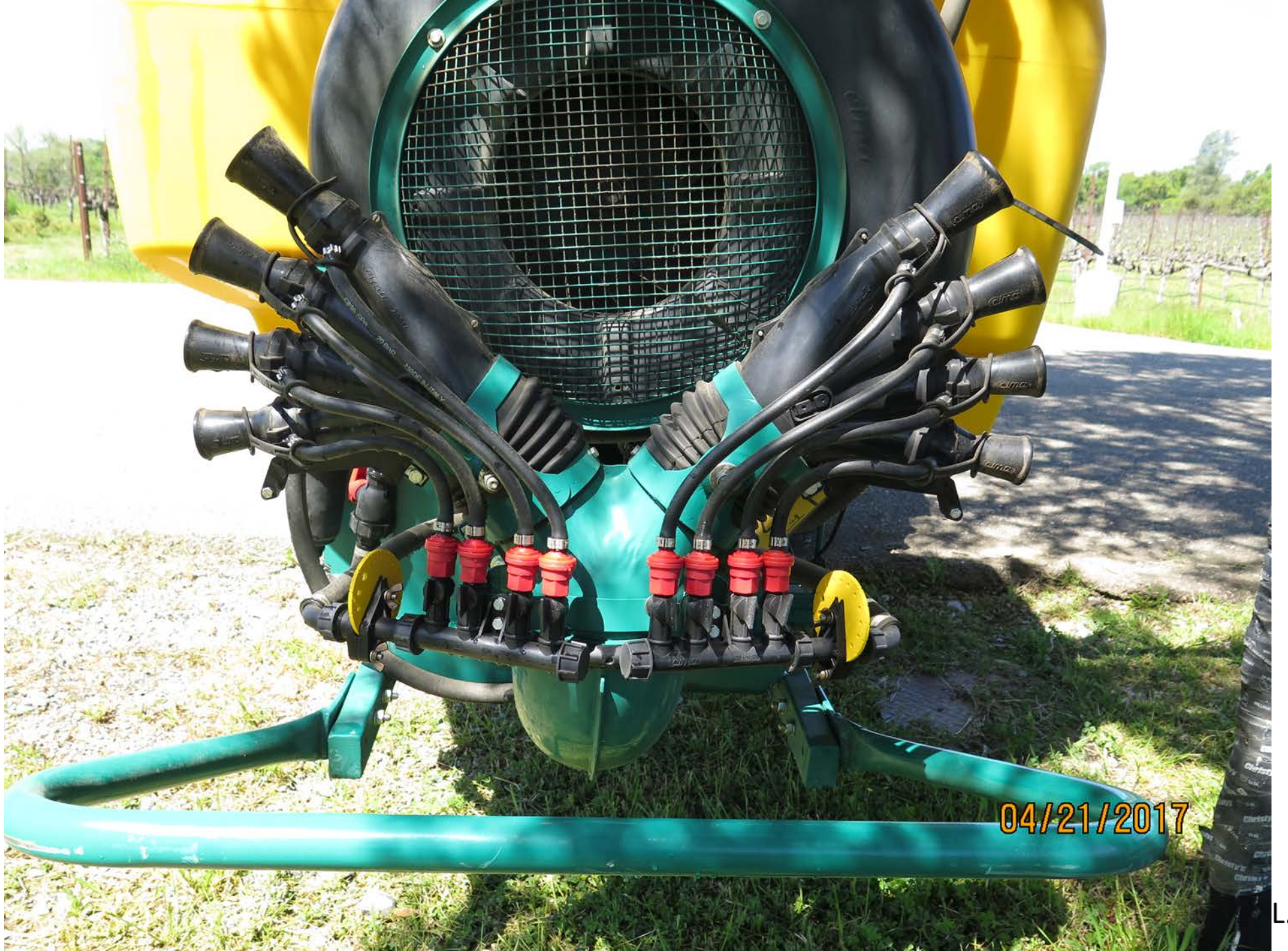

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PHONE (800)833-3023
FAX (909)548-4747
E-mail: sales@gearmore.com

GEARMORE INC.

13477 BENSON AVE.
CHINO, CA 91710
Website: www.Gearmore.com

VENTURI AIR SPRAYER CALIBRATION CHART

4 YELLOW *"DIAL-A-RATE"* DISCS

GALLONS PER MINUTE

DISC SETTING	PRESSURE SETTING (PSI)					
	16	22	25	28	33	36
1	0.5	0.5	0.5	0.6	0.6	0.7
2	0.6	0.8	0.9	1.0	1.0	1.0
3	1.0	1.1	1.1	1.2	1.3	1.4
4	1.2	1.4	1.5	1.6	1.7	1.8
5	1.7	1.9	2.0	2.1	2.2	2.3
6	1.9	2.1	2.3	2.4	2.5	2.6
7	3.1	3.3	3.5	3.7	3.8	4.0
8	3.7	3.9	4.1	4.3	4.5	4.7
9	4.5	4.7	5.0	5.3	5.7	6.0
10	5.3	5.5	5.9	6.2	6.5	6.9
11	6.5	6.8	7.3	7.8	8.1	8.6
12	7.9	8.5	9.5	9.9	10.5	11.1
13	9.4	9.8	10.6	11.4	12.0	12.8
14	10.4	10.7	11.7	12.6	13.5	14.3
15	11.0	11.3	12.7	13.5	14.6	15.7

To determine the required pressure setting, you must ***first*** determine how many Gallons Per Minute will be required.

$$\text{Gallons Per Minute} = \frac{2 \times (\text{Miles Per Hour}) \times (\text{Gallons Per Acre}) \times (\text{Width of Area Treated})}{1000}$$

NOTE for 3-Point Hitch Sprayer Users:

The lower the sprayer pressure, the greater the agitation. Use the lowest possible pressure to achieve the desired G.P.M. For example, a Dial-A-Rate disc setting of #4 @ 36 P.S.I. and a disc setting of #5 @ 22 P.S.I., both produce approximately 0.9 G.P.M. With Gearmore Venturi Air Sprayers, using a lower pressure does not affect the quality of the spray atomization.

THE VALUES GIVEN IN THIS CHART ARE BASED ON WATER WITH NO ADDITIVES. CONDITIONS MAY VARY FROM ONE FIELD TO THE NEXT. THE OPERATOR SHOULD ALWAYS CHECK THE ACTUAL RATE OF SPRAY IN THE FIELD BEING TREATED.

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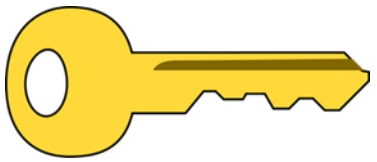
We've been talking about nozzles and their relation to flow rate.

Flow rate (Gallons/minute) is only part of calibration.

What are the other components?



Measure your **speed and swath width** to determine LAND RATE (ACRES/MIN)

- not just tractor speed
- *Area* covered per unit time (ft.²/min)

- **Speed (ft/min) x Swath width (ft.)**
- Convert ft.²/min to acres/min

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Pay attention to swath width-typically the row spacing width.

Land rate (acres/min) is inversely proportional to Application rate.

So if either of the components of land rate (speed or swath width) increases, the application rate (gallons/acre) DECREASES.

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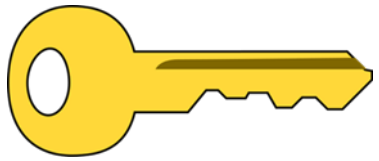

$$\text{Application rate (gal/acre)} = \frac{\text{Flow rate (gal/min)}}{\text{Land rate (ac/min)}}$$

This fundamental relationship works for all sprayers!

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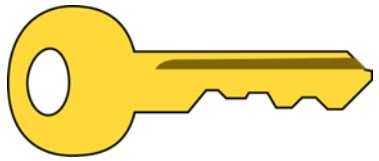
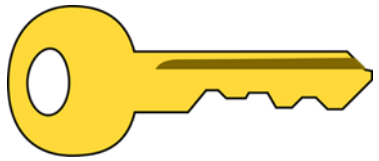


Application rate (gal/acre) = Flow rate (gal/min)
Land rate (ac/min)



Do the MATH: Track your UNITS to make the math easy.

Look up any conversions that you need!

Land rate example: air-blast application

1 mile=5280 feet
1 acre=43,560 ft.²

Tractor speed measured

(Landini 85F tractor at 4 turtle):

1. 100 ft./21 sec
2. 100 ft./20 sec
3. 100 ft./21 sec

average: 100 feet/20.3 sec.

$$\frac{\text{Ft. * 0.68}}{\text{Time (sec)}} = \text{MPH}$$

$$\frac{\text{100 ft. * 0.68}}{\text{20.3}} = 3.35 \text{ mph}$$

Note: Conversion to MPH is not necessary for the calibration calculation, but it is a nice unit to know for reference.

1. Convert speed to feet per min:

(100 ft./20.3 sec) (60 sec/min)=295 ft./min **OR**

(3.35 miles/hour)(1 hr./60 min)(5280 ft./mile) = 295 ft./min

2. **Multiply speed (ft./min) by swath width (ft.) to obtain ft.² /min.**

Our swath width is the vine row spacing, 9 feet.

295 ft./min * 9 ft. = 2653 ft.² /min (area covered/min)

3. Convert ft.² /min to acres per min.

2653 ft.²/min * 1 acre/43,560 ft.²= **0.061 acre/min.**

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App. Rate = Flow Rate / Land Rate

gal./acre= 7.25 gal/min / .061 ac./min

@ 100 psi with noted nozzle configuration

@ 3.35 mph, 9 ft. swath

= 118 gal./acre

This is the application rate, the spray volume per acre.

But how much pesticide (a.i.) goes in the tank?

The label specifies the amount of pesticide, typically “per acre”

SUPPLEMENTAL LABEL

NICHINO AMERICA, INC. | **GROUP** | **16** | INSECTICIDE

APPLAUD® 70DF INSECT GROWTH REGULATOR
For Use on Grapes in California and Arizona Only

EPA Reg. No. 71711-21

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

This labeling and the EPA approved container label must be in the possession of the user at the time of application.

New directions for use appear on this supplemental labeling that do not appear on the Section 3 container label. This supplemental label supersedes any previously approved supplemental label for use in grapes.

NOTICE: Before using this product, read the First Aid, Precautionary Statements, Conditions of Sale and Warranty, and complete Directions for Use found on the container labeling. All applicable directions, restrictions, and precautions on the EPA registered label are to be followed.

Crop	Pests Controlled	Formulated Product/A	Lbs a.i./A	Use Directions and Restrictions
Grapes	Mealybugs	24.0 oz/A (1.05 lb ai/A)	1.05 lb a.i./A	**FOR USE IN CALIFORNIA AND ARIZONA ONLY** USE RESTRICTIONS • Apply by ground application using a minimum of 50 gallons of water per acre depending on the size of the grapevine canopy. • Do not apply more than 24.0 oz (1.05 lb ai/A) per acre per growing season. • Do not apply within 30 days of harvest. RECOMMENDATIONS • **Mealybug:** Apply at the beginning of crawler emergence. • Good coverage is essential. Orient nozzles to assure good coverage. Use of a higher volume of water will assure better coverage, especially under adverse conditions, such as hot, dry weather and/or a dense canopy.

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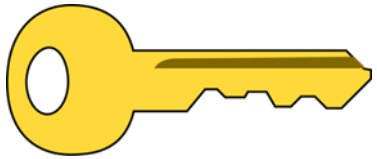
NICHINO AMERICA, INC.
4550 New Linden Hill Road, Suite 501
Wilmington, DE 19808
(302) 636-9001



For this example, the label recommended rate in grapes is **no more than 24 oz./acre per growing season to control mealybugs.** This label also states that good coverage is essential and to use higher volumes under adverse conditions or with dense canopies.

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How much pesticide in the tank?

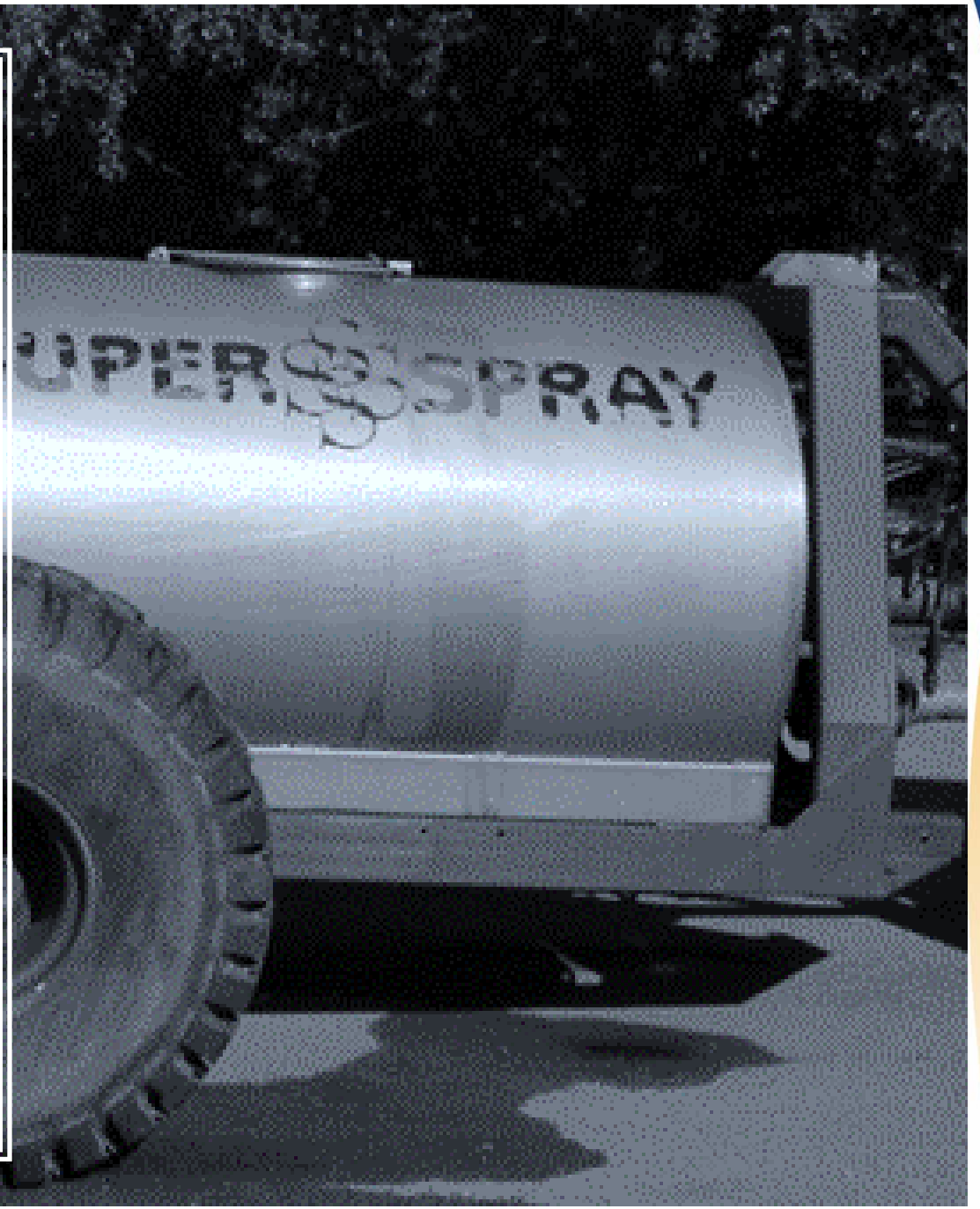
1. In our example, it is a 400 gallon tank.

2. The label for the spray job will provide a rate per acre, in our example we choose 12 oz. per acre.

3. We calibrated our sprayer to deliver 118 gallons per acre.

Number of acres per tank: 400 gallon tank/118 gallons per acre= **3.4 acres** can be sprayed with a full tank at this calibration.

Amount of pesticide per tank: 3.4 acres * 12 oz. per acre= **41 ounces** of pesticide per tank in this example.



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How do we check for coverage?

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The best gauge? $ saved; product premium

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Thank you!

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