Radial airblast sprayer optimization


MICHIGAN STATE UNIVERSITY

WASHINGTON STATE UNIVERSITY
World Class. Face to Face.

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Application Insight, LLC

Why Optimize?

Video Courtesy of Steve Castagnoli

Why does it Matter

- Applying the correct amount –
- Overspraying could harm the plant and Environment
- Underspraying could promote pest resistance and further spraying may be need.
- Chemical Costs
- Liability Risks
- Compliant with Label (and your intent)

Why does it Matter

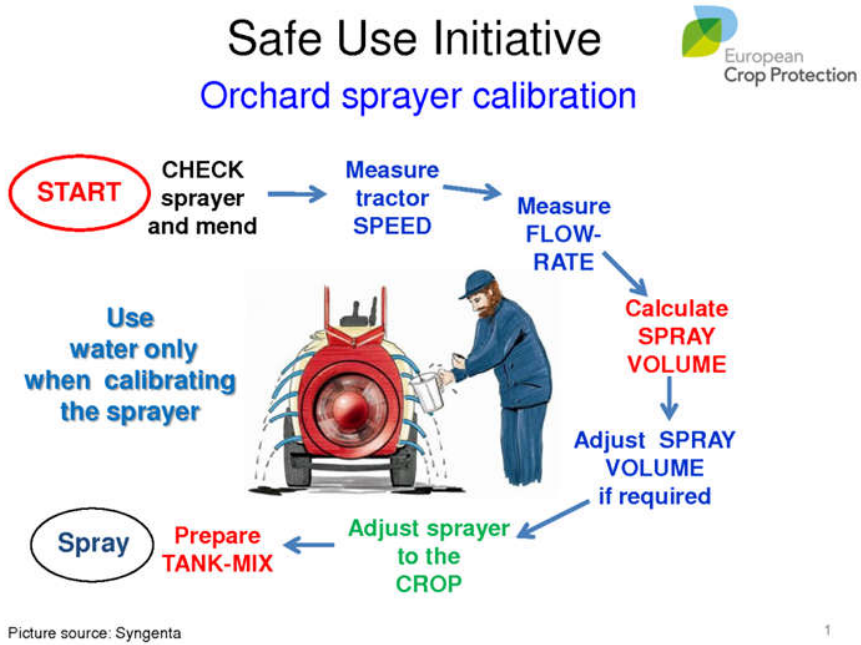
- Economic losses – could result from both over-spraying and under-spraying
- Potential fines due to law violations

Photo by Jaime Ramon

Photo by Jaime Ramon

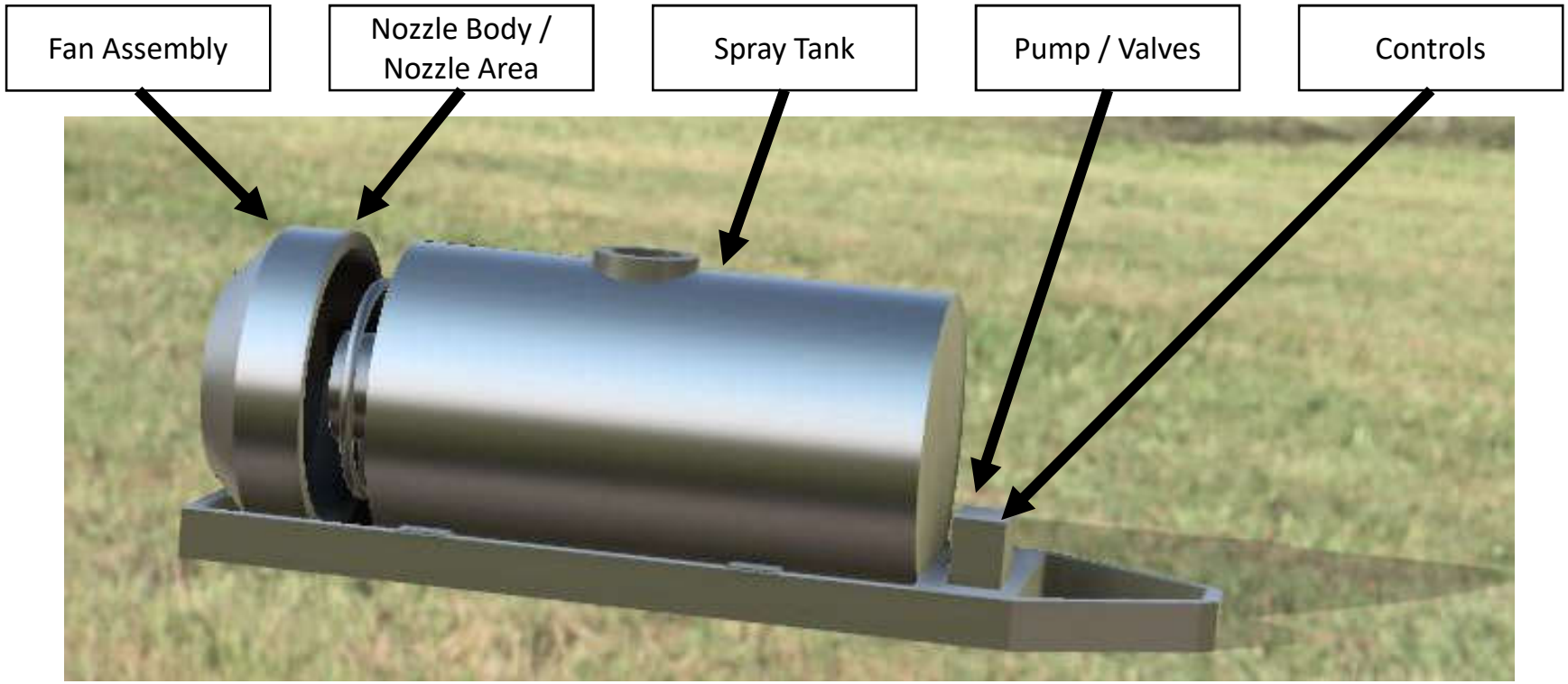
Introduction:

- Airblast sprayer parts
- Sprayer calibration
  - Speed
  - Pressure
  - Nozzles
- Airflow
  - Direction
  - Volume
- Questions and Resources



Airblast Sprayers - Intro

- The basic airblast sprayer has several simple parts

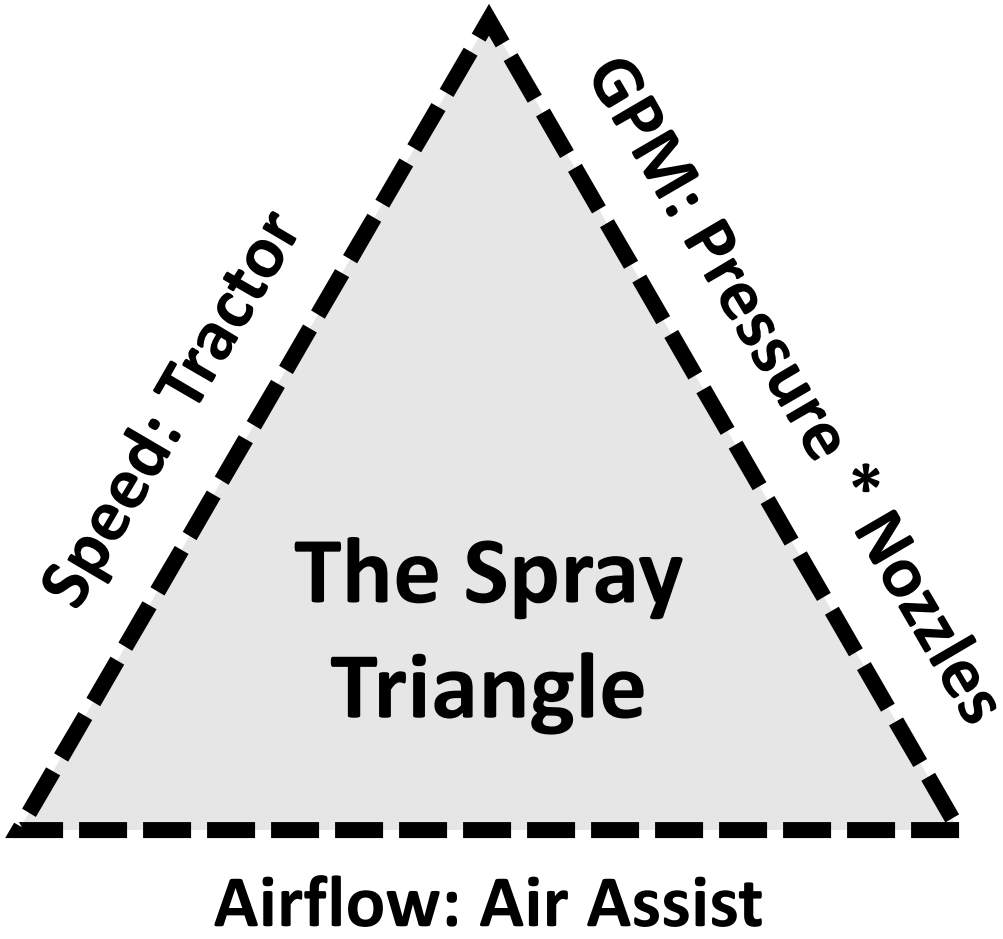


Steps to Sprayer Optimization

1. Measure/Select speed and sprayer pressure (Calibration)
2. Adjust air direction
3. Match the air volume and speed to the canopy
4. Select nozzles with desired output

Calibration Factors

- Forward speed
- Nozzle size
- Spray pressure



Tools Needed for Calibration

- Measuring tape
- Stop watch with second hand
- Water source
- Measuring cup
- Pencil, paper, calculator
  - or Phone App

Six Steps to check output

1. Calibrate in the orchard or vineyard
2. Determine tractor speed
3. Determine your Gallons per Minute
4. Select nozzle sizes
5. Measure the output
6. Make adjustments as needed.

Measuring/Optimizing Speed

Why is speed important to spraying?

- We need to move slow enough to replace the air in the canopy.
- We need fast enough so that we don’t apply more than the desired rate

1. Find a Proper Place

- Work in the vineyard or orchard (or a place representative of the fields).

- Calibrating on a hard surface, concrete surface could lead to errors of up to 15% compared to when calibrated on a soft ground.

2. Calculate Forward Speed

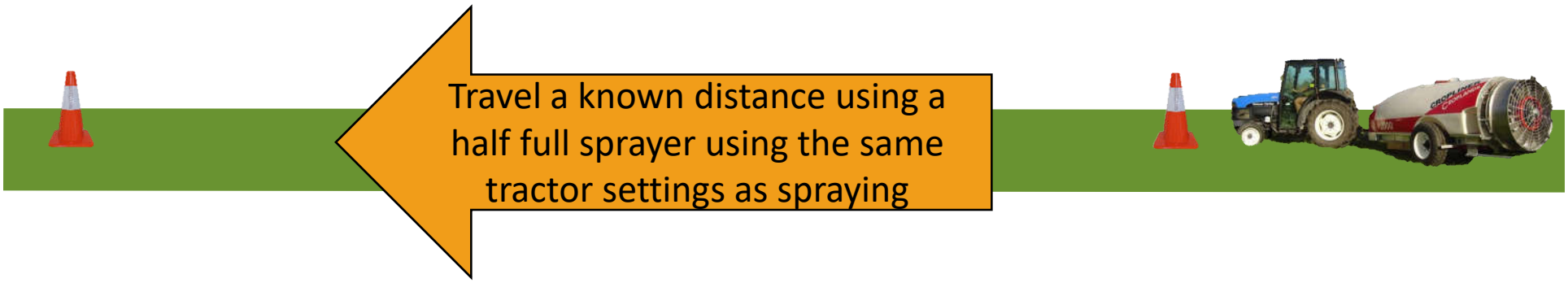
Manually:	Use a Tool:
In the field, mark a 100 foot path with two poles. With a stopwatch, record the time it takes to for the front tire of the tractor to pass from one pole to the next. Use this formula to check the speed. $$MPH = \frac{feet\ traveled\ x\ 60}{\sec traveled\ x\ 88}$$	In the field, start the gps or app. Accelerate and drive down a row until you get to the desired speed (ex. 3.0 mph). Drive that speed for 10-15 seconds and then look at the device to determine accurate speed Map My Ride iPhone App  GPS by TeeJet  eTrex hiking GPS

Measuring Speed

- How to do you measure speed?
  - Manual Method

Supplies needed:

1) ***Distance measuring device (long tape measure at least 150 feet long)***
2) ***Stop watch***
3) ***Flagging/ safety cone to mark stop and start marks***
4) ***A tractor operator and a time keeper***



Measuring Speed

- Calculating your ground speed:

Speed = Distance / Time (answer will be in feet per second)
Miles per hour = 0.68182 * Feet per second

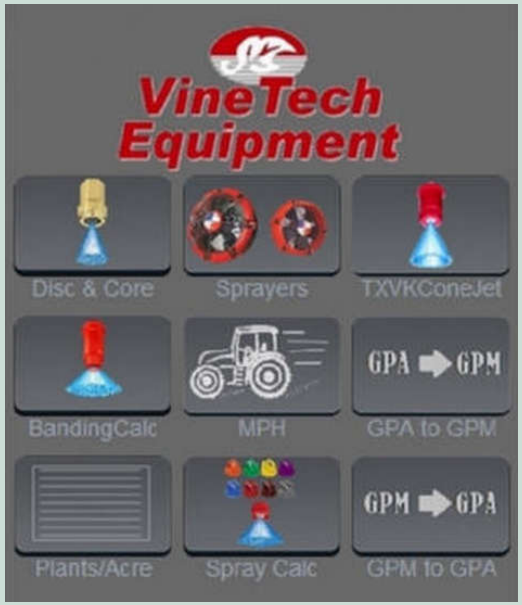
Example

- Tractor covered 150 feet in 33 seconds.

  Speed = Distance / Time => 150 feet/ 33 seconds = 4.545 Feet per second

  Miles per hour = (0.68182 * 4.545 Feet per second) = 3.098 Mph

3. Determine Gallons Per Minute

Manually	Use a Tool
Desired gallons/acre (GPA) = _____ $$\text{GPM} = \frac{\text{GPA} \times \text{mph} \times \text{row width (feet)}}{495}$$ Next divide GPM/2 for each side $$\text{GPM per side} = \frac{\text{GPM}}{2}$$	

3. Determine Gallons Per Minute

- Desired gallons/acre (GPA) = _150_

- GPM for the entire sprayer.

$$\text{GPM} = \frac{\text{GPA } (\mathbf{150}) \times \text{mph } (\mathbf{2.2}) \times \text{row width } (\mathbf{12 \text{ feet}})}{495} = \frac{3960}{495} = 8$$

- GPM per Side

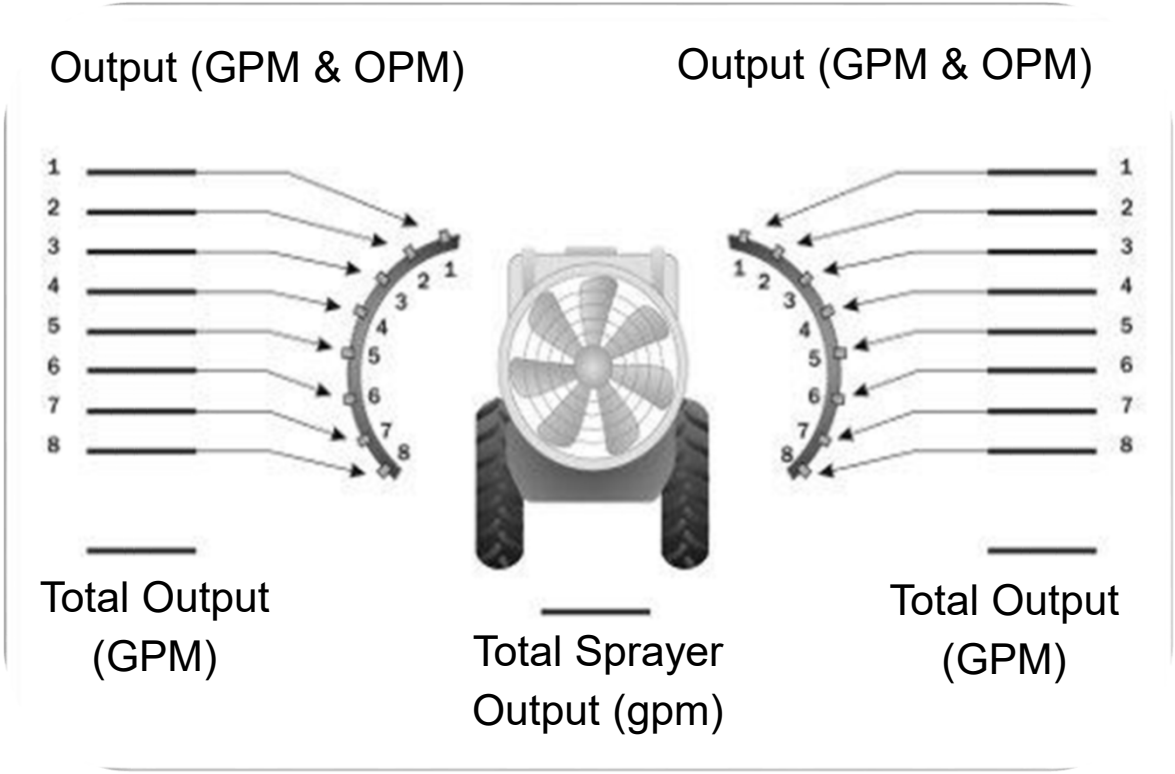
$$\text{GPMS} = \frac{\text{GPM } (\mathbf{8})}{2} = 4$$

GPM = Gallons per Minute
MPH = Miles per Hour
GPA = Gallons per Acre
GPMS = Gallons/Minute/side

- Nozzle output on one side must add up to be 4 GPM

4. Nozzle Selection – Expected Output

- Determine Pressure: _____PSI
- From nozzle catalog select nozzles with the correct output (GPM) for each nozzle and droplet size.



4. Nozzle Selection – Expected Output

TeeJet® Disc-Core Type Hollow Cone Spray Tips

Typical Assembly with Ceramic Disc and Core

TeeJet Nozzle Body | 4514-NY Slotted Strainer* | Core | Disc | CP20230 TeeJet Cap

*Use CP20229-NY gasket when 4514-NY Nylon slotted strainer is not used.

Hollow Cone Spray Pattern
Produced by Cores #13, 23, 25, 45 & 46

Hollow Cone Type Spray Tips

			GPM										Spray Angle		
			10 PSI	20 PSI	30 PSI	40 PSI	60 PSI	80 PSI	100 PSI	150 PSI	200 PSI	300 PSI	20 PSI	40 PSI	80 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°
D3	DC25	.047"	.10	.14	.17	.19	.23	.26	.29	.35	.40	.48	52°	61°	67°
D4	DC25	.063"	.15	.21	.25	.29	.35	.40	.45	.54	.62	.75	67°	74°	80°
D5	DC25	.078"	.18	.25	.30	.35	.42	.48	.54	.65	.75	.90	73°	79°	84°
D6	DC25	.094"	.23	.32	.39	.44	.54	.62	.70	.85	.97	1.19	79°	85°	89°
D7	DC25	.109"	.26	.37	.45	.52	.63	.73	.81	.98	1.18	1.37	85°	91°	93°
D8	DC25	.125"	.31	.43	.53	.61	.75	.89	.97	1.19	1.36	1.68	91°	96°	97°
D10	DC25	.156"	.38	.54	.65	.76	.93	1.07	1.21	1.48	1.71	2.1	97°	102°	103°
D12	DC25	.188"	.46	.61	.80	.93	1.15	1.32	1.47	1.81	2.09	2.55	103°	109°	112°
D14	DC25	.219"	.51	.72	.88	1.03	1.26	1.47	1.65	2.02	2.34	2.89	108°	113°	114°
D1	DC45	.031"	—	—	—	.125	.148	.170	.190	.235	.257	.310	—	22°	34°
D1.5	DC45	.036"	—	—	.14	.16	.20	.23	.25	.31	.35	.43	—	33°	44°
D2	DC45	.041"	—	.14	.18	.20	.25	.28	.32	.38	.44	.53	32°	46°	55°
D3	DC45	.047"	—	.17	.20	.23	.28	.33	.36	.44	.51	.62	40°	53°	60°
D4	DC45	.063"	.18	.25	.31	.36	.43	.50	.56	.68	.78	.95	62°	69°	72°
D5	DC45	.078"	.23	.32	.39	.45	.55	.64	.71	.86	.99	1.22	67°	73°	76°

CP26277-1-NY
Quick TeeJet® Cap
For ceramic disc and core.
See page 63 for ordering information.

How to order:
To order orifice disc only, specify disc number and material.
Examples:

DCER-2	–	Ceramic
D2	–	Hardened Stainless Steel
DE-2	–	Stainless Steel
DVP-2	–	Polymer

To order core only, specify core number and material.

Pull out the catalog!

5. Checking for Calibration Accuracy

- Test water output for each nozzle
- Add output of each nozzle for a total output and compare with calculated amount
- If not using a Flow meter will need to calculate ounces

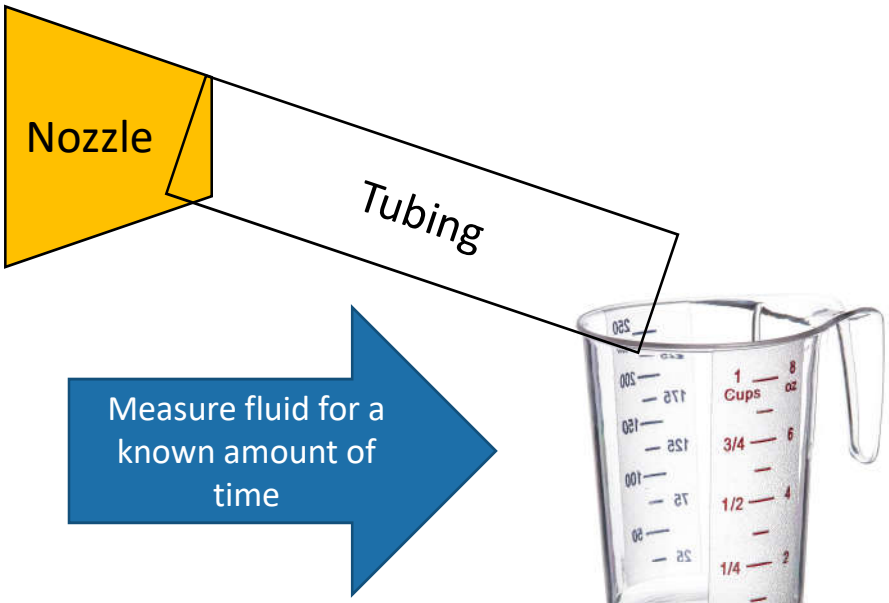
$$\text{Expected output per nozzle (OPM)} = \text{GPM per nozzle} \times 128$$

Nozzles – Fluid Flow

- How much fluid is coming out of the nozzles?

Supplies needed:

1) ***Collection device (large measuring cup)***
2) ***Pipe / rubber fitting that goes over the Nozzle***
3) ***Stop watch***
4) ***A tractor operator and a time keeper***



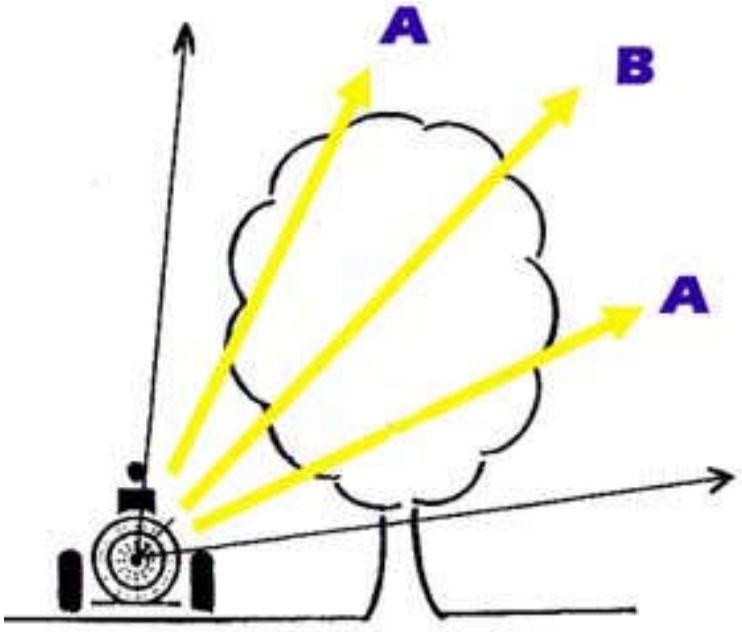
6. Adjustments - Calibration for Speed and Volume is just the beginning!

- Optimization
- Distribute spray based on your tree shape, size and time of the year.

Airflow

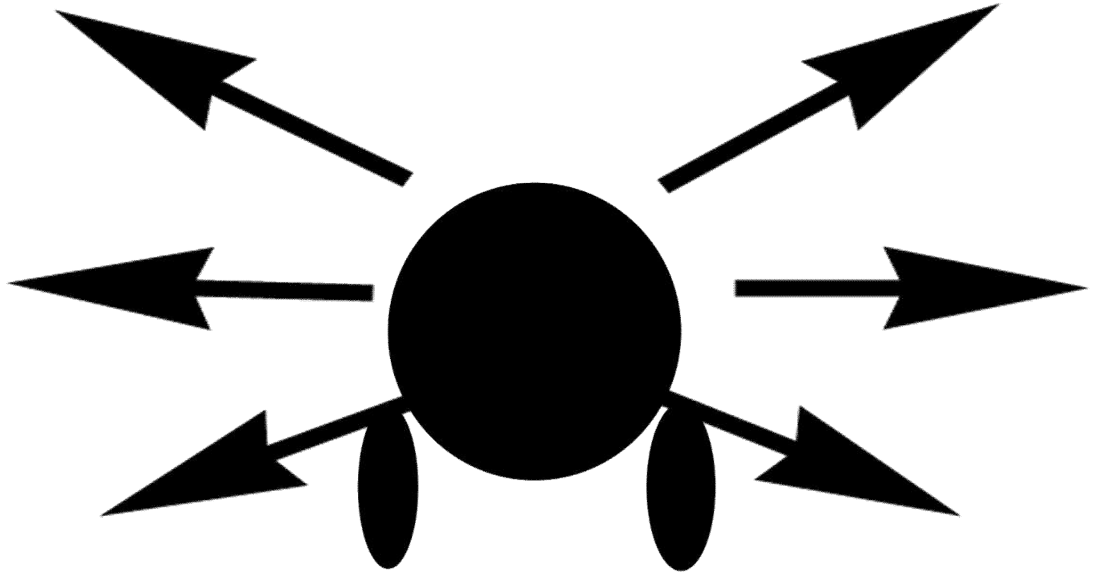
Air moves atomized spray material from the machine to the target

Air flow controls the height at which you apply material and is a major contributor to spray drift



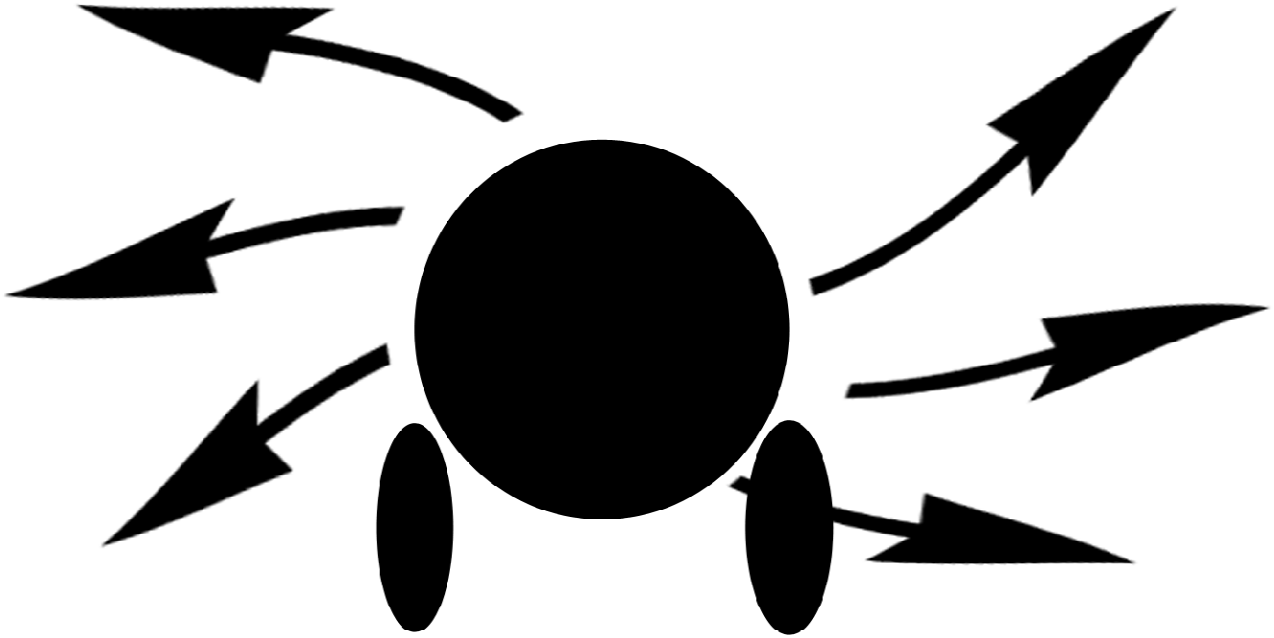
http://county.wsu.edu/chelan-douglas/agriculture/treefruit/Pages/Air-Blast_Sprayer.aspx

What we think a sprayer does



What a typical airblast sprayer actually does

- Air curves with rotation of fan!



Optimizing airflow

- Optimizing air flow is best done in the target crop canopy.

- Step one: where is your fan blowing?
- Step two: is product catching in the canopy?
- Step three: how much air passes through the canopy?

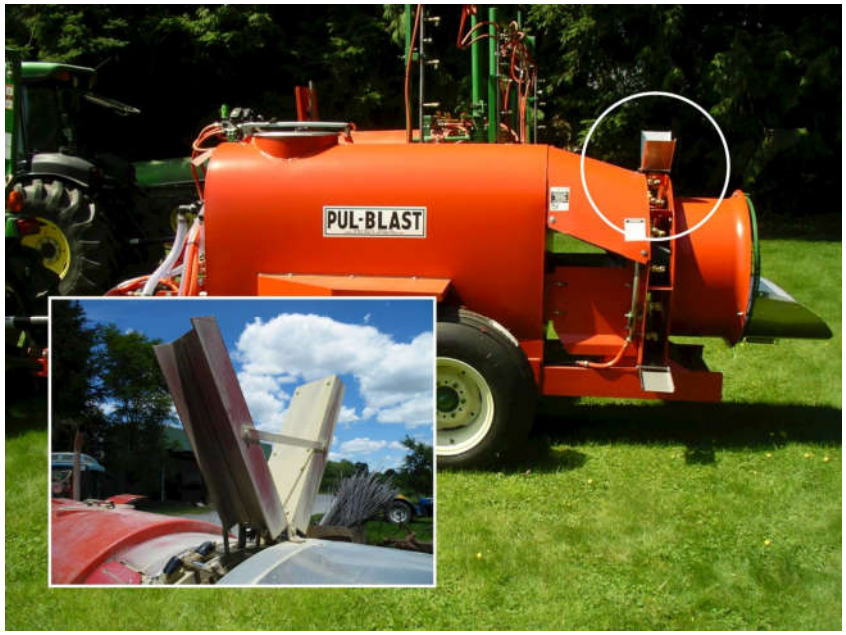
Supplies needed:

1) Flagging tape

2) Water Sensitive Papers

3) A tractor operator and a observer

Optimizing airflow

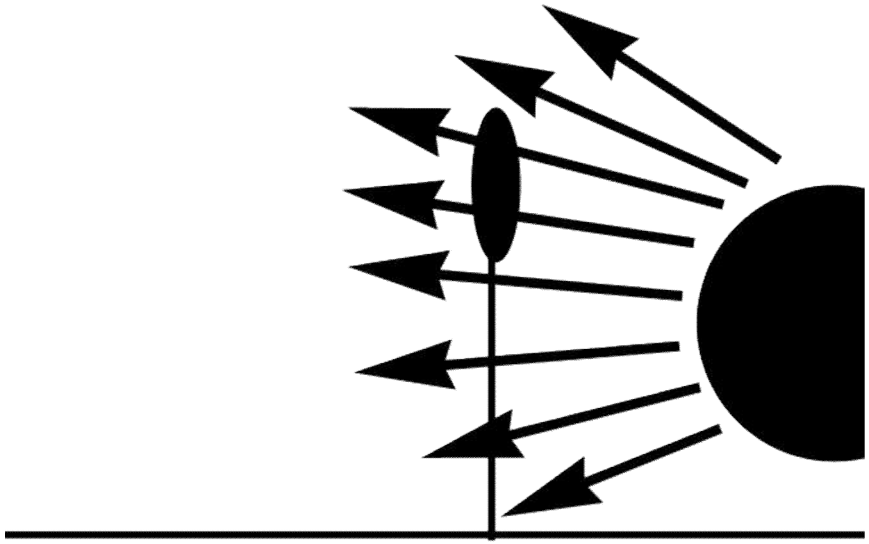


- Step one: where is your fan blowing?
  - Use fins to modify airflow
  - Turn off nozzles that are not pointed at the target!

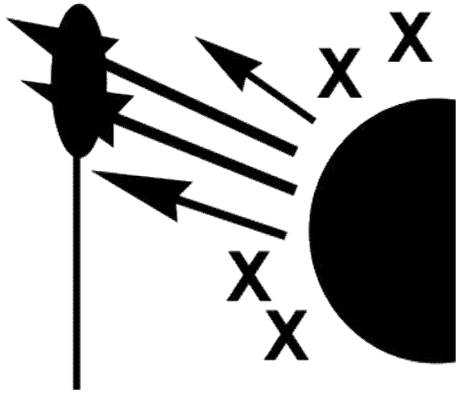
Supplies needed:
1) Flagging tape
2) Wrenches
3) A tractor operator and a observer

A properly targeted sprayer….

Top: unadjusted
Sprayer
High loss to
Ground and drift

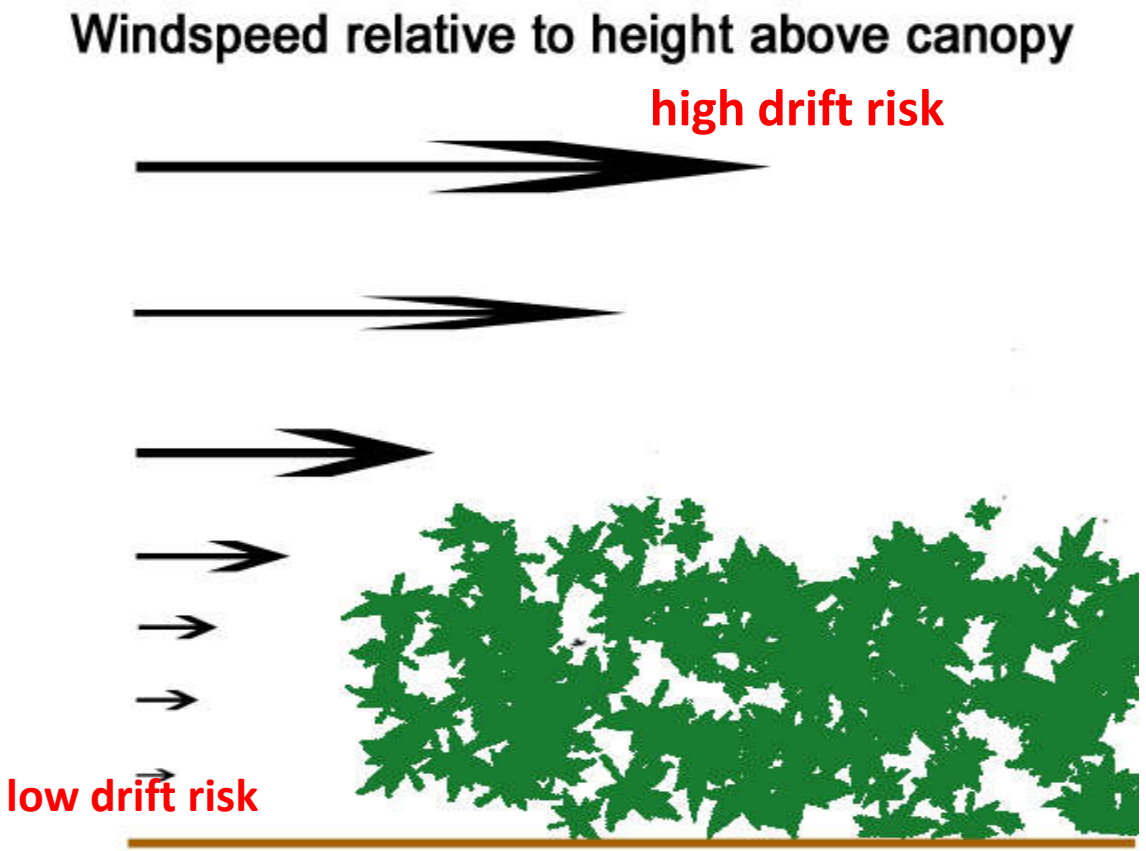


Bottom: nozzles
turned of if not
aimed at canopy, total
spray volume reduced

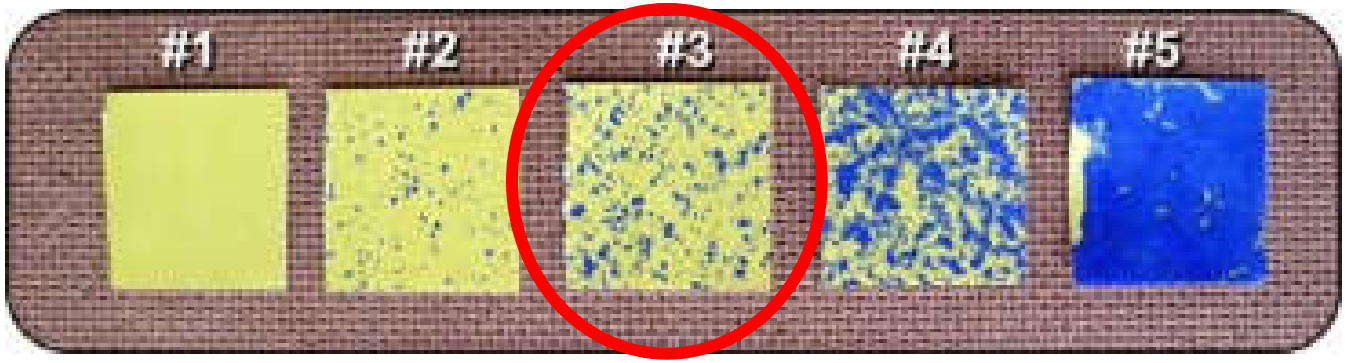


Wind & Canopy

Where your spray release point is, affects drift risk



Optimizing airflow



Supplies needed:
1) Water Sensitive Papers
2) A tractor operator and a observer

- Step two: is product catching in the canopy?
  - Place Water Sensitive Papers in the canopy
  - Evaluate after one pass

Optimizing airflow

- Step three: how much air passes through the canopy?
  - Attach flagging to outside edge of canopy

Supplies needed:

1) Flagging

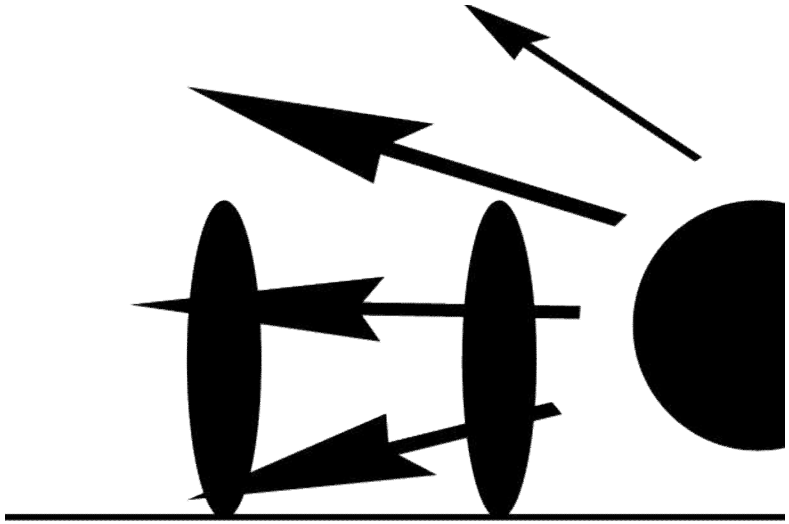
2) A tractor operator and a observer

Modifying Air Volume

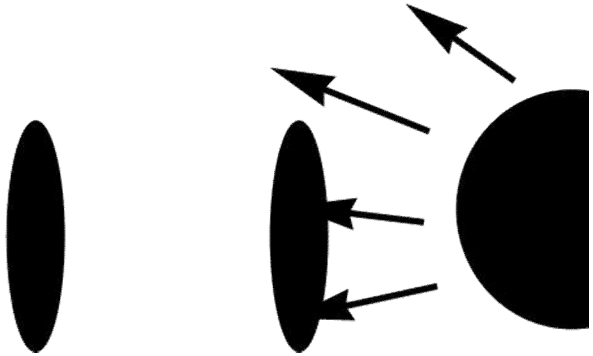
- Ribbons blow straight out:
  - too much air
  - Solutions: reduce fan gear, drive faster,
  - plywood “donut”, cloth shroud,
- Ribbon doesn’t move:
  - too little air
  - Solutions: drive slower, increase rpm or fan gear

Air flow and Thin Canopies

Top: sprayer with high air, poor targeting, high losses



Bottom: air reduced, spray and drift contained

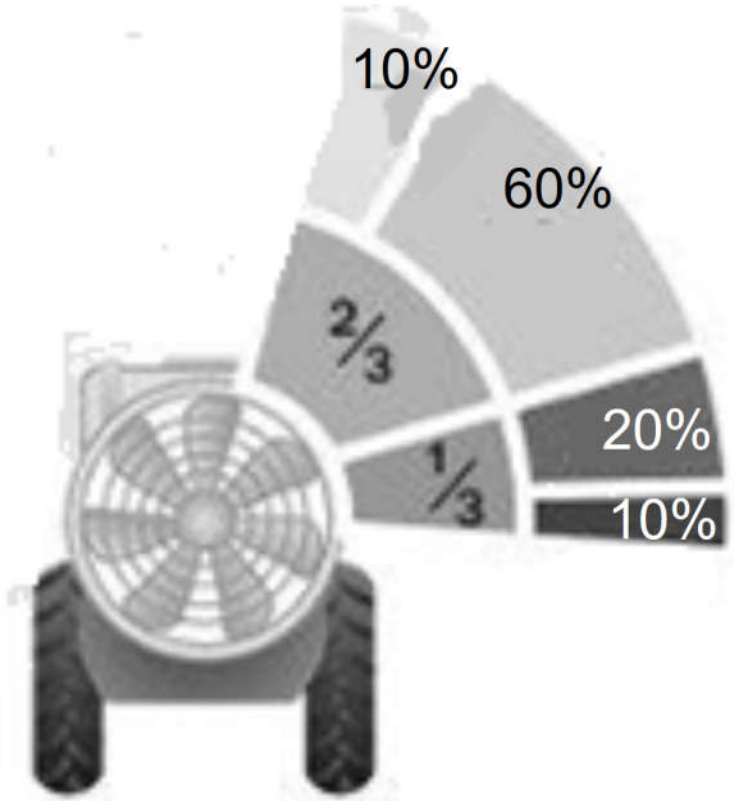


4. Select Nozzles and Desired Output

- Let's assume
  - 200 GPA, 16' Rows, and 3 mph
  - pressure=200PSI
- 7 nozzles per side remain open after step 2 and 3
- GPMS = 9.70 GPM

4. Select Nozzles and Desired Output

- Choose nozzles by density/structure of canopy zones



10% N1=
60% N2=
N3=
N4=
20% N5=
N6=
10% N7=

4. Select Nozzles and Desired Output

10% N1= 9.70*0.1 = 0.97

60% N2= 9.70*0.2 = 1.94

N3= 9.70*0.2 = 1.94

N4= 9.70*0.2 = 1.94

20% N5= 9.70*0.1 = 0.97

N6= 9.70*0.1 = 0.97

10% N7= 9.70*0.1 = 0.97

TOTAL = 9.70

Hollow Cone Type Spray Tips

			GPM														
			10 PSI	20 PSI	30 PSI	40 PSI	60 PSI	80 PSI	100 PSI	150 PSI	200 PSI	300 PSI	20 PSI	40 PSI	80 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°
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D1	DC25	.031"	–	–	.088	.101	.122	.138	.152	.185	.210	.255	–	27°	43°
D1.5	DC25	.036"	–	–	.118	.135	.162	.183	.202	.245	.280	.33	–	38°	49°
D2	DC25	.041"	–	.12	.14	.16	.19	.22	.24	.29	.34	.41	39°	51°	58°
D3	DC25	.047"	.10	.14	.17	.19	.23	.26	.29	.35	.40	.48	52°	61°	67°
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D5	DC25	.078"	.18	.25	.30	.35	.42	.48	.54	.65	.75	.90	73°	79°	84°
D6	DC25	.094"	.23	.32	.39	.44	.54	.62	.70	.85	.97	1.19	79°	85°	89°
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D8	DC25	.125"	.31	.43	.53	.61	.75	.89	.97	1.19	1.36	1.68	91°	96°	97°
D10	DC25	.156"	.38	.54	.65	.76	.93	1.07	1.21	1.48	1.71	2.1	97°	102°	103°
D12	DC25	.188"	.46	.61	.80	.93	1.15	1.32	1.47	1.81	2.09	2.55	103°	109°	112°
D14	DC25	.219"	.51	.72	.88	1.03	1.26	1.47	1.65	2.02	2.34	2.89	108°	113°	114°
D1	DC45	.031"	–	–	–	.125	.148	.170	.190	.225	.257	.310	–	22°	34°
D1.5	DC45	.036"	–	–	.14	.16	.20	.23	.25	.31	.35	.43	–	33°	44°
D2	DC45	.041"	–	.14	.18	.20	.25	.28	.32	.38	.44	.53	32°	46°	55°

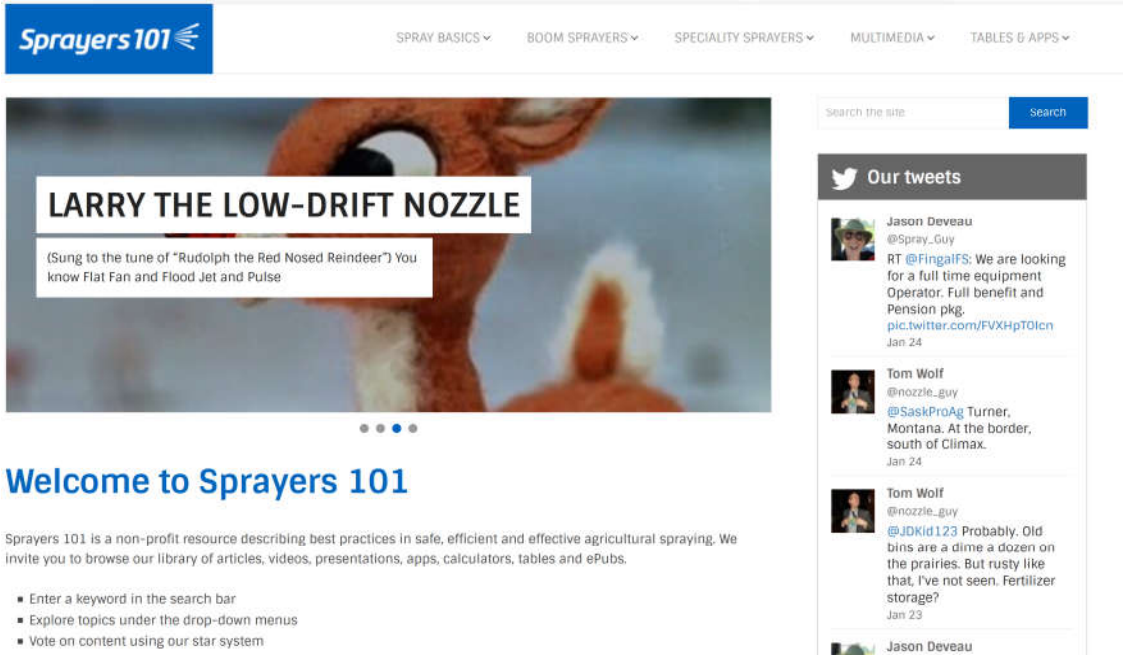
- Select nozzles.
- 200 PSI

Maintain/Update Optimization

- Speed: Manually check tractor speed after new tire installation or when using on unfamiliar terrain
- Spray volume:
  - Visually inspect nozzles and gauges for wear and leaks before each application
  - Clean nozzles with a brush made for the task: using wire will change orifice size = uncalibrated sprayer
  - Check calibration 1-2 times per year (early Spring and Fall)
  - Check guage accuracy 1-2 times per year and/or install a secondary guage
  - Replace nozzles on a regular cycle or if they are > 5% from factory GPM
- Airflow:
  - Use ribbons to evaluate where air is directed for each canopy type on your farm –mark presets for wings or choose a happy medium
  - Evaluate spray deposition and wind penetration at multiple canopy stages and adjust air volume accordingly

Additional Resources

- Airblast 101: https://sprayers101.com/airblast101/
  - A book is also available.
- Ask your local extension educator to contact the **national spray application work group** if you are interested in more educational materials (SAWG)
  - https://projects.sare.org/project-reports/ew13-022/!



Sprayer Calibration Supplies:
https://innoquestinc.com/product-category/agriculture/ag-spray/

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Project GREEEN

Michigan Cherry Committee

MICHIGAN APPLES
GREAT LAKES, GREAT FLAVORS

Michigan State Horticultural Society

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