Air Blast Sprayer

Maintenance

Calibration

Vines & Wines
Feb. 9 & 10, 2023

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Plant Science

Sprayer Performance

- A National Survey on Sprayer Performance Showed:
  - About 1 in 3 sprayers are applying pesticides at the recommended rates
  - 2/3 of sprayers were either under or over applying sprays

- Calibrated and adjusted:
  - When new (possibly)
  - Ocasionally
  - Annually

Principal of Air Blast Spraying

- To completely replace air in canopy of vines with pesticide-laden air from the sprayer
- The pump injects the spray solution into the air stream generated by the fan.
- The air stream further breaks down spray droplet size and delivers them to the fruits and foliage with enough force to cause them to stick to the she surface


DURAND WAYLAND

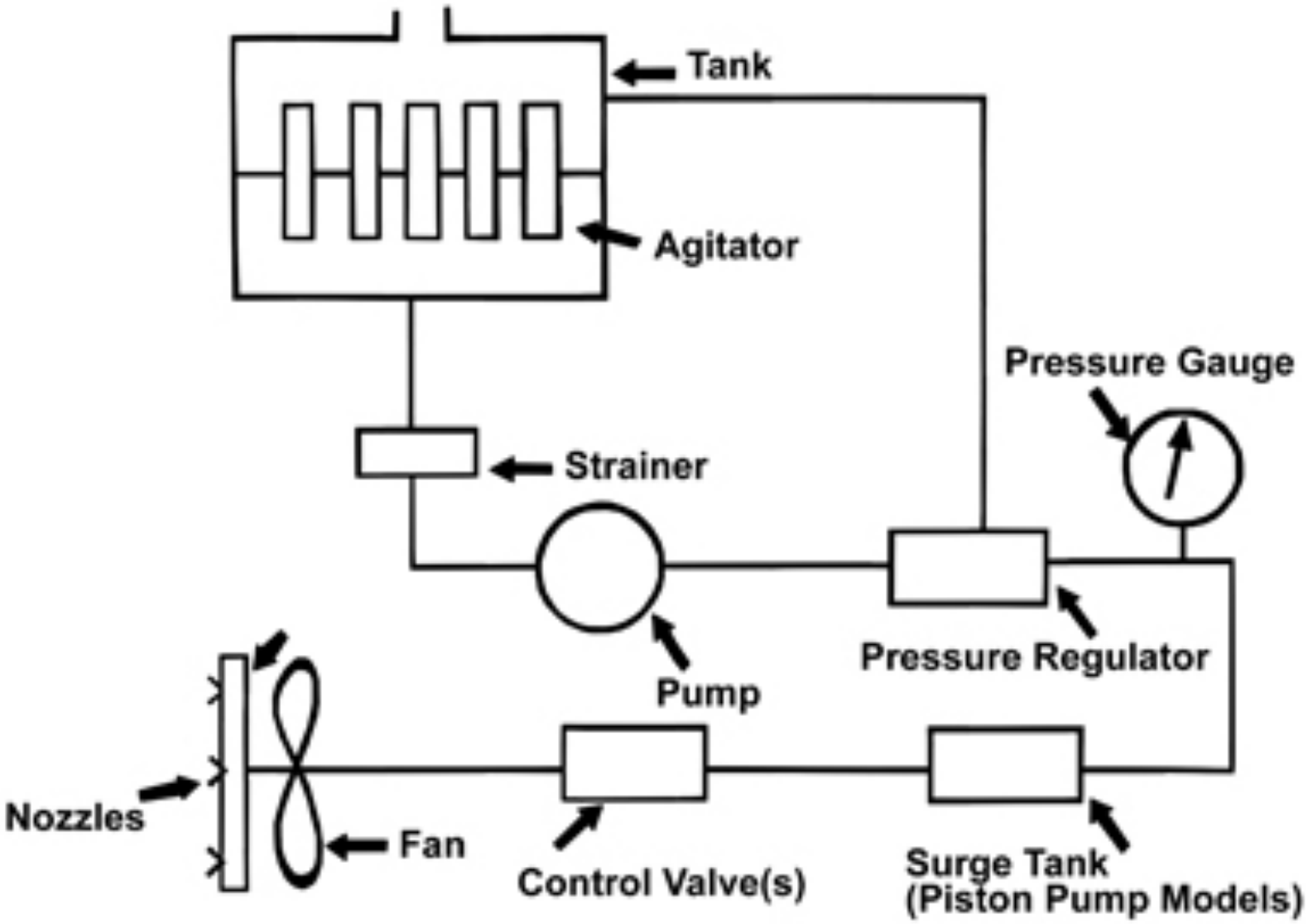

DURAND WAYLAND

Jacto Arbus 270 Air Blast Sprayer

1. PTO Shaft
2. Suction filter
3. Level indicator
4. Belts tension
5. Fan
6. Nozzle branch
7. Tank
8. Lever of the package washer
9. Clean water tank
10. Adjustable flap
11. Pressure regulator
12. Gauge
13. Chemical control
14. Pump

TECHNICAL SPECIFICATIONS	
Model	Arbus 270
Length (in)	39.36
Width (in)	41.33
Height (in)	45.27
Weight (lb)	399.03
Tank	
- Capacity (gallons)	71.33
- Material	Polyethylene (plastic)
Clean water tank for hands wash	
- Capacity (gallons)	3.17
- Material	Polyethylene (plastic)
Filter	
- Model	FVS-100
- Mesh	60
Pump	
- Model	JP-50
- Flow rte (gpm) at 540 rpm	13.20
- Maximum pressure (kgf/cm² - psi)	28 - 400
- Power consumpion (HP) at 400 psi	3.2
Nozzle holder	
- Model	With valve
- Quantity	10
- Nozzle model	JA-2
- Maximum pressure (kgf/cm² - psi)	14 - 200
Pressure gauge	Glycerin-filled
Filler unit (OPTIONAL)	
- Model	EJ-250
Level indicator	Hose attached to tank
Agitator	With hydraulic return
Working speed	From 1.5 to 4 mph

Basic Components of an Air Blast Sprayer



Pump

- Depending on the type of sprayer, several types of pumps are used on air blast sprayers. All of them need to be capable of handling wettable powders as well as liquid material, generating high pressures and moving larger amounts of spray solution at a constant rate and pressure.
  - Centrifugal –move high volumes of liquid at low to medium pressures, simpler design, requires less horsepower
  - Diaphragm – higher pressures than centrifugal, requires higher horsepower to generate higher pressures
  - Piston – handles higher pressures than diaphragm

Pump

PUMP

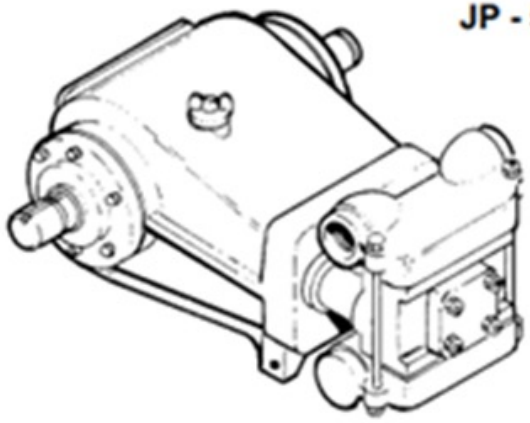
The pumps mounted to JACTO sprayers have flow rate ranging from 10.03 to 79.25 gallons per minute.

PUMP MODEL	FOW RATE (gpm)	MAXIMUM WORKING PRESSURE	
		psi	kgf/cm²
JP - 402	10.03	300	21
JP - 50	13.20	500	35
JP - 75	19.81	500	35
JP - 100	26.41	500	35
JP - 150	39.62	500	35
JP - 300	79.25	500	35

The ceramic liners ensure greater resistance to abrasion and agrochemicals' action.

Piston cup replacement becomes easier by removing the head assembly in a quick and simple operation with no need to remove the pump.

JP - 50



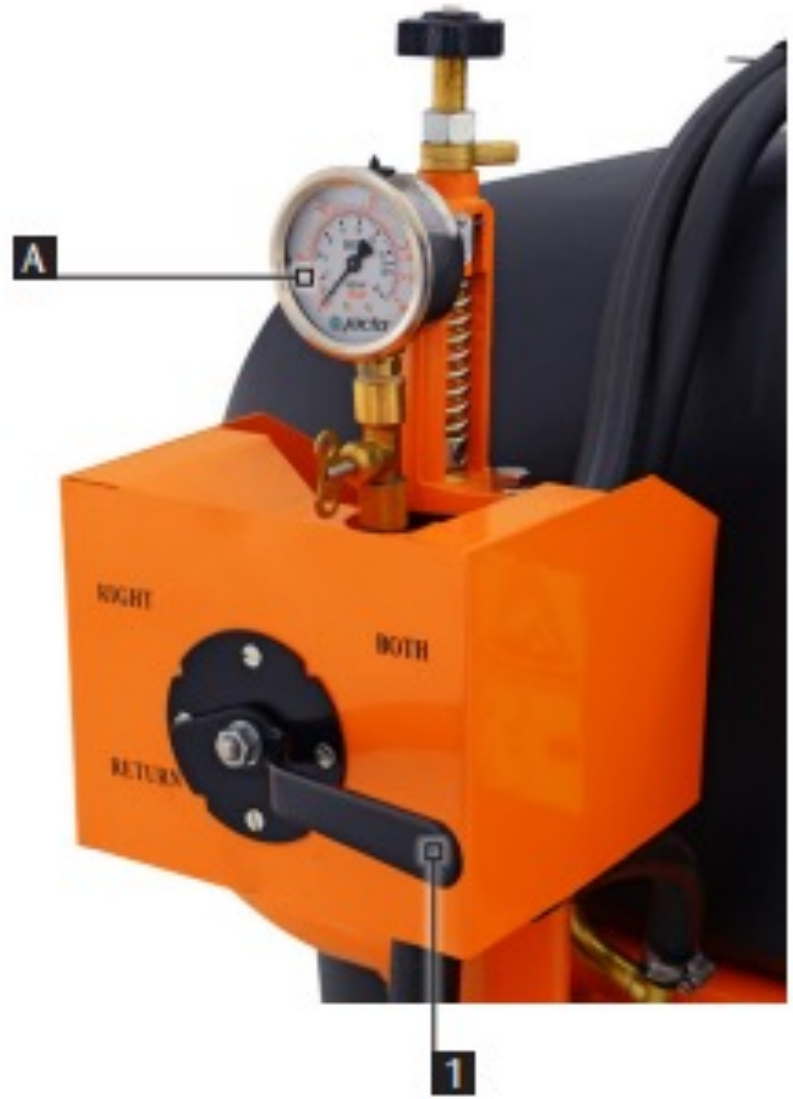
Pressure regulator

- The pressure regulator control provides adjustments ranging up to 28 kgf/cm² (400 psi), shown by the pressure gauge (A).

- The lever (1) turns on and off the chemical flow to both sides or to one only, making the spraying easier and with less waste of agrochemicals.

ATTENTION!

In order to ensure longer life of the pressure gauge, close lever (1) after regulating the sprayer, thus releasing the pressure, and close the pressure gauge valve.

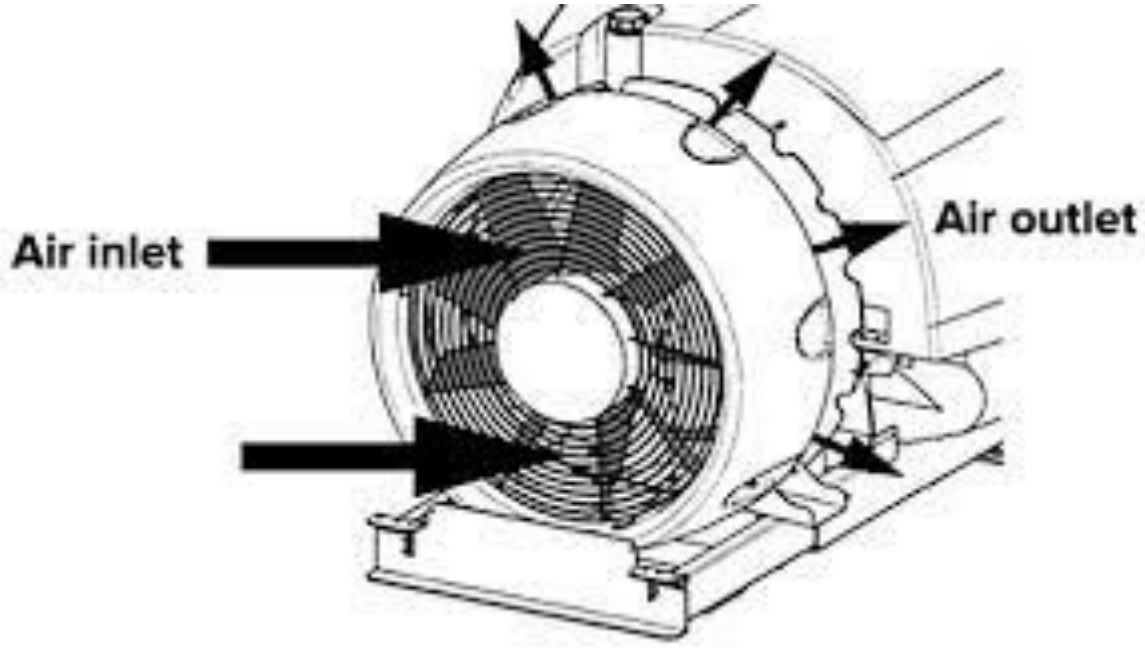


Agitator

- Types of agitation:
  - **Bypass** - excess spray material is returned to the tank by a pressure relief or other design valve, **pros** - works well for basic herbicide applications and is cost effective, **cons -** fluid is returned to the tank at low to moderate pressure that may not keep wettable powders in suspension, pump must be large enough to devote 5 to 10% of its capacity to agitation.
  - **Mechanical** – shaft with paddles, usually driven by an auxillary shaft from the pump, **pros –** consistency (as long as pump is running, agitator is turning), **cons –** moving parts
  - **Jet Agitation** - a pressure line, (not bypass), that returns product to the tank and usually through some type of jet agitation nozzle, depending on the pump and nozzle this form of agitation can be more effective than the mechanical type as long as your system has adequate volume for a second pressure line.

Fan

- Needs to generate sufficient discharge volume to:
  - Break down droplet size (smaller droplets = better coverage)
    - Air speeds in excess of 100 mph is common
  - Deliver spray droplets to the target (leaves & fruit) with enough force to cause them to adhere to the target
  - Discharge enough air to displace the air within the tree canopy with spray-laden air within a realistic time



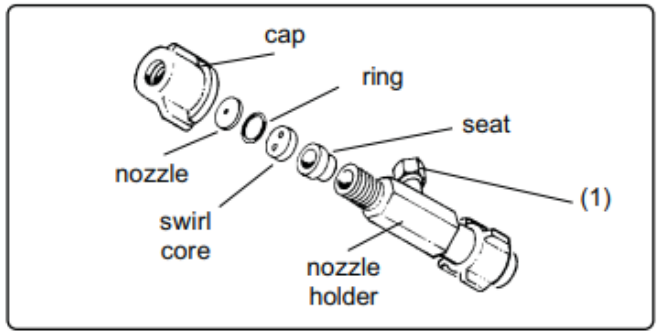
NOZZLES

The nozzles have the job to generate droplets and distribute them uniformly over the surface being sprayed.

Flow, angle and droplet sizes vary according to working pressure. Operating with pressure over that recommended by the manufacturer will decrease the nozzles' life.

This sprayer is equipped with alumina (ceramic) nozzles, very resistant to wear and to chemical action, and mounted as shown in the figures below.

NOZZLE HOLDER WITH VALVE

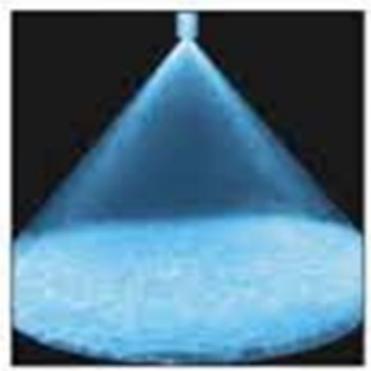


The nozzle holders with valve can be adjusted to desired angle and can be shut off individually.

NOTE: To adjust the nozzle, loosen the nut (1), set it in the desired position and retighten the nut.

ATTENTION: Do not overtighten the nut.

Hollow cone



solid cone

flat fan

DOUBLE NOZZLE HOLDER (OPTIONAL)

DIRECTING THE NOZZLE

Loosen the nut (1) and set the desired nozzle at the mark (A) existing on the nozzle body.

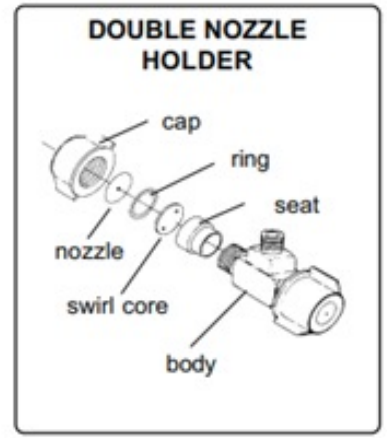
NOTE: This mark indicates the spray direction. So the nozzle at this mark is turned on.

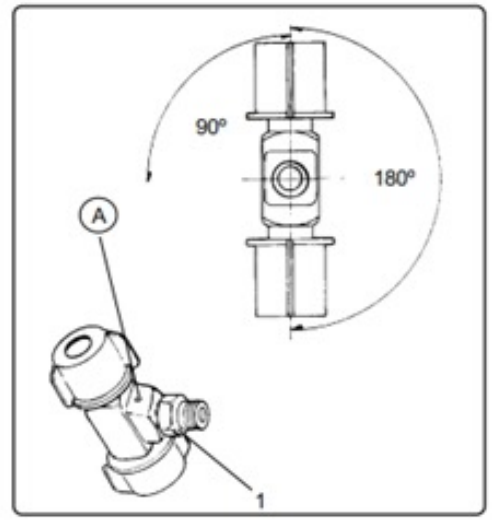
CHANGING THE SPRAY VOLUME

With a simple 180° turn of the nozzle holder it is possible to turn off one nozzle and turn on the other.

SHUTTING THE FLOW

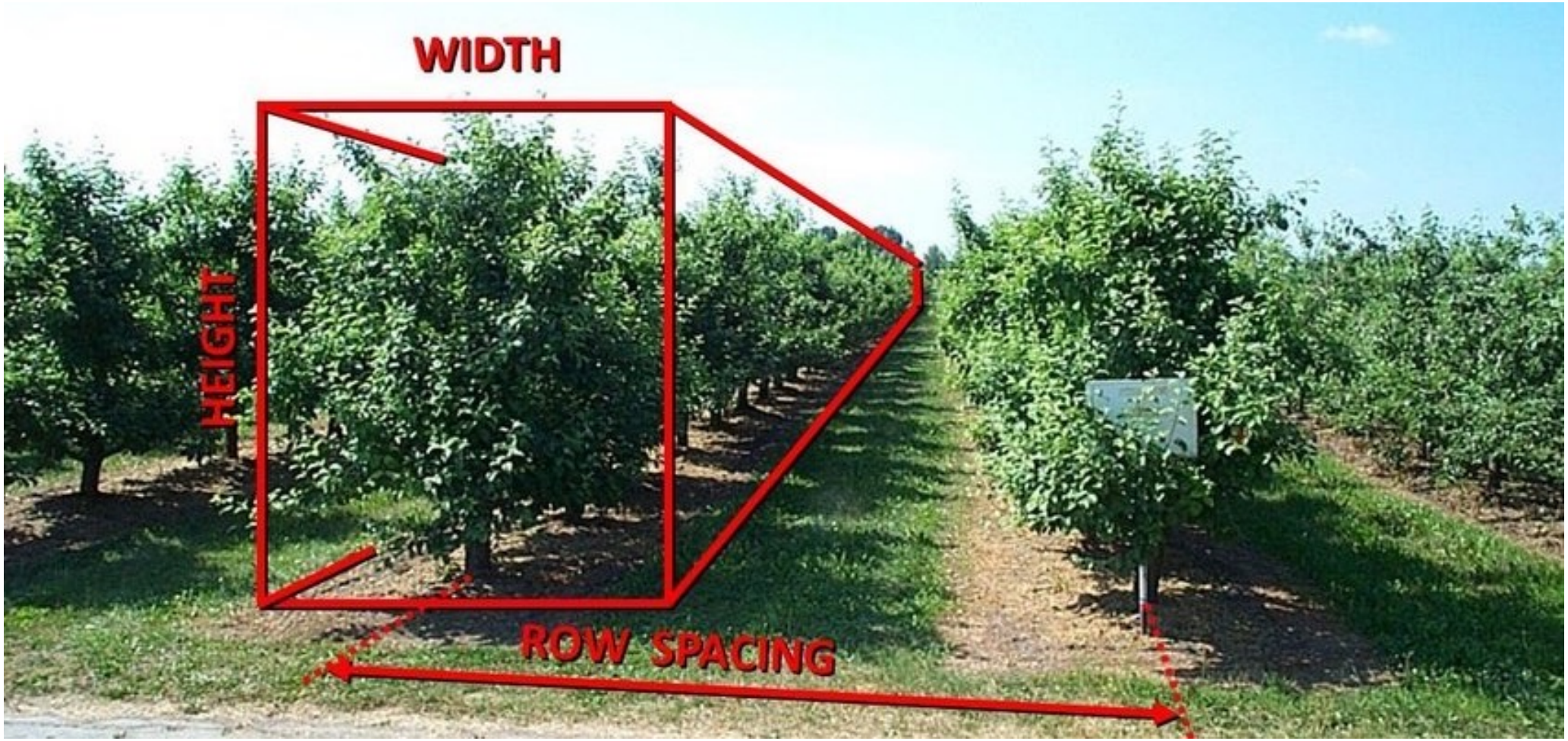
Just give the nozzle holder a 90° turn in relation to the mark (A) and the flow will be turned off.





Tree Row Volume Calculations

$$\frac{\text{Tree Height X Tree Width X 43,560 X 0.7}}{\text{Between Row Spacing X 1,000}}$$



Leaf Wall Area may be used in vineyards instead of Tree Row Volume

CHOOSING THE IDEAL TRACTOR

PROCEDURES

Different working conditions lead us to adopt the following criterion for choosing the tractor that will drive the Arbus 270 line sprayers.

- Check the sprayer weight on the identification plate.
- Check the tank capacity.
- Check in the specifications table the total power consumption of the sprayer at the PTO.

Example:
Sprayer weight = 399.03 lb
Tank capacity =71.33 gallons
Total power consumption = 11.9 HP

- Total power consumption:
  - Pump ---------- 3.2 hp
  - Fan (position A) ---- 8.7 hp

  Total ---------- 11.9 hp

CHOOSING THE TRACTOR CONSIDERING THE POWER CONSUMPTION AND THE LOAD TO BE TRANSPORTED

1st - POWER CONSUMPTION
The tractor should have power (HP) at least 90% higher than the power required to run the sprayer.
Ex.: Power required by the sprayer = 11.9 HP
Minimum tractor nominal power = 22.6 HP

2nd - LOAD TO BE TRANSPORTED
The tractor gross weight should be at least equal to the sprayer gross weight (sprayer net weight plus full tank weight).
Ex: Sprayer net weight = 399.03 lb
Filled up tank = approximately 595.24 lb (71.33 gallons tank)
Tractor gross weight = 994.27 lb or more

ATTENTION
In this case the recommended tractor should have minimal nominal power of 22.6 HP and weigh at least gross 994.27 lb.

FAN

SPECIFICATIONS	ARBUS 270
Fan diameter (in)	24.21
Pulley diameter (in)	3.14
Rotation (rpm)	2,000

PERFORMANCE	PLASTIC BLADES POSITION	
	*A	B
Air speed (mph)	83.5	74.5
Air volume (ft³/s)	241.55	216.48
Power consumption (HP)	8.7	6.3

*This sprayer i shipped with the blades set in the position "A".

Total power consumption:

Pump ... . 3.2 HP

Fan **(position A)** ..... 8.7 HP

TOTAL ..... 11.9 HP

	Blade Position	
Air Volume	A	B
ft³/second	241.55	216.48
ft³/minute	14,493	12,989

Is the Sprayer Up To the Job?

- Tractor speed (88 ft/min = 1 mph)
  - 2 mph = 176 ft. min
  - 3 mph = 264 ft./min
  - 4 mph = 352 ft/min

ft^3 canopy passed per minute

	Sprayer discharge – blade position A	Vineyard	Orchard
2 mph	14,493		14,080
3 mph	14,493	3,168	21,120
4 mph	14,493	4,224	28,160

Vineyard:

Rows 10 ft. apart

Vines 8 ft. apart in the row

Canopy height 6 ft.

Canopy width 2 ft.

Semi-dwarf apple orchard:

Rows 16 ft. apart

Trees 8 ft. apart in the row

Limb spread on a tree – 8 ft.

Tree height 10 ft.

Tree Row Volume

Used to:

1. Determine the volume of tree (vine) canopy on an acre of orchard (vineyard)
2. Dilute application water rate needed to effectively spray that orchard (vineyard)

Step 1: 43,560 ft^2/acre ÷ 10 (distance between rows) = 4,356 ft. of row/acre

Step 2: 4,356 ft. of row/A X 6 ft. (canopy height) X 2 ft. (canopy width) = 52,272 ft^3 of foliage/acre

Step 3: 0.85 canopy density adjustment

Step 4: 52,272 ft^3 foliage/acre X 0.85 (canopy density rating) ÷ 1,000 ft^3 = 44.43 gallons per acre (GPA) dilute spray application

Step 5: 44.43 GPA dilute X 0.70 (adjustment from "runoff" to "pesticide dilute" = 31 GPA

Step 6: Converting from dilute to 3X concentration

Dilute pesticide TRV gallonage ÷ Concentrate rate = 31 gal/acre ÷ 3 = 10.3 GPA

Sprayer Maintenance

- Tire pressure of tractor and sprayer
- PTO speed – pump speed, fan speed
- Hoses – check for cracks, splits
- Belts: condition, tension
- All filters, strainers, screens (clean or replace)
- Nozzles – clean, check to see if they are proper size and type
    - Replace if necessary

Setting up an air-blast sprayer for proper sprayer calibration & operation

- Inspect equipment
- Adjust air stream
- Adjust spray pressure
- Select spray volume
- Measure ground speed
- Calculate the required output per side
- Select nozzle size
- Measure delivery rates
- Adjust sprayer output

Before Calibration:

- Run sprayer, inspect for leaks, make sure all vital parts are functioning correctly and that nozzles are in good shape
  - Clean nozzles
  - Observe spray pattern from each nozzle before calibration
  - Check flow rate at each nozzle for at least 30 seconds
    - Replace nozzle if needed (if old nozzle has a flow rate 10% greater than a new one)

- 2 key measurements needed
  - Actual ground speed
  - Nozzle flow rate

- 3 things needed to take sprayer calibration measurements:
  - Timer or stopwatch
  - Measuring tape
  - Measuring cup graduated in ounces

Determining Ground Speed

- Forward speed must be slow enough to:
  - allow the air stream to completely replace air within the canopy with spray-laden air from the sprayer,
  - but not so slow that excessive blow through occurs
- Choice of speed depends on:
  - Plant size & spacing
  - Density of foliage (canopy density increases as the growing season progresses)
  - Air stream speed
  - Air volume discharge

To Measure Forward Speed:

- Mark of a test strip 200 feet long in an area representative of typical field driving
- Fill sprayer tank about half full of water (to represent an average load)
- Select gear and set tachometer @ 540 rpm pto speed
- Engage fan
- Attain & maintain forward speed before entering test strip
  - Measure time to traverse strip (in seconds)
  - Repeat several times for each gear selection to determine a realistic time
- Calculate forward speed:
  - Forward speed (mph) = $\frac{\text{total distance traveled (feet) X 0.68}}{\text{total time required (seconds)}}$

Steps in Calibrating an Air-Blast Sprayer

5. Calculate travel speed as follows:

Travel speed (mph) = distance (feet) ÷ travel time (seconds) X 0.68

Example:

travel distance = 200 ft.

time to cover measured course = 40 seconds

0.68 is the constant used to convert feet per second to miles per hour

Travel speed = (200 ft. ÷ 40 seconds) X 0.68 = **3.4 mph**

Inspect with the sprayer operating

- Fill tank about ½ full of clean water
- Start pump & set tractor speed for correct pto speed
  - (usually 540 rpm)
- Open valve(s) to fill manifold and lines
- Begin spraying
- Once all nozzles are operating, adjust pressure regulator to the desired operating speed for the pump and spraying operations
  - Use the lowest recommended pressure to extend pump life)
- Check that each ON/OFF valve is working
- Test pressure gauges for accuracy by installing a 2nd gauge at the manifold and compare pressures
- Check agitation system
- Check for leaks

Steps in Calibrating an Air-Blast Sprayer

6. Park sprayer, run it at the pressure and rpm's to be used while spraying
   - Catch output from each nozzle in a measuring cup for a set amount of time
     - At least 30 seconds, preferably 1 minute
7. Convert output from ounces collected from each nozzle to ounces collected from each nozzle in 1 minute
   - (If 20 oz. collected in 30 sec., then 40 oz. would be collected in 1 min.
8. Convert oz/min to gal/min (128 oz = 1 gal)
   - Example: 40 oz. collected per min. = 0.3 gal per min. (40 ÷ 128 = 0.3)
9. Add gal/min. from each nozzle together to determine the actual gal/min (GPM) flow rate from all the nozzles on both sides of the sprayer

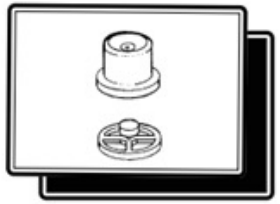
Measure delivery rate per nozzle

- Must measure the actual output per minute to calculate delivery rate
  - Need to know this in order to:
    - determine how much pesticide to add to the spray tank
    - to ensure it is within the range of the recommended spray volume

Measuring total sprayer output per minute

- Position on a level area
- Fill tank about half full to a marked point on the tank or on a measuring stick
- Start the pump operating at the pressure to be used when spraying
- Spray for a measured time (10 minutes), with both sides operating
- Measure the amount sprayed (determine the amount of water needed to refill to the original level)
- Calculate the sprayer output per minute
  - Sprayer output/min. = $\frac{\text{amount sprayed (gallons)}}{\text{time of test (minutes)}}$

HOLLOW CONE NOZZLE
HIGH QUALITY CERAMIC
SERIES JA



TECHNICAL CHARACTERISTICS

SPRAY PATTERN ..... HOLLOW CONE
SPRAY ANGLE ..... 75 TO 80 DEGREES AT 150 PSI
MANUFACTURING MATERIAL ..... **SINTERED ALUMINA**
FLOW RATE IDENTIFICATION ..... NOZZLE COLOR AND DESCRIPTION

TABLE 01 - FLOW RATE

Pressure (psi)	Nozzle model					
	JA - 1	JA-1.5	JA-2	JA-3	JA-4	JA-5
	Flow rate (gpm)					
30	0.06	0.08	0.12	0.16	0.24	0,31
45	0.07	0.10	0.14	0.20	0,29	0,36
60	0.08	0.11	0.17	0.23	0,33	0,42
90	0.10	0.14	0.20	0,28	0,39	0,51
120	0.11	0.15	0.22	0,31	0,45	0,58
150	0.13	0.17	0,26	0,35	0,50	0,64
180	0.14	0.18	0,27	0,38	0,54	0,70
210	0.145	0.20	0,29	0,41	0,58	0,75
240	0.15	0.21	0,32	0,44	0,61	0,85
270	0.16	0.22	0,33	0,46	0,63	0,90
300	0.19	0.23	0,37	0,48	0,67	0,94

NOZZLES STRAINERS: Use 50 or 60 mesh for all nozzle models.

- Pump Model JP-50
  - Flow rate @ 540 rpm – 13.2 gpm
  - Maximum pressure: 28 – 400 psi
- JA-2 Nozzle
  - 0.29 gpm/nozzle @ 210 psi
  - Using 6 nozzles (3/side)
    - = 1.74 gpm
  - Maximum pressure: 14 – 200 psi

Nozzle		Pressure (psi)	Flow rate (GPM)	Tractor speed (MPH)								
				2.5	3	4	4.5	5	5.5	6	6.5	7.5
Model	Color			Spraying volume (GPA)								
JA - 1	Blue	60	0.08	0.79	0.66	0.49	0.44	0.39	0.36	0.33	0.30	0.26
		90	0.10	0.99	0.82	0.62	0.55	0.49	0.45	0.41	0.38	0.33
		150	0.13	1.28	1.07	0.80	0.71	0.64	0.58	0.53	0.49	0.43
		210	0.14	1.38	1.15	0.87	0.77	0.69	0.63	0.58	0.53	0.46
JA - 1.5	Brown	60	0.11	1.09	0.91	0.68	0.60	0.54	0.49	0.45	0.41	0.36
		90	0.14	1.38	1.15	0.87	0.77	0.69	0.63	0.58	0.53	0.46
		150	0.17	1.68	1.40	1.05	0.93	0.84	0.76	0.70	0.64	0.56
		210	0.20	1.98	1.65	1.24	1.10	0.99	0.90	0.82	0.76	0.66
JA - 2	Black	60	0.17	1.68	1.40	1.05	0.93	0.84	0.76	0.70	0.65	0.56
		90	0.20	1.98	1.65	1.24	1.10	0.99	0.90	0.82	0.76	0.66
		150	0.26	2.57	2.14	1.60	1.43	1.29	1.17	1.07	0.99	0.86
		210	0.30	2.98	2.47	1.86	1.65	1.48	1.35	1.23	1.14	0.99
JA - 3	Orange	60	0.23	2.30	1.90	1.42	1.26	1.14	1.03	0.94	0.87	0.76
		90	0.28	2.77	2.31	1.73	1.54	1.38	1.26	1.15	1.06	0.92
		150	0.35	3.46	2.88	2.16	1.92	1.73	1.57	1.44	1.33	1.15
		210	0.41	3.96	3.38	2.54	2.25	2.03	1.84	1.69	1.56	1.35
JA - 4	Red	60	0.33	3.27	2.72	2.04	1.81	1.63	1.48	1.36	1.25	1.09
		90	0.40	3.96	3.30	2.47	2.20	1.98	1.80	1.65	1.52	1.32
		150	0.50	4.95	4.12	3.09	2.75	2.47	2.25	2.06	1.90	1.65
		210	0.59	5.84	4.87	3.65	3.24	2.92	2.65	2.43	2.24	1.94
JA - 5	Green	60	0.42	4.16	3.46	2.60	2.31	2.08	1.89	1.73	1.60	1.37
		90	0.51	5.05	4.20	3.15	2.80	2.52	2.29	2.10	1.94	1.68
		150	0.64	6.37	5.28	3.96	3.52	3.17	2.88	2.64	2.43	2.11
		210	0.75	7.42	6.19	4.64	4.12	3.71	3.37	3.09	2.85	2.47

JA-2 nozzle

- 210 psi pressure
- 0.30 gpm flow rate/nozzle

- Tractor Speed 3 mph
  - 2.47 GPA spraying vol./nozzle
  - 6 nozzles open
  - Total spraying vol. = 14.82 GPA
- Tractor Speed 4 mph
  - 1.86 GPA spraying vol./nozzle
  - Total spraying vol. = 11.16 GPA

Steps in Calibrating an Air-Blast Sprayer

10. Calculate the expected (required or intended) nozzle output in GPM
    - Base calculations on the application rate on the label or the desired rate of application (GPA), the calculated travel speed (mph) and the row spacing (ft.)using the following equation:
    - Output on both sides (GPM) = application rate (GPA) X MPH X row spacing (ft.) ÷ 495
        - 495 is a constant used to convert GPA, MPH & ft. to GPM
        - 31 gpa X 3 mph X 10 ft. row spacing ÷ 495 = 1.9 gpm
        - 31 gpa X 4 mph X 10 ft. row spacing ÷ 495 = 2.5 gpm

11. Compare the actual gal/min. nozzle flow rate determined in step 10 with the intended nozzle flow rate
    - Determine % error using the following formula:

    - % error = (actual flow rate – expected flow rate) ÷ (expected flow rate X 100)
        - 3 mph: 1.88 – 1.9 ÷ 100 = 0.0002 (0.02%)
        - 4 mph: 1.86 – 2.5 ÷ 100 = -0.0064 (-6.4%) underapplication

Steps in Calibrating an Air-Blast Sprayer

12. If the difference between the actual and the intended flow rate is greater than 5% of the intended rate, adjust sprayer to bring the error margin below 5%.
    - Adjustments might include changing spray pressure, changing travel speed, or changing both **OR** change nozzle sizes (larger or smaller nozzles of the same type

Adjust Spray Pressure

- Spray pressure affects:
  - Volume of spray output
  - Size of spray droplet

  - Increased spray pressures cause increased wear on pump, hoses & nozzles and reduces droplet size

  - Decreased spray pressure reduces sprayer output and increases droplet size, resulting in poor foliage penetration and coverage

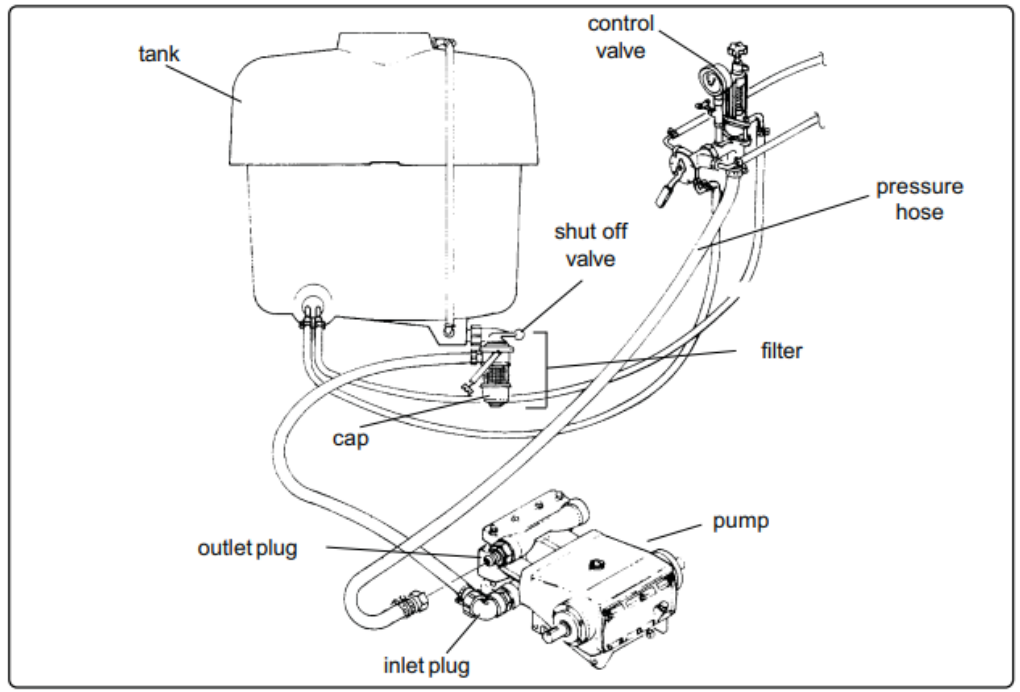
  - It takes a 4X change in pressure to get a 2X change in flow rate

Adjusting Output

- Changing nozzle sizes is the only way to make large changes in output
  - At a constant pressure, doubling the orifice size of a nozzle will increase output by 4 times
- Changing forward speed for pto-driven sprayers should only be done by changing gears, leave pto speed @ 540 rpm to keep pump and fan speeds at desired levels
- Pressure – to double sprayer output, pressure would have to be increased by a factor of 4
  - Increased nozzle & pump wear

WINTER STORAGE

ATTENTION: In regions where temperatures drop to 32 Fahrenheit or less, the water accumulated in the pump can freeze and cause serious damage.



PROCEDURES

- Empty the tank completely by removing the filter cap and opening the filter shut off valve.
- Disconnect the pressure hose from the pump or remove the plug from the valve cover.
- Run the sprayer for about 30 seconds at half speed.

NOTE: To avoid damage, do not run the sprayer over the recommended time.

- Assemble the components again in their correct place.
- Repeat this operation at the end of each daily spraying job during the winter to avoid problems in future applications.

Directing Spray from the Sprayer to the Target

1. Turn off any upper nozzles that are not putting spray into the canopy
2. Use deflector plates to direct the air stream toward the target
   - May need readjustment with time as the target size changes
3. Tie ribbons on the outside of the fan housing,
   - turn on the fan
   - watch how the ribbons are being blown
4. Adjust the angle of the deflectors to change the air pattern

Determining Air Flow

Efficient Penetration & Uniform Deposition of Spray Droplets Inside the Canopy

- Goal:
  - Adjust sprayer so the rate & volume being directed into the canopy
    - replaces the air within the canopy
    - But dies down significantly once it leaves the canopy on the far side
  - Adjust air stream characteristics (direction, air speed, & air flow rate) to make it suitable for the crop at the time of application

- To determine if there is optimum air flow through the crop canopy,
  - Tie ribbons on the opposite side of the canopy from the sprayer
  - Turn on the fan
  - Watch how ribbons move
    - Should have very little movement versus being blown out
      - Change air volume by changing fan setting and/or changing ground speed
  - Use water sensitive cards

Use of spray Sensitive Cards

“Smart” Sprayers

- Uses multiple ultrasonic or optical detectors to sense the presence or absence of trees or portions of trees to activate spray nozzles only when a target in the spray zone sensor is detected.

- Provide both environmental and economic benefits.
  - Reduced pesticide usage 15 to 40%
  - Reduced non-target orchard-floor deposition by 5 to 72%

The “Intelligent Sprayer”

- A laser guided sprayer that can:
  - Visualize the
    - Presence
    - Size
    - Shape
    - And foliage density of the target plants

And

Apply only the amount of pesticide needed (recalibrates for each tree at every spray)

Resources:

- Ozkan, Erdal. 2021. “Calibration of Orchard and Vineyard Sprayers,” (FABE-537). *Ohioline*, The Ohio State University. https://ohioline.osu.edu/factsheet/fabe-537
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