KEYS to CALIBRATION

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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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SELECT, CHANGE and INSPECT THEM REGULARLY

KNOW YOUR NOZZLES
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.
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
http://teejet.it/media/427750/cat51_spanish.pdf
Check the manufacturer’s catalog to determine the flow rate for a given nozzle(s) at a given pressure.

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

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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 | 0.046  | 0.053  | 0.059  | 0.064  | 0.069  | 0.073  | 0.077  | 0.081  | 0.089  | 0.101  | 0.113  | 0.118  | 0.123  | 0.127  | 0.132  | 0.136  | 0.140  | 0.144  | 0.148  |
| TXR800077VK | 0.062  | 0.071  | 0.079  | 0.086  | 0.093  | 0.099  | 0.105  | 0.110  | 0.120  | 0.138  | 0.146  | 0.153  | 0.160  | 0.167  | 0.180  | 0.186  | 0.192  | 0.197  | 0.203  |
| TXR80011VK  | 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  |
| TXR80013VK  | 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  |
| TXR80015VK  | 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  |
| TXR80017VK  | 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  |
| TXR80021VK  | 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  |
| TXR80028VK  | 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  |
| TXR80031VK  | 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  | 0.876  | 0.902  |
| TXR80036VK  | 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  |
| TXR80041VK  | 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  |
| TXR80049VK  | 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  |

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.
“VMD” is Volume Median Diameter. Half of the droplets are larger, half are smaller. VMD is in MICRONs.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Code</th>
<th>VMD (0.5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very fine</td>
<td>VF</td>
<td>&lt; 150</td>
</tr>
<tr>
<td>Fine</td>
<td>F</td>
<td>150 - 250</td>
</tr>
<tr>
<td>Medium</td>
<td>M</td>
<td>250 - 350</td>
</tr>
<tr>
<td>Coarse</td>
<td>C</td>
<td>350 - 450</td>
</tr>
<tr>
<td>Very coarse</td>
<td>VC</td>
<td>450 - 550</td>
</tr>
<tr>
<td>Extremely coarse</td>
<td>XC</td>
<td>&gt; 550</td>
</tr>
</tbody>
</table>

CONSIDER DRIFT THE OPPOSITE OF COVERAGE: DROPLET SIZE MATTERS!

Table 1. Movement of spray particles.

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

*American Society of Agricultural Engineers.
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

| Tip       | 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 |
|-----------|--------|--------|--------|--------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| AITX8001VK| 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   |
| AITX80015VK| 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   |
| AITX8002VK| 0.247  | 0.266  | 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   |
| AITX80025VK| 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   |
| AITX8003VK| 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   |
| AITX8004VK| 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    |

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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?)
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.
What about Venturi sprayers?
# Venturi Air Sprayer Calibration Chart

## 4 Yellow "Dial-A-Rate" Discs

<table>
<thead>
<tr>
<th>Disc Setting</th>
<th>Gallons Per Minute</th>
<th>Pressure Setting (PSI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>16</td>
<td>22</td>
</tr>
<tr>
<td>1</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>2</td>
<td>0.6</td>
<td>0.8</td>
</tr>
<tr>
<td>3</td>
<td>1.0</td>
<td>1.1</td>
</tr>
<tr>
<td>4</td>
<td>1.2</td>
<td>1.4</td>
</tr>
<tr>
<td>5</td>
<td>1.7</td>
<td>1.9</td>
</tr>
<tr>
<td>6</td>
<td>2.1</td>
<td>2.3</td>
</tr>
<tr>
<td>7</td>
<td>3.1</td>
<td>3.3</td>
</tr>
<tr>
<td>8</td>
<td>3.7</td>
<td>3.9</td>
</tr>
<tr>
<td>9</td>
<td>4.5</td>
<td>4.7</td>
</tr>
<tr>
<td>10</td>
<td>5.3</td>
<td>5.5</td>
</tr>
<tr>
<td>11</td>
<td>6.5</td>
<td>6.8</td>
</tr>
<tr>
<td>12</td>
<td>7.9</td>
<td>8.5</td>
</tr>
<tr>
<td>13</td>
<td>9.4</td>
<td>9.8</td>
</tr>
<tr>
<td>14</td>
<td>10.4</td>
<td>10.7</td>
</tr>
<tr>
<td>15</td>
<td>11.0</td>
<td>11.3</td>
</tr>
</tbody>
</table>

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

**Formula:**

\[
\text{Gallons Per Minute} = \frac{\text{Main Per Hour} \times \text{Gallons Per Acre} \times \text{Width of Area Treated}}{1009}
\]

**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.
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
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.
Application rate (gal/acre) = \textbf{Flow rate (gal/min)} \\
\textbf{Land rate (ac/min)}

This fundamental relationship works for all sprayers!
Application rate (gal/acre) = \frac{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

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.

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.
App. Rate = Flow Rate \over Land Rate

gal./acre= 7.25 \text{ gal/min} @ 100 \text{ psi with noted nozzle configuration}

.061 \text{ ac./min} @ 3.35 \text{ mph, 9 ft. swath}

= 118 \text{ 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”

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.
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.
How do we check for coverage?
Water sensitive paper is one way to check for coverage.
The best gauge? $ saved; product premium
Thank you!